Summary

During Year 4 of the project, the TransPacific Asia-US High Performance International Networking project (TransPAC) continued its collaborative and engineering activities to support international science. This report outlines collaborations, software and systems work, operational activities, and usage statistics for the project. America Connects to Asia (TransPAC) project continues its collaborative and engineering activities to support international science. Highlights of the year include hiring a new director, some additional staff changes to accommodate changing project needs, significant SDN experiments including extending the international OpenFlow capabilities by directly connecting to the JGN-X OpenFlow RISE testbed, a re-focusing on monitoring, and extended collaborations.

1. TransPAC Overview

The TransPAC project supports three circuits and a set of network services between the US West coast and Asia. In the current set up, these circuits are:

- The **TransPAC Circuit**: a 10Gbps link between Los Angeles, California, and Tokyo, Japan. This is the primary, NSF-funded circuit for the project and used for the bulk of the production project network bandwidth.
- The **JGN-X Circuit**: a 10Gbps layer-2 circuit, largely used for experiments and Software Defined Networking (SDN) trials. The Japan Gigabit Network Extension (JGN-X) project is a testbed funded by the Japanese National Institute of Information and Communications Technology (NICT) (http://www.nict.go.jp/en). This link is not supported by NSF funds. A backup routed peering connection between TransPAC and APAN also runs across this link.
- The **CERNET circuit**: a 10Gbps link between Los Angeles, California, and Beijing, China, which is only partially funded by NSF. This is a layer-3-only connection at this time.

These circuits are used in production to support a wide variety of science applications and demonstrations of advanced networking technologies.

In addition, the TransPAC award supports tool development, SDN experimental work, measurement deployments, and security activities. More information on the operations and the project can be found online at [http://noc.transpac.org/](http://noc.transpac.org/).
2. Staffing

At the beginning of the year, project staff consisted of:

- Jim Williams, Director
- Brent Sweeny, primary TransPAC senior network engineer
- John Hicks, primary network research engineer
- Scott Chevalier, primary contact for GlobalNOC support desk
- Alice Warner, administration
- George McLaughlin, Asia-Pacific network consultant (contract extended through June)
- Gabriel Iovino, REN-ISAC staff member
- Wesley Young, REN-ISAC staff member
- Doug Person, REN-ISAC staff member

Several significant staffing changes took place this year.

Jim Williams retired as the director for this project on August 30, 2013. He was replaced by Dr. Jennifer Schopf, who was hired on August 1, 2013. She has held positions at IEEE Computer Society, the US National Science Foundation (NSF), the Woods Hole Oceanographic Institution, the UK National eScience Center, Argonne National Laboratory, and Northwestern University. She began a project overview upon arrival, which is ongoing.

Starting June 1, 2013, Dale Smith was hired on as a consultant to assist with recruitment and interviewing for the new director, to assist in the transition from the old director to the new director, and to offer advice on work in Asia-Pacific and Africa. This is ongoing. His expertise will also in part make up for the loss of Eric-Jan Bose on the ACE project, who stepped down as a consultant in September 2013 for family reasons.

John Hicks began a new position with Internet2 on February 1, 2014. We are currently hiring to replace this position.

After consultations with GlobalNOC staff, Von Welch (Center for Applied CyberSecurity Research), and members of the ESnet team involved in security work, a re-evaluation of security staffing was performed, and the value contributed by the REN-ISAC staff was found lacking. They had had no direct activities related to TransPAC to report many months running, and upon consultation with them could not enumerate a work plan with Schopf. As such, Schopf terminated the contract paying REN-SAC staff members as of November 30, 2014. TransPAC will continue to receive basic REN-ISAC updates via the contract with the GlobalNOC, and if needed Welch offered staffing support for any security planning in the future.

At year’s end, project staff consisted of:

- Jennifer Schopf, Director
- Brent Sweeny, primary TransPAC senior network engineer
- Scott Chevalier, primary contact for GlobalNOC support desk
- Alice Warner, administration
- George McLaughlin, Asia-Pacific network consultant (contract extended through June)
- Dale Smith, consultant
3. Collaborations, Travel, and Training

Over the year, the group participated in many international conferences and training sessions. Quarterly reports include additional details for meetings before Dec 1, 2013. These included:

Large international meetings:
- McLaughlin attended Pragma 24 in Bangkok, Thailand in March 2013.
- Hicks, Williams, and Sweeny attended the Internet2 Members in April in Arlington VA
- Williams and McLaughlin attended the Terena meeting in Maastricht, Neterlands, in May
- Williams, Schopf, Hicks, and Smith attended the APAN36 conference in Daejon, Korea in August, 2013
- Schopf and Hicks attended SC’13 and associated workshops in Denver in November
- Schopf and Smith attended APAN37 in Bandung, Indoensia.

Smaller collaboration meetings:
- Williams participated in the Orient+ meeting in London
- Hicks attended the Chinese American Network Symposium (CANS) meeting in Hangzhou, China, August 2013
- 15-year Global NOC celebration was held at IUPUI in September
- Schopf attended a 2-day meeting with ESnet staff at Lawrence Berkeley Lab in September.
- Schopf attended a collaboration meeting with other senior members of the IU Networks group and Internet2 in Washington DC, February 2014. This meeting established roles and relationships for additional collaboration in international circuits and outreach.

Training:
- Sweeny ran the Open Flow for OIN training, Washington DC May 2013
- Hicks taught a one-day performance workshop for the InCENTRE Summer of Networking (SoN)
- Hicks assisted with PerfSONAR training for the Open Science Grid (OSG) in October 2013
- Sweeny gave an OpenFlow tutorial and hands-on training to the GlobalNOC staff in Bloomington and Indianapolis in October
- Hicks helped the NSRC with PerfSONAR training at their December 2013 meeting in Tunisia
- Sweeny assisted with the Operating Innovative Networks (OIN) training workshops in Los Angeles, sponsored by UCLA and USC on January 29-30, 2014 and at LBNL, co-sponsored by CENIC and Lawrence Berkeley National Laboratory, on February 27-28, 2014
4. Software and Systems Work

A. Tool Development

The development of new and expanded GlobalNOC tools, funded in small part by ACE, continued throughout the year. The most notable release was the next generation of the GlobalNOC’s database, DB2, which was officially launched in Spring, 2013. A new schema allows technicians to more easily view information tied into the DB and will simplify many of the steps for searching that were previously part of the Service Desk workflow.

The Brocade switch, which provides OpenFlow connectivity for TransPAC in Los Angeles underwent a major code revision. This upgrade brings it into the same version used in Internet2 AL2S and exchange points and avoids some serious bugs. The FEC improvements important to 100G circuits and available in this code are not particularly important for our 10G circuit, however.

B. Dynamic Circuits and Software Defined Networking (SDN) Activities

The TransPAC project provides Dynamic Layer 2 Network services through the OSCARS software suite. This service peers with the Internet2 ION project and the JGN-X Dynamic network facilities. Researches and scientists can interactively create a layer2 dynamic circuit between the US and Asia to transfer data.

As part of the GEC meeting in March, TransPAC staff and collaborators demonstrated stitching together a set of protoGENI testbeds with the VNode project using dynamic circuit technology over multiple domains. ProtoGENI is an NSF-funded prototype implementation and deployment of GENI, led by the Flux research group at the University of Utah (http://www.flux.utah.edu/). It is largely based on Emulab software. ProtoGENI consists of the Control Framework for GENI Cluster C, the largest set of integrated projects in GENI. More detail is available at http://groups.geni.net/geni/wiki/SpiralTwo#ControlFrameworkIntegrations. VNode is a programmable SDN testbed research project in Japan, created by collaborators from the University of Tokyo, NTT, NEC, Hitachi, Fujitsu, and KDDI.

Figure 1 shows the default and revised provisioning demonstrated at GEC. The largest contribution was a pragmatic demonstration of inter-domain connectivity using different circuit technologies, which provided an example of dynamically building a circuit between separate administrative SDN domains in order to transfer data.
Hicks supported several SDN demonstrations over the year. One for CANS, joint with Professor Jun Bi (CERN/Tsinghua University), showed the transfer of Genomics Data on Inter-domain paths set up by WE-Bridge software for CERNET-CSTNET-Internet2 SDN Peering. The setup consisted of a virtual OpenFlow switch, controller, and host. Data was transferred through the virtual switch to the virtual host in China. A more complex multi-continent SDN demo join with Dr. Martin Swany and Dr. Ezra Kissel, IU, demonstrated segmenting long application paths into shorter pieces and provide pre-tuned hosts strategically paced in the network. These hosts act as a gateway to move data along taking advantage of different circuit provisioning mechanisms and are pre-configured to deal with heterogeneous network technologies. Figure 2 shows the architecture for this demonstration, and more details are given in the Q3 report.
**D. Measurement Activities**

The TransPAC project supports a perfSONAR deployment in Los Angeles that provides periodic testing between several US and Asian sites. A testing matrix is available at [http://tp3-3.transpac3.iu.edu/maddash-webui/](http://tp3-3.transpac3.iu.edu/maddash-webui/). As part of the ongoing evaluation of TransPAC services taking place by the new director, support of monitoring services over the TransPAC links will be handed off to the GlobalNOC production team and the maddash for these links will be addressed. The GlobalNOC team already receives support funding for those efforts, however the TransPAC project has not taken advantage of this to date, preferring in the past to do their own, one-off support. By handing off these services, TransPAC staff will be able to focus more on novel experimental work, and the monitoring services will be professionally managed.

As part of the evaluation work, Schopf and Sweeny have held several meetings with our JGN colleagues about coordinating to get additional passive data for those links to try to better understand who is using them and how they can be better supported. Addition conversations on this topic are slated for the Terena meeting in May, and we hope to be able to move forward shortly. We will also contact our colleagues at CERNET to see if they can provide even limited flow data for that link going forward.
5. Operational Activities

A. Network Engineering

The TransPAC 10Gbs circuit between Los Angeles and Japan continues to function as designed with no unscheduled outages. It continues to support ipv4, ipv6, and dynamic-circuit functions. Typically for R&E circuits, its usage characteristics (see Figs 2&3) are bursty, with approximately 2-3Gbs flattened averages and bursts above 7Gbs.

The JGN-X circuit between Los Angeles, California, and Tokyo, Japan, operates in layer 2 between switches in Tokyo and Los Angeles, and is primarily used for experimental network research, particularly DCN, OpenFlow, glif, Optical testbeds, and OpenGOLEs.

The CERNET circuit between Los Angeles, California, and Beijing, China, saw increased usage over the year, with several peaks above 1Gbs.

TransPAC staff upgraded the router and switch, including an upgrade to the Brocade software needed upgrading to a more SDN-capable and bug-free version, from 5.2 to 5.4.0d, the most current version and the same version used by Internet2.

As part of the general project cleanup taking place, TransPAC staff worked to clean up TransPAC DNS and database entries. This involved moving all DNS entities from the domain name 'transpac2.net' to 'transpac.org', in part to avoid having recurring renaming and allow for consistency. This was coordinated with IDC configuration, GRNOC SysEng group, DNS managers, and the GRNOC database.

B. Traffic Graphs

Figures 3 and 4 show the traffic on the NSF-funded 10G TransPAC network during this reporting year, using daily averages and maximums. Figures 5 and 6 show data for the CERNET connection for the same period. The hole in the CERNET traffic graph in early December is due to a configuration change on the CERNET router that took 2 weeks to get SNMP access again; the early-February one is a lapse in reachability. Figure 7 shows the available traffic data on the JGN Tokyo to Los Angeles circuit.
Figure 3: Traffic showing average daily usage on the 10Gbps TransPAC (NSF-Funded) circuit between Los Angeles and Tokyo, March 2013 – February 2014.

Figure 4: Traffic showing maximum daily usage on the 10Gbps TransPAC (NSF-Funded) circuit between Los Angeles and Tokyo, March 2013 – February 2014.
Figure 5: Traffic showing maximum daily usage on the 10G CERNET circuit between Beijing and Los Angeles, March 2013–February 2014.

Figure 6: Traffic showing average daily usage on the 10G CERNET circuit between Beijing and Los Angeles, March 2013–February 2014.
C. Trouble Tickets December, 2013 through February, 2014

Over Project Year 4, there were 4 outages, three for unscheduled maintenance, detailed in Table 1, and one for scheduled maintenance, detailed in Table 2. Table 3 shows a summary of the number and type of tickets by quarter. Additional trouble ticket information is available at https://tick.globalnoc.iu.edu/fp_tools/public_ticket_viewer/index.cgi.

<table>
<thead>
<tr>
<th>Ticket Number</th>
<th>Customer Impact</th>
<th>Network Impact</th>
<th>Title</th>
<th>Outage Type</th>
<th>Start Time (UTC)</th>
<th>End Time (UTC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1407</td>
<td>1-Critical</td>
<td>1-Critical</td>
<td>Outage Resolved - TransPAC Core Node</td>
<td>Hardware</td>
<td>11/14/13 19:15</td>
<td>11/14/13 19:45</td>
</tr>
</tbody>
</table>
Table 1: Summary of unscheduled outages.

<table>
<thead>
<tr>
<th>Ticket Number</th>
<th>Customer Impact</th>
<th>Network Impact</th>
<th>Title</th>
<th>Maintenance Type</th>
<th>Source Of Impact</th>
<th>Start Time (UTC)</th>
<th>End Time (UTC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1428</td>
<td>3-Elevated</td>
<td>3-Elevated</td>
<td>Outage Resolved - TransPAC Peer APAN via TransPAC2</td>
<td>Circuit - Damaged Fiber</td>
<td>1/18/14 18:57</td>
<td>1/19/14 11:35</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Summary of scheduled outages.

<table>
<thead>
<tr>
<th>TransPAC Core Nodes</th>
<th>Down Time</th>
<th>Reporting Period Availability</th>
<th>52 Week Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>TransPAC MX480 - LA</td>
<td>0 hr 32 min</td>
<td>99.99%</td>
<td>99.99%</td>
</tr>
<tr>
<td>Brocade MLXe4</td>
<td>0 hr 9 min</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>3410 Ethernet Switch</td>
<td>0 hr 0 min</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>OOB Router</td>
<td>0 hr 0 min</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>Aggregate TransPAC Core Nodes</td>
<td>0 hr 41 min</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TransPAC Backbone Circuits</th>
<th>Down Time</th>
<th>Reporting Period Availability</th>
<th>52 Week Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>TransPAC LOSA-JGN2 LOSA 10GigE</td>
<td>0 hr 9 min</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>TransPAC LOSA-Pacific Wave LOSA 10GigE</td>
<td>0 hr 9 min</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>TransPAC TOKY-TransPAC2 LOSA</td>
<td>16 hr 38 min</td>
<td>99.81%</td>
<td>99.81%</td>
</tr>
<tr>
<td>Aggregate All TransPAC Backbone Circuits</td>
<td>16 hr 56 min</td>
<td>99.94%</td>
<td>99.94%</td>
</tr>
</tbody>
</table>

Table 3: Summary of downtimes for Project Year 4.

**6. Security Events and Activities**

Basic security measures were maintained over the course of the year, and there were no security incidences to report. TransPAC software and equipment was updated as needed to patch the NTP mirror vulnerability in Q4 without incident.
REN-ISAC had no TransPAC activities to report over multiple quarters, and were removed from the project in December 2013. Basic security work continues to be a part of the ongoing funded support TransPAC receives from the GlobalNOC. If additional assistance is needed, Von Welch at the IU Center for Applied Cybersecurity Research has volunteered staff members who can consult with ACE.

7. Beyond Year 5 Sustainability Plan

Discussions have begun to address sustainability of the TransPAC effort past the end of Year 5 (May 2015). We consider only the situation where funding is ceased, or it is cut to a level where this is the approximate outcome. We split this plan into several components, and address them separately.

**Production Traffic:** The current 10G NSF-funded TransPAC circuit averages around 2-3G of traffic, but can spike to 6 or 7 during high volume periods such as SC or APAN demos. The most likely result of removal of this circuit would be for traffic to be routed over the JGN sister circuit, with some traffic routed over the CERNET circuit, both of which will continue to exist past the end of the TransPAC3 funding cycle. It is likely that APAN partners would need to find funding for additional capacity, which is not currently planned for 2015, to have this not affect the existing application use.

**Experimental SDN Traffic:** If funding for the TransPAC3 project were discontinued, it is likely that there would be a decrease in the number of networking experiments run between the US and Asia. What experiments continued past the end of the project would likely use only the JGN-X link, and would be limited in size until other circuits could be started with solely Asian funding.

**Monitoring Work:** The TransPAC monitoring work has not been a strong focus of the project to date, although it is planned to be a focus of TransPac3 Year 5. It is likely this work would simply shut down if TransPAC funding did not continue.

7. Reporting against Objectives Year 4

1. Overall
   a. New director to review activities and adjust as needed
   b. REN-ISAC staffing adjusted
   c. PerfSONAR monitoring to shift to production support
2. Staffing
   a. Contracted with Dale Smith, NSRC
   b. Hired new director
   c. Recruitment of replacement half-time engineer for the project (ongoing)
3. Collaboration, Travel, and Training
   a. Attend variety of large scale international meetings
   b. Training for OIN, NSRC, and others
4. Systems and Software Work
   a. Software upgrades of core devices in Los Angeles
   b. Upgraded InterDomain Controllers
c. Preliminary SDN experiments using Phoebus

5. Operational Activities
   a. Continued full support of TransPAC circuit

8. Plans for Year 5

1. Overall
   a. New director to review activities and adjust as needed

2. Staffing
   a. Recruitment of replacement half-time engineer for the project

3. Collaboration, Travel, and Training
   a. Attend and speak at major Asian meetings
   b. Co-chair PRAGMA meeting in October with Networking focus
   c. Additional TransPAC meetings at APAN in August
   d. Identify scientific applications using TransPAC more specifically

4. Systems and Software Work
   a. Re-focus on monitoring of all circuits
   b. Identify and if possible implement flow-analysis tools
   c. Extend current SDN experiments with JGN

5. Operational Activities
   a. Continue full support of TransPAC circuit
   b. Continue to shift production system support to production GlobalNOC teams