

**Annual Report  
America Connects to Asia (TP3)  
(SCI - 0962968)  
1-March-2012 through 28-February-2013**

**James G. Williams – Principal Investigator**

***Yearly Summary***

The TP3 project is operating within budget. See the Budget Summary section.

TP3 continued engineering work on US-China circuit, including arranging for redundant peerings and beginning perfSONAR deployment in support of the US-China service. Planning for the US-China link launch event in China began. CERNET official 'launch event' was held in Beijing in June 2012. See Quarterly Milestones for more details.

Williams participated in phone calls with the Internet2 Global Education Group to discuss their use of the US-China link.

Sweeny worked closely with Internet2 on commissioning and engineering the new Internet2 Collocation Space in Singapore in support of the Global Education Group efforts in the region, and arranging for R&E peering service. This service equipment was installed in November and will have its official launch in May 2013.

TP3 got an IPv6 address block.

Williams will lead the perfSONAR measurement working group at CANS. Planning continues for that activity.

Sweeny and Hicks have both become much more deeply involved in OpenFlow training. An OpenFlow-enabled Brocade Ethernet switch has been installed in the TransPAC3 POP in Los Angeles. Our Japanese partners are scheduled to install comparable equipment in early 2013. Discussions continue with our Japanese partners regarding implementation of OpenFlow across the TP3 link. Williams will attend the Internet2 Fall Member Meeting and host an OpenFlow meeting regarding inter-domain OF connectivity. The report from Steven Wallace about OpenFlow Workshops is attached at the end of this AR.

Williams, Sweeny, and Hicks attended CANS meeting in Seattle and the Internet2 Fall Member meeting. Williams, Sweeny, and Hicks attended TIP Joint Tech/APAN conference at the University of Hawaii, January 2013.

Williams attended an ESnet sponsored meeting at PNNL in Washington State to discuss the BELLE2 collaboration.

Hicks is working with NSRC to develop curriculum for an IU-NSRC trip to South Africa planned for April 2013.

In cooperation with DANTE, Internet2, and CERNET, a backup to the new DANTE-China ORIENTPlus service was completed and tested. Agreement signed at Joint Techs in Hawaii.

## ***Quarterly Milestones and Accomplishments***

### **Quarter 1**

The 10Gbs circuit from Beijing to Los Angeles was completed into CERNET equipment in late October 2011, and TransPAC3 arranged for it to be connected to the PacificWave switch in Los Angeles, which was completed in December 2011, and peerings were then brought up with Internet2, NLR, ESnet, and TransPAC3, and traffic has begun to flow over the new circuit.

At CERNET's request, TransPAC3 also worked with PacificWave to set up backup vlans from CERNET to PW's Seattle switch in order to create backup peerings with Internet2, NLR, and ESnet, begun in January and completed in this quarter.

Following on initial implementation of the CERNET-US connection, much was accomplished this quarter in instrumenting the connection so that traffic and performance can be measured both in real time and over arbitrarily long periods, using the GRNOC's SNAPP high-speed measurement software, and perfSONAR tools, planning for the June 2012 China celebration of the US-China link.

A Globally-routable IPv6 address block application was submitted for TransPAC3.

### **Quarter 2**

CERNET official 'launch event' for the US-China circuit was held in Beijing in June. Williams attended and participated in a "link capacity demonstration" designed by Hicks between the US and China.

CERNET peering with NORDUnet was added through Pacific Wave. Additional peering connections are being investigated.

Hicks participated as an instructor in a Brocade-sponsored OpenFlow workshop in Indianapolis; Sweeny attended. Sweeny participated as an instructor in an OpenFlow workshop for CIC in Chicago. Hicks and Sweeny attended summer Joint Techs conference in July at Stanford University and helped teach two OpenFlow Workshops.

Hicks and Sweeny attended and participated in APAN34 meetings in August in Colombo, Sri Lanka.

A globally-routable ipv6 address block (2620:F5:8000::/48) was assigned by ARIN to TransPAC3, an addressing plan developed, and addresses assigned not only to TransPAC3 devices in Los Angeles, but also used for some point-to-point peering connections. Address assignments are tracked in the GRNOC database.

### **Quarter 3**

Discussions with DANTE, Internet2, and CERNET begin on engineering a backup to the new DANTE-China Orient+ service between London and Beijing. Agreement will be signed at Joint Techs in Hawaii.

OpenFlow-capable switch identified for deployment in Los Angeles, engineering of that connection designed, preparation for installation started.

Sweeny participated as an instructor in two OpenFlow workshops for GRNOC staff in Indiana.

Williams attended an ESnet sponsored meeting at Pacific Northwest National Laboratory to discuss the update of the current BELLE experiment at KEK in Japan and the network requirements for the upgraded experiment (BELLE2). TransPAC3 will likely provide backup services for the BELLE2 experiment.

Williams, Sweeny, and Hicks attended CANS meeting in Seattle. Williams co-chaired the Measurement working group and Hicks co-chaired the OpenFlow/SDN group.

Williams hosted a session on OpenFlow and held discussions with Internet2 and our Asian partners (NICT and NII) about 100G service between the US and Asia at the Fall Internet2 Member meeting.

#### **Quarter 4**

In cooperation with DANTE, Internet2, and CERNET, a backup to the new DANTE-China Orient+ service was completed and tested. Agreement signed at Joint Techs in Hawaii.

Hicks and Sweeny installed an OpenFlow-capable switch in Los Angeles.

Hicks and Sweeny participated as instructors in OpenFlow workshops at the TIP meeting. Hicks made presentations at the Future Internet Testbed and Engineering sessions at the TIP meeting.

Hicks began working with NSRC to develop curriculum for an IU-NSRC trip to South Africa planned for April 2013.

The report from Steven Wallace about OpenFlow Workshops is attached at the end of this AR.

## Operations Events and Activities

For the year in review we report the following updates and additions to the services and support of TransPAC network services:

The GlobalNOC Service Desk began the annual review of its Business Continuity Plan in March of 2012. As part of the IU Ready system, the Service Desk maintains a structured Continuity plan and performs periodic testing to insure TransPAC NOC viability in situations where physical or network accessibility is not available in the primary location. The service desk regularly exercises this plan throughout the year. This plan has expanded further to include off-site techs. These off-site techs periodically work remotely given another point of contact should both GRNOC locations suffer catastrophic loss of connectivity or are forced to vacate those facilities for any reason.

A Specialized Support Technician (SST), Scott Chevalier, was assigned to cover International Networks, including TransPAC. SST's focus on high level user support and troubleshooting, training of frontline Network Technicians, and documentation of process and procedures for the networks under their supervision beginning in April of 2012. TP SST, Scott Chevalier, participates in the off-site technician program.

Work Flow tool development for the Service Desk was completed for several networks after launching for production testing during the last quarter of 2011.

Updates continue to be made to existing notifications adding trouble-ticket impact status and further definition within the ticketing system for clarity.

System Engineering continued development of the Service Desk "targeted notification tool" to enable us to further define a "target" recipient group and provide notification on services to only those affected. As part of TransPAC NOC processes and procedures, network documentation continues to be reviewed and updated accordingly.

The GlobalNOC completed hiring and began training six new technicians. In tandem with this expansion of personnel, the GlobalNOC has also focused its members into specialized teams (focus teams) able to provide assistance more efficiently and with greater knowledge of ongoing and network-specific issues. These teams bridge across the Service Desk and Engineering groups allowing for greater information-sharing and wider training on diagnosis, triage, and planning of network events.

The development of new and expansion of existing GlobalNOC tools has continued. DB2, the next generation of the GlobalNOC's database, has been in full testing and is expected to launch officially soon. The new schema will allow techs to more easily view information tied into the DB and will simplify many of the steps of searching that done as part of the Service Desk workflow today.

Planning and preparation for the Singapore POP of Internet2 has been a priority through this reporting period; by first quarter of the 2013 reporting period this POP will be fully operational.

## ***Network Engineering Yearly Summary***

The TransPAC3 10Gbs circuit between North America and Japan continues to function as designed, with no unscheduled outages. It continues to support ipv4, ipv6, and dynamic-circuit functions. We continue to support the CERNET Beijing-Los Angeles connection, roll out increased functionality and support for dynamic-circuits including DCN and OpenFlow across TransPAC3, and provide leadership in many areas of network technology for this region.

The new CERNET circuit becomes operational. To review, the CERNET circuit between Beijing and Los Angeles was completed with some help from the NSF through the TransPAC3 project late in 2011 and TransPAC3 arranged for PacWave connectivity, addressing, and peering relationships on CERNET's behalf in the subsequent few months. The final arrangements to complete the first round of peerings in Los Angeles were completed in December 2011, with a set of backup peerings in Seattle following.

In follow-up discussions with CERNET engineers at APAN33, they agreed to implement PerfSONAR monitoring on the link and make usage data available to the R&E community.

CERNET engineers also confirmed that they're sending us all the routes they have for R&E institutions inside China. A public 'launch' event was held in June in Beijing for the new CERNET connection with a live demo of linespeed connectivity. Significant planning, coordination, and preparation occupied TransPAC3 engineers and Jim Williams during this period, with John Hicks leading the measurement and instrumentation activities and Sweeny providing some technical support. As can be seen in the GRNOC SNAPP graph accompanying this report, there have been several peaks in service above 1Gbs during the year.

At the CANS meeting in October, DANTE asked if it would be possible to use the CERNET connection between Beijing and the US as a backup for the new London-Beijing Orient+ project, scheduled to come up 2 Jan 2013. This was agreed to in principle by the affected parties and engineering discussions followed with TransPAC3, CERNET, Internet2, and GEANT engineers all involved. Implementation and verification followed in late November and December, and a validation test completed in January. Currently only layer3 backup is provided, but eventually a layer2 backup function will also probably be required. This will be more complex as layer2 circuits don't normally fail over to backup paths as nicely as layer3 ones do, but we have some ideas on how this can be done. As mentioned above, however, currently CERNET has no layer2 function so they can't provide a backup even if DANTE wanted it; the DCN capability on TransPAC3 is the most likely and most-functional alternative.

The TransPAC3 OSCARS IDC is now operational. Final peering arrangements between JGN-X & I2 will be completed in December 2012. Oscars now dynamically provision vlans across TransPAC3 between the US and Japan, and between US R&E networks and APAN ones.

TransPAC3 procures from ARIN an ipv6 address block (2620:F5:8000::/48), which gives us the ability to assign ipv6 addresses to all of our own routing, management, measurement, and test equipment.

TransPAC3 staff continued to show leadership globally in R&E networking and hosted network engineers (and administrators) from other nations, including this year from India, Japan, Singapore, and others. As part of this effort, John Hicks is providing service to the NSRC.

During this year TransPAC3 engineers added an OpenFlow capability for TransPAC3, in close coordination with our NICT/APAN/JGN colleagues. We have installed a Brocade

MLX switch into the TransPAC3 POP and are working closely with JGN colleagues on their complementary OpenFlow capability deployed in Tokyo and Los Angeles using NEC equipment. The new switch has two ports dedicated to OpenFlow connected with the TransPAC3 router and two ports set aside for high-speed direct JGN-X connections and replaces a multi-10Gbs-port HP6410cl switch which had reached the end of its useful life.

This installation necessitated an outage of the link between the TransPAC3 router and the PacificWave exchange point (and its North American peers), but it was very brief. Also, a nice side-effect of the Brocade installation is that we now have many more 10Gbs ports available to us for experimentation and high-performance server connections. It is now possible to use Oscars to add OpenFlow or DCN dynamic-circuits across TransPAC3 between US and APAN-area networks for experimental and production projects. One aspect of our plans with NICT/APAN/JGN is to use complementary aspects of DCN and OpenFlow together, along with the communicating IDCs, across these paths to provide maximum functionality and flexibility.

The TransPAC3 OSCARS IDC is now operational and interoperates with JGN-X & I2 IDCs..

TransPAC3 supported several research projects and demonstrations at Supercomputing SC12, notably including those using IPv6 and dynamic circuits, between researchers in the APAN region, Europe, and the US.

Hicks and Sweeny continue to help in presenting and supporting OpenFlow implementation workshops. More than 25 such workshops have been delivered by the GRNOC to the R&E community in 2012 and early 2013 (see Wallace report at the end of this document). An explicit goal is that in addition to InCNTRE's role as a leader in development and testing for OpenFlow, the GRNOC will increasingly be seen as an expert resource for training in advanced technologies. Sweeny is also participating in the planning and delivery of a brand-new OpenFlow 'Operations' workshop aimed at going beyond the theoretical and historical background and simple setup that the current workshops have done so well. New workshops will emphasize developing a better operational understanding among campus and regional network operators (such as those with GENI installations) of how OpenFlow works in practice, including its idiosyncrasies, oddities, and special cases. The first of these workshops is currently planned for mid-May in Washington, DC.

Cisco Telepresence for R&E continues to grow, both domestically and internationally, under our leadership. Building on the success of the NLR Cisco Telepresence exchange, the Internet2 Video Services exchange is now operational, with Sweeny acting in a leading architectural, engineering, and operational role. Unlike the NLR exchange, which interconnects only Cisco Telepresence devices, this new exchange emphasizes interoperability among all high-end video technologies including Cisco Telepresence and SIP and 'legacy' H.323 systems, and connects institutions to its new exchange in Washington DC (completed in early 2012 and co-located with WIX, Sweeny helped with installation and configuration). Significantly for the APAN region, Internet2 in late 2012 installed an additional highly-interoperable video services exchange in Singapore and in early 2013 will connect systems and networks to it. This exchange is an extension of the US exchange and will also have access to the NLR exchange through R&E networks. By the end of 2012, R&E-oriented telepresence exchanges are in place in Kansas (NLR), Washington DC (Internet2), and Singapore (Internet2), with many hundreds of R&E systems connected.

Like the WIX facility, the new Singapore colocation space provides not only for telepresence interoperation, but also for disk farms, service support, and support for US university colo in the region in an Internet2 facility. The facility will likely be important to US universities in support of their programs in the region and in the interconnection of

that Internet2 facility with regional NRENs, including, initially, CERNET, TEIN, Gloriad, and Singaren. These interconnections will provide good reachability back to APAN, TransPAC3, and the US RENS. It's equally important that the Singapore colocation not be perceived as a competing 'exchange point', which is not its intention.

A number of technical discussions were held at the "TIP" APAN/Joint Techs meetings with APAN colleagues on topics and projects of mutual interest, especially our complementary and cooperating OpenFlow deployments, technical requirements and support for the upcoming GEC meeting, SC13, and many other topics.

One APAN project we have helped with that should be of interest to the US REN community is the creation of an APAN connectivity 'directory' showing how each APAN-member NREN is connected in the region, with a graphical interface and some backend database information.

In addition to normal research, TransPAC3 will support several research projects and demonstrations at GEC between researchers in the APAN region, Europe, and the US.

We have had considerable discussion among ourselves and with the wider community about so-called 'elephant flows', characterized by single flows that are larger than 10Gbps each (the size of the circuits carrying them), and how best to support them given the hashing algorithms for larger circuits aggregated into LAGs. (This is chiefly a problem for ACE with its LAGged multi-10Gbps circuits, and is no longer theoretical as >10Gbps single flows were demonstrated at SC12, and are increasingly likely.) Some of the problems are:

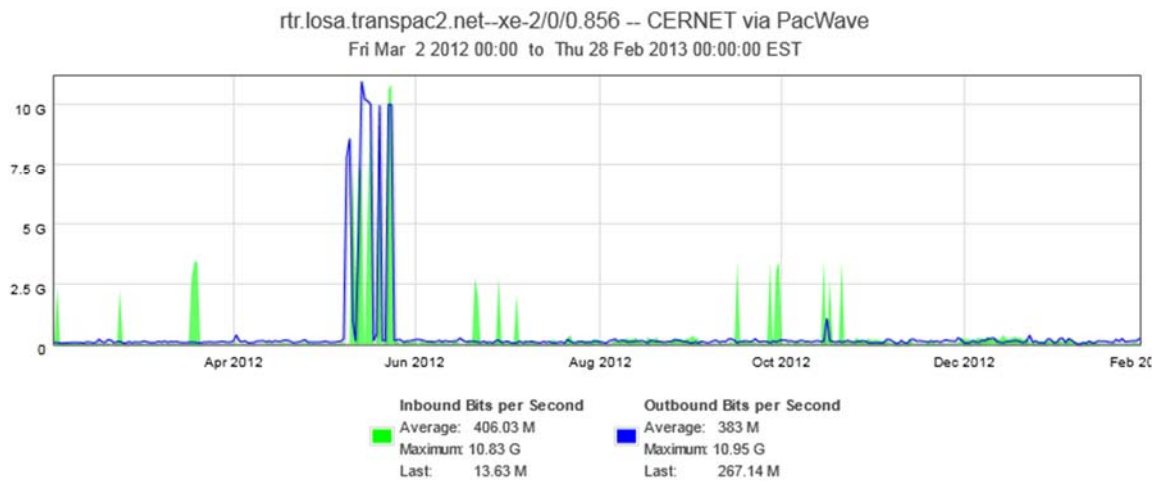
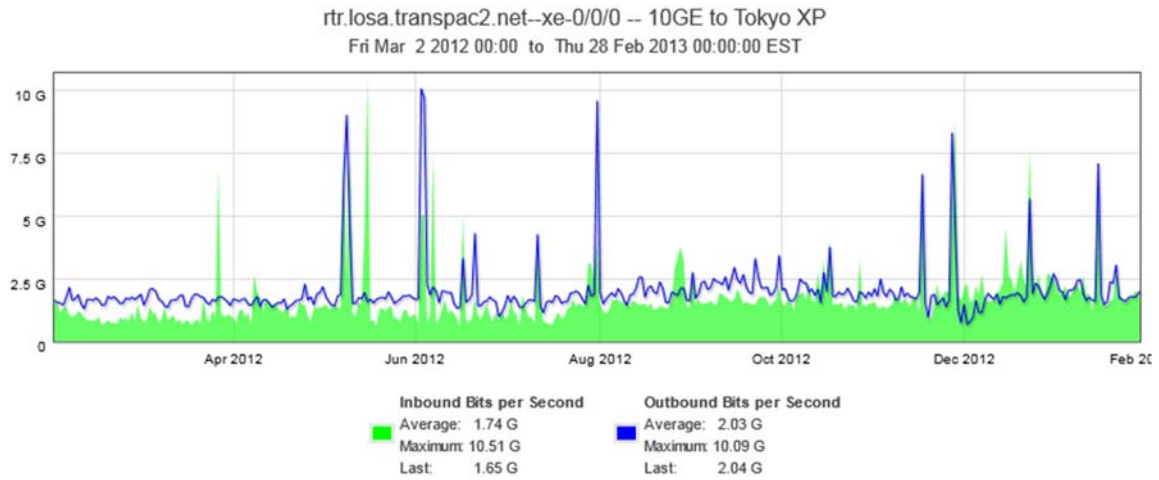
1. When multiple circuits are available along the same path, higher aggregate bandwidth can be achieved using LACP/LAG.
2. To avoid packet-out-of-order problems, the preferred LAG hash is per-flow (rather than per-packet). However, this can result in less-even distribution of traffic, and perversely to the elephant-flow question, limits flow sizes to the size of the pipe.
3. The conventional solution for this problem is to continue to increase the size of the single-flow 'pipe' or transport (in this case, the next available technologies are 40Gbps and 100Gbps)

Among the resultant questions are:

1. Whether such large flows fail altogether when fragmentation is required
2. Are there functional alternatives without the cost of larger pipes? GridFTP or high-performance file systems like Lustre apparently can accommodate large flows without out-of-order, but not all transfers use one of those.
3. 'Transparent' file-transfer-enhancement protocols like Swany's Phoebus or his new RDMA-based work may provide a solution across LAGs without requiring larger pipes, but to our knowledge this has not been attempted across large LAGs or across the very long distances typical of transfers using TransPAC33. We are working to facilitate such experiments/demonstrations between Swany's lab and cooperative facilities within the APAN region.

In parallel with the above technical discussions about large flows, we have worked with colleagues in ACE, GEANT, and Internet2 to investigate the new requirements for all of the aspects necessary to support 100Gbps service over trans-oceanic distances, such as across the Pacific or Atlantic.

Following are the yearly traffic graphs for TP3 and the US-China connection.





## **Intern Activity**

In this annual report year the ACE+TP3 project supported four undergraduate interns. Their projects varied from basic international networking written communications work to security tools development.

The reports of these interns are attached at the end of this AR.

## **Transition Strategy**

The TP3 Project supports two international connections (the US-Japan connection and the US-China connection). There is no transition strategy for the US-Japan connection. That strategy will be developed over the next year with our Japanese colleagues.

The US-China connection does have a formal, written and signed transition strategy in place today. At the end of the IRNC project (June 1, 2015), the US responsibility for the US China connection (the O/M on the Chinese funded IRU) will transition from the TransPAC3 project to Internet2.

## **Software Defined Networking (SDN) Activities**

SDN and specifically OpenFlow has become an area of great interest in the networking community in the last couple of years. SDN provides a new networking paradigm that separates the control plane with the data plane. A data plane connection simply provides an exchange of user data in an OpenFlow environment. A control plane connection provides control of OpenFlow resources and the ability to manipulate OpenFlow rules. We refer to a set of OpenFlow resources with a common control structure as an OpenFlow domain or testbed. OpenFlow controller technology and path provisioning within an OpenFlow domain has matured over the last year.

Inter-domain path provisioning and resource sharing is less mature. There are efforts that use external layer 2 dynamic provisioning mechanisms like OSCARS and NSI to provide path provisioning between OpenFlow domains. These methods only provide connections on the data plane level. Full peering will require some form of sharing resources and control but it is currently unclear what this will be. We hope to help define what peering means and how to implement this between our international partners.

TransPAC3 has deployed an OpenFlow capable switch on the U.S. side of the connection that will aid in interconnecting Asian and U.S. OpenFlow environments. This switch is now directly connected with the Japanese RISE network on the OpenFlow side and uses OSCARS to connect to the U.S. Internet2 OpenFlow testbed, the Advanced Layer 2 Services (AL2S). This approach provides an excellent OpenFlow peering/exchange platform to experiment with different inter-domain connection techniques. We are working with Asian, U.S. (ACE, Internet2, ESNNet), and European (SURFNet, DANTE) colleagues to provide a mechanism to transfer data, over the three continents use OpenFlow technology.

TransPAC3 staff also helped coordinate a visit from NICT staff in Japan to work in the Indiana University SDN lab in July. NICT/JGN is developing a trema based controller implementation of the SDN control plane and making it compatible with other existing control plane implementations. Mr. Shuji and Mr. Takata from NICT in Japan. Mr. Shuji stayed in Bloomington for three weeks and worked with the GRNOC to incorporate the

TREMA controller into the OESS software suite. This is a step towards international peering between the Japanese and US OpenFlow testbed activities. This work was reported on at APAN34 and updates and shown at the TIP2013 in Hawaii.

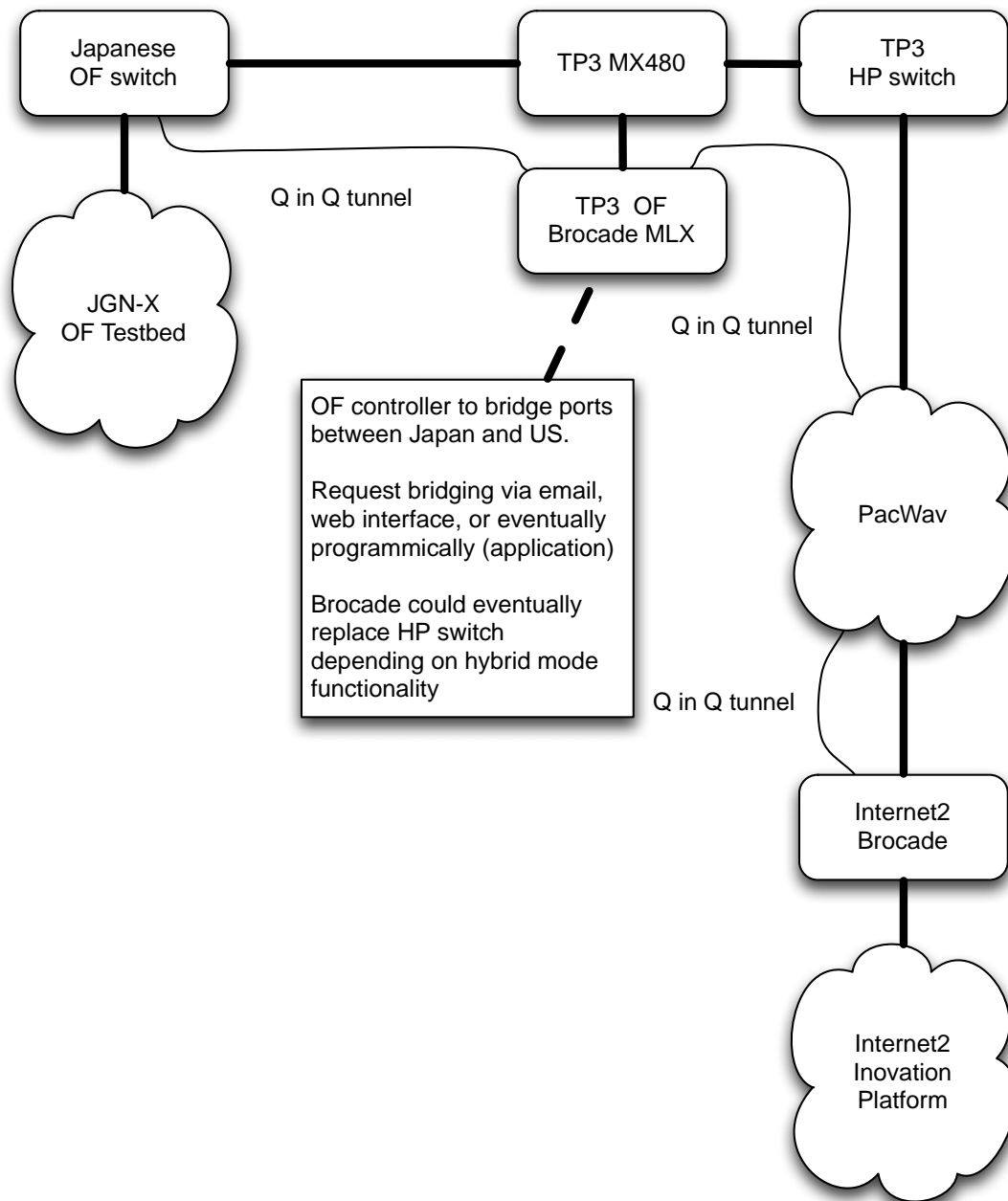
Another aspect of TransPAC3's SDN involvement is teaching and outreach. Hicks helped develop course material for Brocade SDN workshop and participated as an instructor at Brocade SDN workshop. This workshop provides a general overview of OpenFlow capabilities and hands on experience with real OpenFlow capable equipment. A lot of the workshop material was developed using HP switches. We discovered, first hand, that OpenFlow implementations differ greatly even though they adhere to the OpenFlow 1.0 specification. Here are a few key differences between the current implementations on the HP and Brocade switches:

- Brocade switches do not automatically send packets that do not match an OpenFlow rule to the controller. This process is called a 'packet in' procedure. HP switches perform a 'packets in' procedure by default.
- Brocade switches only provide one Data Path Identification (DPID) number. The DPID numbers identify an OpenFlow instance. HP switches can have a DPID per vlan.
- Brocade will not match on layer 3 fields only limited layer 2 fields. HP currently provides a full set of match fields based on the OpenFlow 1.0 specification.

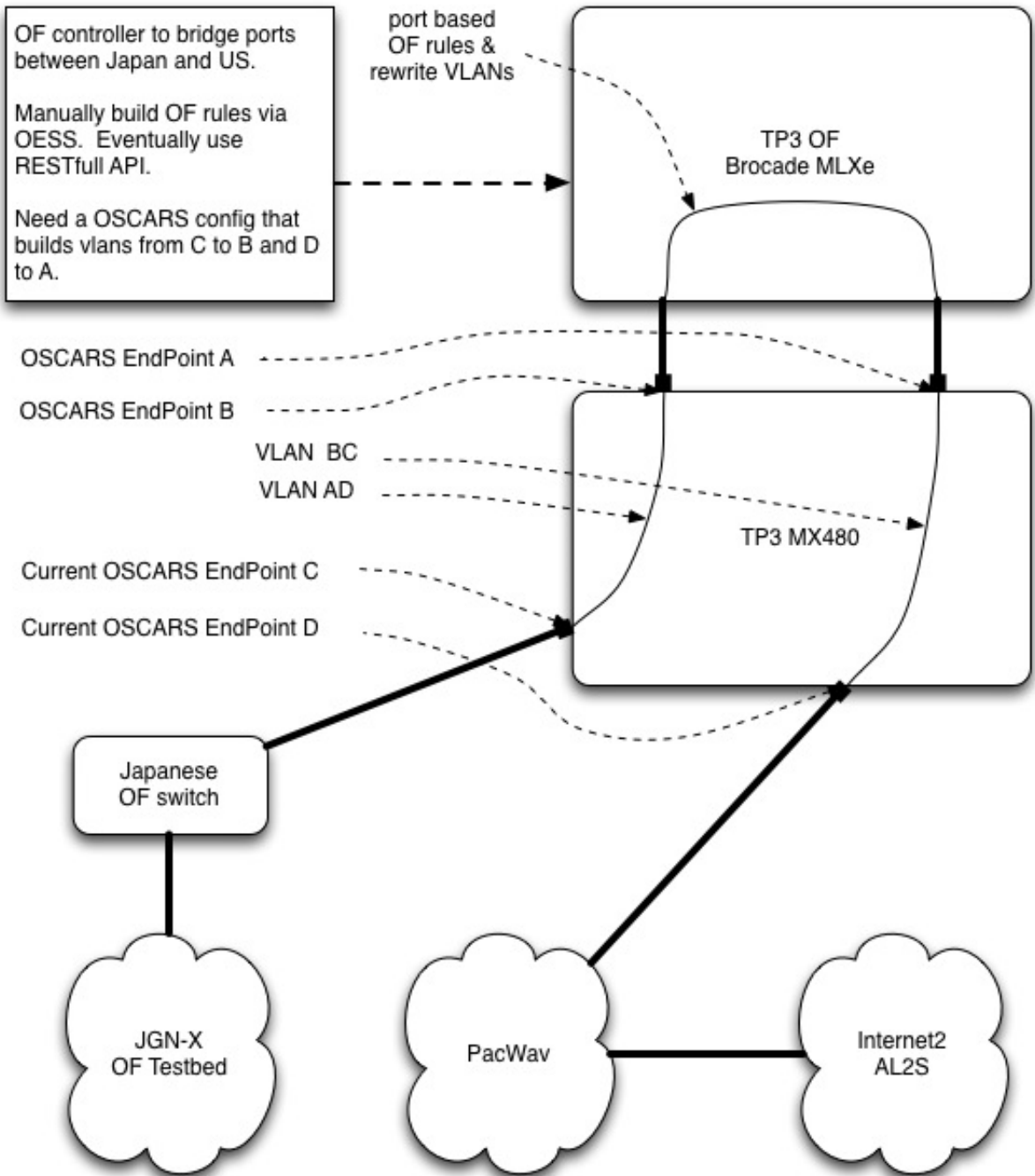
Hicks helped teach the OpenFlow Workshop at IU for the Summer of Networking SDN OpenFlow week. One interesting outcome was that we discovered a bug in FlowVisor. The bug was identified and later fixed by the FlowVisor development team.

Hicks and Sweeny attended summer Joint Techs conference at Stanford University and helped teach OpenFlow Work Shop. GRNOC is establishing itself as a major SDN resource, through the InCENTRE lab and the hands-on OpenFlow workshops led by Steven Wallace, and Hicks and Sweeny are among those at GRNOC who are active in this effort, including providing input to the development of the instructional materials, systems support, user support, and actual instruction.

TransPAC3 staff worked on draft charter for Future Internet Working Group at CANS.



TransPAC3 SDN deployment  
version 0.1  
December, 12 2012  
John Hicks



## Measurement and Dynamic Circuit Activities

TransPAC3 has a mature measurement infrastructure using the perfSONAR software suite at its' core. The goal of the measurement effort is to provide debugging and circuit performance verification to engineers, researchers, and staff. TransPAC3 provides the following NOC supported monitoring services.

- Manage the measurement machines, tools, data archives
- Weather-map service
- Nagios monitoring status service
- perfSONAR Toolkit
- perfSONAR Lookup service (gLS)
- perfSONAR SNMP MA
- perfSONAR BOUY
  - BWCTL
  - OWAMP

TransPAC3 staff recently upgraded the hardware in Los Angeles included new 1g and 10G servers.

Another aspect of the TransPAC3 measurement effort is education and outreach.

- Hicks gave perfSONAR talk to ERnet (India) visitors.
- Attended CANS meeting and gave talk concerning measuring and monitoring 'elephant flows'. Also participated in the CANS measurement working group meeting.
- Attended TIP meeting and gave talk concerning TP3 measuring and monitoring.
- Hicks participated in CENIC perfSONAR calls.

Prepared and performed perfSONAR demonstration for the CERNET ceremony in Beijing.

Continued discussion post demo to start regular testing. CERNET now has a perfSONAR server running the toolkit at the Beijing center supported by the CNGI-6IX NOC (<http://202.112.117.76/toolkit/>). Implement a mesh of perfSONAR testing sites in the U.S., China, and Japan. We are working on increasing the number of testing sites.

Met with Jon Dugan of ESnet at the Joint Techs conference to discuss possible collaboration to develop a portal and application database for TP3 and ACE traffic. Talks stalled with ESnet so this same idea was introduced to the GRNOC. Preliminary portal efforts are underway.

## IDC

OSCARS provides dynamic layer 2 circuit creation and management between multiple administrative domains. The TransPAC3 OSCARS domain provides a 'gateway' between Asia and U.S.. The TP3 OSCARS (0.54) IDC is in full production operation. The TP3 OSCARS (0.62) is in its' final stages of testing. Peering arrangements between

JGN-X in Japan and Internet2 ION in the U.S. are complete.

TransPAC3 IDC information follows:

- Domain: [TransPAC3.iu.edu](https://transpac3.iu.edu)
- idc url: <https://idc.TransPAC3.iu.edu:8443/OSCARS/>
- Notify Broker: <https://idc.TransPAC3.iu.edu:8443/axis2/services/OSCARSNotify>
- Cert Subject Name: **CN=idc.TransPAC3.iu.edu, OU=TRANSPAC3, O=Indiana University, L=Bloomington, ST=Indiana, C=US**
- link id: urn:ogf:network:domain=TransPAC3.iu.edu:node=rtr.losa:port=x-2/0/0:link=internet2
- link id: urn:ogf:network:domain=TransPAC3.iu.edu:node=rtr.losa:port=x-0/0/0:link=jgn-x

TransPAC3 worked on various demonstrations with RISE/NICT/JGN-X including SC12 demonstrations and Proto-GENI demo for GEC15 using JGN-X and TP3.

The TransPAC3 OSCARS facility also provides inter-connection between international OpenFlow test beds.

## ***Security Events and Activities***

<Duplicated in the ACE QR, as the EU and Asia are approached together>

Pearson and Iovino developed an activity for an intern to:

- (1) Develop a testbed of two CIF<sup>1</sup> instances, representing different trusted communities (e.g. the REN-ISAC community and APAN);
- (2) To establish a security sensor collection point feeding one of the CIF instances;
- (3) To inter-federate share security indicator data from one CIF to another; and to thoroughly and publicly document (published open source along with the CIF code) all steps in standing up the CIF instance, adding local sensor inputs, and inter-federating with another CIF instance.

This work will serve as a guide for establishing inter-federated threat indicator information sharing.

The inter-federation use case documentation<sup>2</sup> is published at the open source CIF project wiki. Kyushu University successfully setup a CIF instance following the documentation. The Kyushu CIF instance is collecting indicators generated from failed login attempts to their servers. A test CIF instance at REN-ISAC is configured to aggregate several public feeds of indicators. The two community instances are successfully sharing data with one another.

Upon successful outcome of the work - testbed inter-federation of security event information sharing using the CIF tool between US REN-ISAC and APANTransPAC3

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<sup>1</sup> <http://code.google.com/p/collective-intelligence-framework/>

<sup>2</sup> [http://code.google.com/p/collective-intelligence-framework/wiki/Recipe\\_FederatedSharing\\_v1](http://code.google.com/p/collective-intelligence-framework/wiki/Recipe_FederatedSharing_v1)

partners - the partners gave a joint talk concerning the activity and results at the APAN/ESnet/Internet2 TIP2013 Conference. The talk "*International Collaboration for Security Event Information Sharing*"<sup>3</sup> was given January 16, 10:00 AM HAST by Asst. Prof. Yoshiaki Kasahara (Research Institute for Information Technology, Kyushu University), Yasuichi Kitamura (National Institute of Information and Communications Technology, Japan), Kevin Benton (PhD Student, Security Informatics, Indiana University), and Gabriel Iovino (Principal Security Engineer, REN-ISAC).

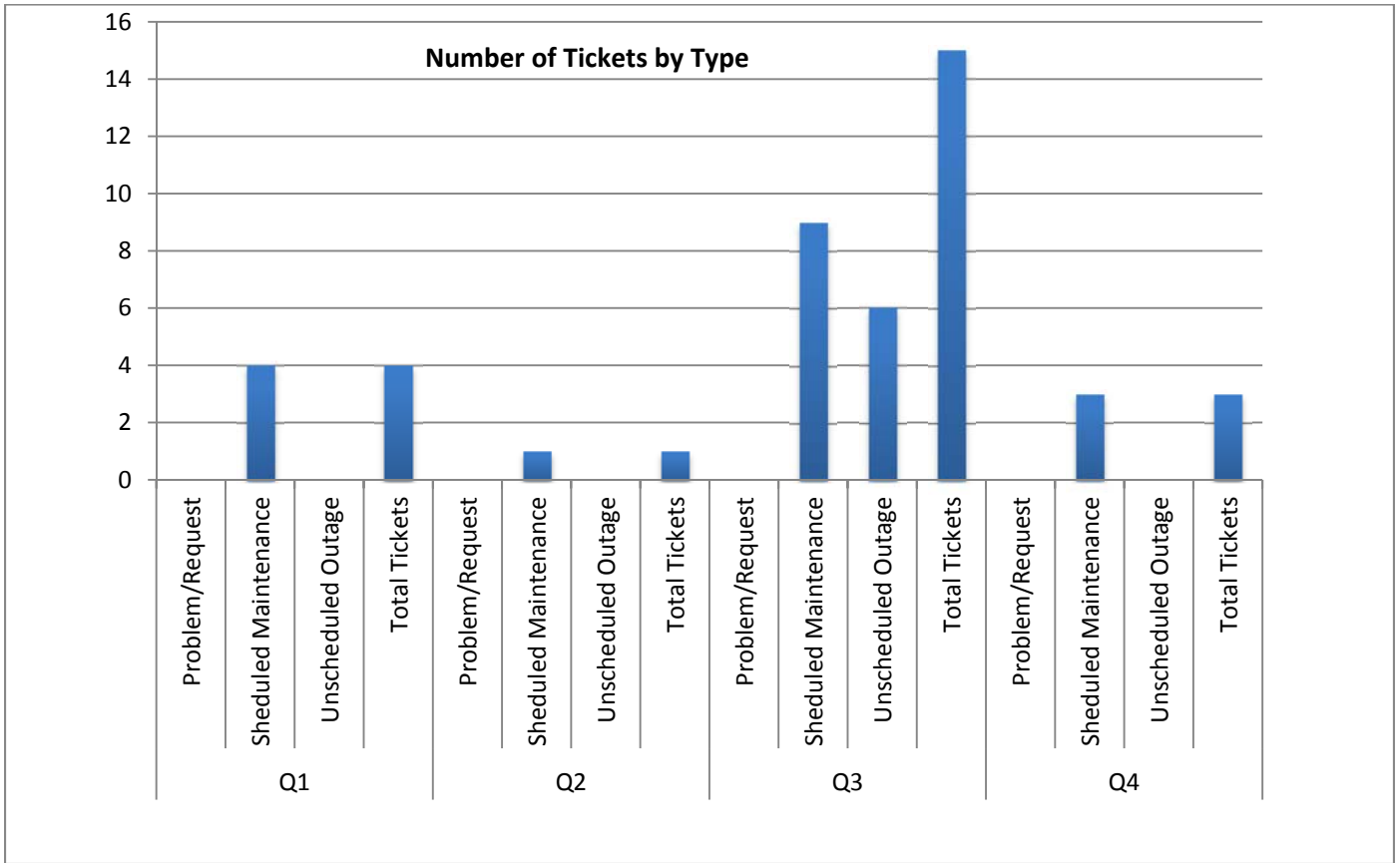
The work revolved around the REN-ISAC Collective Intelligence Framework (CIF). CIF provides a near real-time path from community and global observations of security-related events, to the derivation of threat indicators, and application to local defenses; and provides analyst interface for threat research and incident response. CIF is the open source component of the REN-ISAC Security Event System (SES)<sup>4</sup>. SES version 3 is the subject of a current NSF award, SDCI Sec: SESv3 (Security Event System - Version 3), award OCI-1127425. A typical CIF/SES installation serves a circumscribed trust community, such as REN-ISAC. Among the deliverables of the SESv3 project is to develop the capability to "inter-federate" indicator sharing among trust communities, guided by policy and sharing markers (e.g. Traffic Light Protocol<sup>5</sup>)

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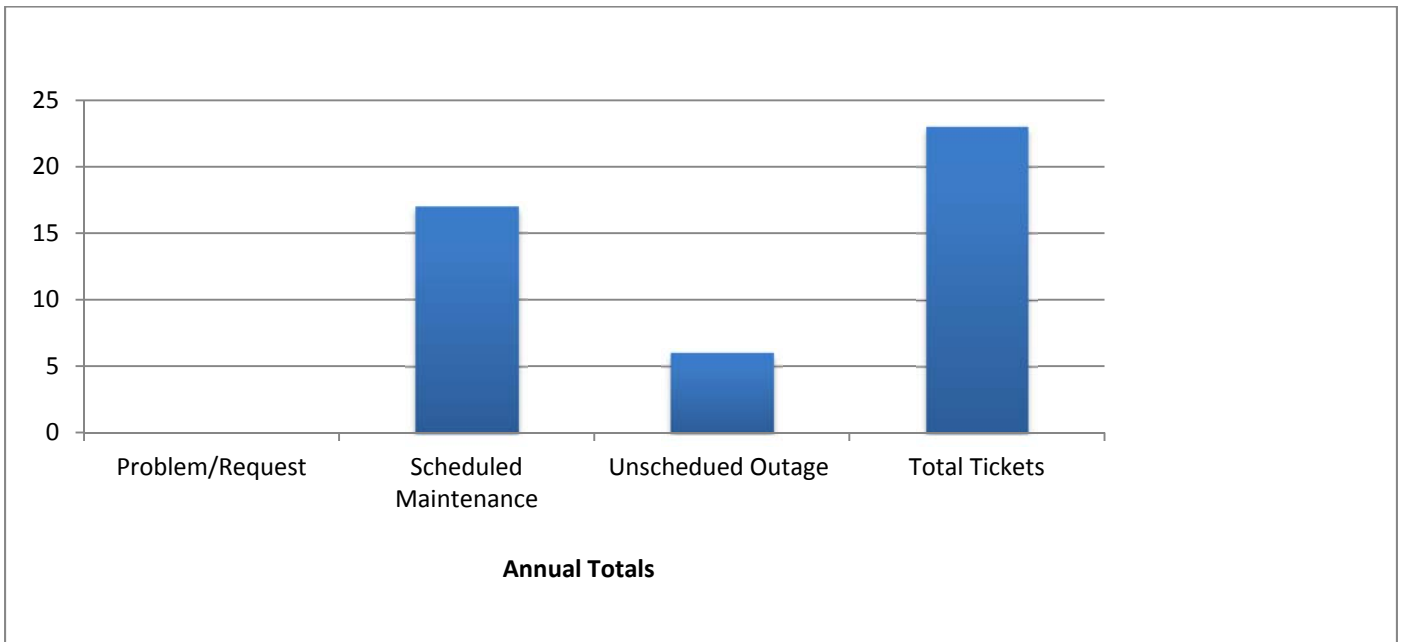
<sup>3</sup> <http://events.internet2.edu/2013/tip/agenda.cfm?go=session&id=10002762&event=1261>

## TransPAC3, 2012-2013, Ticket Types by Quarter\*

- Outages initiated by peer have been removed



## TransPAC3, 2012-2013, Annual Tickets by Type





# Financial Reporting Details March 1, 2012 – Feb 28, 2013

<b>TP3 NSF, OCI-0962968</b>					
<b>Compensation</b>	<b>1st Quarter total(s)</b>	<b>2nd Quarter total(s)</b>	<b>3rd Quarter total(s)</b>	<b>4TH Quarter total(s)</b>	<b>Annual total(s)</b>
Williams, James	3,245.16	2,216.04	4,537.28	3,402.96	13,401.44
Sweeny, Brent	(17,799.90)	24,108.82	18,363.33	18,363.33	43,035.58
Iovino, Gabriel	-	12,793.62	5,375.25	(1,791.77)	16,377.10
Young, Wesley	-	8,760.83	5,355.03	(7,140.03)	6,975.83
Benton, Kevin	-	8,869.43	400.00	-	9,269.43
Young, Michael	-	3,101.00	-	-	3,101.00
Pearson, Douglas	887.22	1,526.06	1,845.48	458.75	4,717.51
Patton, Darah	1,088.75	-	998.75	(184.52)	1,902.98
NOC Service Desk Support	-	11,372.18	-	6,681.50	18,053.68
F&A on Compensation 32%	(4,025.21)	23,279.35	11,800.04	6,332.87	37,387.06
<b>Total Qtr Compensation</b>	<b>(16,603.98)</b>	<b>96,027.33</b>	<b>48,675.16</b>	<b>26,123.09</b>	<b>154,221.61</b>
<b>Other Expense</b>					
Corp for Ed Network/Landing for US China Connection	21,000.00	22,800.00	-	-	43,800.00
Credit for SKYPE Charges Posted in Error	-	(177.88)	-	-	(177.88)
Credit for FEDEX Charges Posted in Error	-	(2,044.41)	(4.48)	-	(2,048.89)
Brocade Communications PO1231527	-	-	-	13,397.47	13,397.47
FEDEX Charges	-	234.79	-	216.24	451.03
Skype Communication for Intl Calls	-	53.94	-	-	53.94
Visa Charge for J. Williams	-	235.00	-	-	235.00
Printing of TP3 brochure	-	-	289.00	-	289.00
George McLaughlin/Consultant Services	32,640.00	16,320.00	24,480.00	24,480.00	97,920.00
Credit - Travel/J. Williams I2 Meeting (Raleigh, NC 10/2011)	-	(1,166.41)	705.11	-	(461.30)
Credit - Travel J. Graham (Hibernia, I2 and IRNC Mtgs)	-	(5,759.44)	-	-	(5,759.44)
Travel - J. Hicks Conference Fee Internet2	-	450.00	-	-	450.00
Travel - J. Hicks/APAN Conference 8/2012	-	2,791.10	10.00	-	2,801.10
Travel - Hicks/TransPac Mtg 5/31/12	-	57.72	-	-	57.72
Travel - Hicks/TransPac Mtg 6/7/12	-	57.72	-	-	57.72
Travel - Hicks/TransPac Mtg 6/14/12	-	57.72	-	-	57.72
Travel - J. Hicks/Mtg w/Internet 2 and Visitors from Japan	-	57.72	-	-	57.72
Travel - J. Hicks/Mtg w/INCTRE	-	56.61	-	-	56.61
Travel - Hicks/Teaching Summer of Networking Openflow Workshop	-	115.44	-	-	115.44
Travel - J. Williams/ Mtg w/Steve Wolff for India-US Mtg	-	957.31	-	-	957.31
Travel - J. Williams/China/US Conference	-	361.84	1,022.19	-	1,384.03
Travel - J. Williams/Internet 2 Mtg 10/2012	-	422.60	1,031.52	(804.51)	649.61
Travel - Williams/Mtg w/Partners from India 3/27/2012 Indianapolis	57.72	-	-	-	57.72
Travel - Hicks/Meeting on BL Campus w/M. Swany & Others to discuss	57.72	-	-	-	57.72
Travel - Hicks/Mtg on BL Campus w/M. Swany & other INCNTRE Members	56.61	-	-	-	56.61
Travel - Sweeny/APAN Conference 2/2012	1,079.47	-	-	-	1,079.47
Travel - Hicks/APAN Conference 2/2012	1,450.76	-	-	-	1,450.76
Travel - Winter I2 Conference Fee J. Hicks	525.00	-	-	-	525.00
Travel - Williams/US India workshop Participating as host 3/21-3/24	386.31	-	-	-	386.31
Travel - Williams/APAN Conference Registration Fee	300.00	-	-	-	300.00
Travel - J. Graham/Hibernia Mtg. /This trip moved off in June, 2012 and	1,943.00	-	-	-	1,943.00
Travel - J. Hicks Meetings w/various groups at the GRNOC	-	-	57.72	-	57.72
Travel - J. Hicks/Infrastructure for Network Perf Monitoring Meeting	-	-	57.72	-	57.72
Travel - J. Hicks/Ghost writing meeting 11/5/12	-	-	57.72	-	57.72
Travel - B. Sweeny/APAN Conference	-	-	3,818.60	-	3,818.60
Travel - J. Hicks/Chinese-American Networking Symposium	-	-	755.21	613.14	1,368.35
Travel - J. Williams/ Mtg w/NSF 11/6/12	-	-	633.56	-	633.56
Travel - B. Sweeny/Joint Techs & APAN Meeting 1/12-1/25	-	-	-	2,281.23	2,281.23
Travel - K. Benton/APAN & Joint Techs 1/2013	-	-	-	3,465.17	3,465.17
Travel - J. Hicks/APAN & Joint Techs 1/2013	-	-	-	3,544.53	3,544.53
Travel - J. Hicks/Brocade Install 2/2013	-	-	-	432.60	432.60
Travel - J. Williams APAN & Joint Techs 1/2013	-	-	-	3,847.83	3,847.83
Wire Transfer fee	60.00	20.00	60.00	40.00	180.00
F&A on Other Expense 32%	19,058.11	11,488.44	10,551.64	16,484.38	57,582.57
<b>Total Qtr Other Expense</b>	<b>78,614.70</b>	<b>47,389.81</b>	<b>43,525.51</b>	<b>67,998.08</b>	<b>237,528.10</b>
<b>Circuit Expense</b>					
KDDI Circuit Charges	101,900.00	130,400.00	68,800.00	99,600.00	400,700.00
<b>Total Circuit Expenses</b>	<b>101,900.00</b>	<b>130,400.00</b>	<b>68,800.00</b>	<b>99,600.00</b>	<b>400,700.00</b>
<b>Grand Total ACE Annual</b>	<b>163,910.72</b>	<b>273,817.14</b>	<b>161,000.67</b>	<b>193,721.17</b>	<b>792,449.71</b>

## **Completed Tasks for 1-March-2012 through 28-February-2013**

### **OpenFlow**

Worked on redesigning Transpac3 to accommodate OpenFlow capable device using a Brocade switch. Installed OpenFlow-capable Brocade switch in Los Angeles, connected to TransPAC router, to PacificWave, and to JGN.

Continue developing and helping teach OpenFlow training workshop. Continued to teach OpenFlow workshops (Stanford, Merit, GRNOC staff). Helped teach OpenFlow training workshop at the TIP2013/APAN meeting

Produced phase 1 diagram to incorporate Brocade switch for TP3 NDDI JGN-X OpenFlow connectivity. Obtained initial quote for Brocade switch maintenance contract.

### **Dynamic circuits**

Brought up test image of OSCARS 0.6. There are issues with OSCARS 0.6 and measurement functionality. Progress of the APAN installation: Initial APAN installation was completed. In coming quarter will move them to latest revision of the code. Possibly implement production OSCARS 0.6 based on compatibility with JGN-X.

### **Measurement**

Worked with CERNET to implement perfSONAR-BOUY on the CERNET 10G circuit. Extensive prep work for the US-China circuit launch in Beijing. Prepared and performed perfSONAR demonstration for the CERNET ceremony in Beijing.

TP3 perfSONAR SNMP MA services under full GRNOC support.

Continued to work with CERNET to implement production support for perfSONAR on the CERNET 10G circuit.

Installed new 10G server in LA to facilitate measurement activities.

### **Engineering**

Continue to work with CERNET on peering questions, both externally (other peering requests) and to ensure that the Chinese destinations important to researchers are represented, enabling them to take advantage of this resource.

Worked with DANTE, CERNET, & Internet2 to engineer and implement Orient+ backup before Jan 2, 2013 turn-up.

## **Security**

Draft information sharing agreement: Completed [1]. Shared with AP and EU partners for their review.[1] <https://github.com/collectiveintel/cif-legal>

Developed testbed for inter-federation sharing of security threat indicators; implemented testbed sharing between REN-ISAC and APAN researchers; and developed cookbook documentation for establishing similar inter-federation sharing based on the CIF tool.

Continue to work on the X-ARF to CIF translation (for DANTE<->US sharing).

## **Meetings**

TP3 staff attended various meetings during the year (APAN, CANS, SC12). These are detailed in the Quarterly Activities Section.

## Plans for 1-March-2013 through 28-February-2014

1. Move IDCP 0.6 into production
2. Implement full PS-PS measurement mesh
3. Implement OpenFlow capabilities
4. Continue work on portal
5. Continue measurement work with CERNET and CSTNET (via CANS)
6. Continue work with OSCARS PS measurement
7. Continue to support development of OpenFlow Operations workshop.
8. Assist in delivering first OF Ops workshop in May.
9. Provide support for Martin Swamy-NICT (and possibly KISTI) experiments/demonstrations of high-performance long-distance low-loss file transfers using new RDMA-based file-transfer technologies.
10. Help develop NREN activities in Africa.
11. Worked with DANTE, CERNET, & Internet2 to support ORIENTplus backup over CERNET and Internet2.
  - Continue to work with DANTE, Internet2, and CERNET to add layer2 backup capabilities to ORIENTplus service.
12. Continue to work with CERNET on engineering their service in Los Angeles, including evaluating requests and adding new peers.
13. Now that the TransPAC3 Brocade OpenFlow-enabled switch is installed (complementary JGN switches in Los Angeles and in Tokyo at the end of the TransPAC3 circuit should also be installed soon), move forward with actual OpenFlow experiments and demonstrations advancing toward full operation.
14. Work with Internet2 to roll out production services in Singapore collocation space.
15. Examine potential for conducting security event and threat indicator information sharing with the European partner (exploring such issues as privacy), and establish a testbed implementation.
16. Develop TP3 transition plan
17. Work with TP3 partners on feasibility of 100G trans-Pacific service.

**Summer Internship Report**  
**IRNC:ProNet: TransPAC3 - Asia-US High Performance International**  
**Networking NSF OCI Award #0962968**  
Kevin Benton

## **Background**

I am a PhD student about to start my second year in Security Informatics at Indiana University this fall (2012). I received a M.S. in Informatics with a focus on security from the University of Nevada, Las Vegas (UNLV) and a B.S. in Network Technology from Montana Tech.

I have experience developing web applications from my employment at UNLV. However, my primary background is in network engineering and systems administration from my work in the IT department at Montana Tech during my undergraduate career.

## **Internship Activities**

The work centered on “community security” deliverables identified in the TransPAC3 project<sup>1</sup> description, specifically: “[the] community security plan emphasizes linkage of US and Asian trusted information sharing communities and engagement with those communities to effectively address security threats and incidents. In the US, we will engage with the Research and Education Networking Information Sharing and Analysis Center (REN-ISAC) to accomplish these objectives.”

The work was conducted in engagement with REN-ISAC staff, and revolved around the Collective Intelligence Framework (CIF) they have developed for sharing network security intelligence data on a large scale.<sup>2</sup> CIF is the open source component of the REN-ISAC Security Event System (SES), which is utilized by hundreds of institutions to get nearly real-time threat indicators.<sup>3</sup> SES version 3 is the subject of a current NSF award, SDCI Sec: SESv3 (Security Event System - Version 3), award OCI-1127425.

The goals of the internship were to: (1) establish a test bed of multiple CIF installations sharing data through "inter-federation", (2) create documentation, as a case study, on configuring and establishing inter-federation, and (3) work with our TransPAC3 partners to establish an active inter-federation pilot.

## **Accomplishments: Federated Sharing Use Case**

The primary goal of the internship was to create documentation that describes how to utilize the Collective Intelligence Framework developed by REN-ISAC in a federated data sharing use case scenario. In this context, "federated data sharing" involves the capability for sharing threat

<sup>1</sup><http://internationalnetworking.iu.edu/TransPAC33> <sup>2</sup><http://code.google.com/p/collective-intelligence-framework/> <sup>3</sup><http://www.ren-isac.net/ses/>

indicators among disparate trust communities, such as REN-ISAC sharing with other ISACs, the DHS, national CERTs, etc. This goal was accomplished and the finished document is available to the public on the project's website.<sup>4</sup>

The document also includes a small Perl script I wrote that extracts failure events from SSH authentication logs and puts them into a format that can be consumed by a CIF instance. While not directly related to federated sharing, it illustrates how an organization can easily format and collect private internal data using CIF.

This documentation can be used by anyone to setup a CIF instance and begin sharing network threat intelligence with other organizations. We are working with the chair and co-chair of the APAN Security Working Group to establish a data sharing relationship between Kyushu University and REN-ISAC.

Kyushu University has successfully setup a CIF instance following the documentation developed from the test bed at REN-ISAC. The only issues they ran into were related to an older version of Perl that they were using, but they worked around them with a few minor changes.

A test CIF instance at REN-ISAC is configured to aggregate several public feeds of indicators and provide access to Kyushu University. Additionally, their CIF instance is collecting indicators generated from failed login attempts to their servers. Each CIF instance is also configured to share the collected data with the remote CIF instance, which completed the goal of setting up a functional test bed of federated data sharing.

The co-chair has proposed a joint presentation of the results of the collaboration in a session at the Winter 2013 APAN / ESnet / Internet2 international technical conference.<sup>5</sup>

### **Amazon EC2 Image**

Setting up a CIF instance has a large number of software prerequisites and steps which led us to the idea of creating a pre-configured Amazon Machine Image (AMI) to lower the technical barrier to try out the framework. An AMI is a snapshot of a virtual machine that can be turned into a virtual machine on Amazon's Elastic Compute Cloud.<sup>6</sup>

The complete guide is available to the public along with the AMI image on the collective intelligence framework website.<sup>7</sup> This AMI drastically reduced the setup time because it eliminated the need to provision hardware, configure prerequisites, compile code, etc.

### **Browser Clients**

One of the barriers to overcome when working with CIF is learning to use the Perl client on a command-line interface to run queries against CIF to view data. A command-line environment with the Perl CIF client installed may not be available or easily accessible for many CIF users. To lower the barrier for the inter-federation pilot sites to interact with CIF, I wrote browser plugins for Mozilla Firefox and Google Chrome, both of which are open source and available to

<sup>4</sup><http://code.google.com/p/collective-intelligence-framework/wiki/FederatedSharingExample> <sup>5</sup><http://events.internet2.edu/2013/tip/> <sup>6</sup><https://aws.amazon.com/amis/> <sup>7</sup><http://code.google.com/p/collective-intelligence-framework/wiki/CIFDemoOnEC2>

the public on Github.<sup>8</sup>

The plugins offer a convenient interface integrated directly into the browser, allowing security researchers to query CIF instances for data points in a few clicks and get formatted, sortable results with links to related events without leaving their browser. The plugins also offer functionality beyond the command-line client by allowing users to submit threat indicators directly to a CIF instance rather than adding them to a separate data-source that the CIF instance would eventually read.

### **Web Interface (work in progress)**

One of the current limitations of CIF is its lack of support for a commenting system. REN-ISAC handles this with additional custom components in their SES system that handles conversations. However, the custom components are very specific to REN-ISAC and are not available to the public.

To make similar functionality available to inter-federation partners, I began work on an open-source web interface that allows users to submit threat indicators and have conversations centered around each indicator. These indicators are then aggregated into feeds that can be consumed by CIF instances. This partially completed project will be available on Github in the Collective Intelligence repository collection.<sup>9</sup>

### **Experience Gained**

All of the experience I received while working for REN-ISAC over the summer involved working with the Collective Intelligence Framework, ranging from creating test beds and documentation to writing clients and contributing code. The browser clients are used on a daily basis by many CIF users and REN-ISAC has received positive feedback about them several times.

I gained a better understanding of the challenges when working with big data with limited hardware resources and the impact of software architecture decisions at large scales. The current version had started to hit performance bottlenecks due to the way data was represented during transportation and storage. I saw how the new version being developed performed an order of magnitude better by switching to Protocol Buffers for storage and transport along with a new component-based architecture that scales better by spreading the workload across many processors/servers .

This was the first time I authored code that was part of a larger project (outside of class projects) with multiple active developers. I gained experience using source code version control systems in a collaborative environment to allow concurrent development on software while ensuring quality control and change history for accountability. It was also the first large project I've worked on using the Perl language, which gave me experience with object-oriented programming in Perl and common Perl practices to make code easy to maintain and reuse.

Finally, I gained insight into how information sharing communities work and the advantages they provide to network operators trying to mitigate threats. From a research perspective, the information aggregated by communities in systems like CIF could provide insight into the behavior of attackers or networks over time. I plan to continue working with REN-ISAC throughout this school-year and utilize the Collective Intelligence Framework for a research project as part of my academic work.

<sup>8</sup> <https://github.com/collectiveintel/cif-client-chrome> <sup>9</sup> <https://github.com/collectiveintel>

Darah Patton  
International Networking @ Indiana University: Reflection  
April 13, 2012

After growing up in a Boilermaker family, to say my family was surprised I chose to attend Indiana University is an understatement. But IU's prestigious Journalism School was just too difficult to turn down. I am now about to finish my junior year at IU with a double major in Journalism and Political Science. At IU, I stay busy through my involvement in the Public Relations Student Society of America, Indiana Daily Student reporting, and Greek life. After studying abroad in London last summer, I became consumed with plans of future travel. I would love to work for an international public relations firm and live abroad for a few years after graduation.

This interest in travel and global affairs led to my internship with International Networking @ Indiana University. To be honest when I first started this position, I was not even sure what international networking was. I read through the IN@IU website feeling as though I was trying to comprehend a foreign language. But after a lot of research and a lot of questions I began to understand the basics of computer networking. One of our first assignments as an intern was to write a science highlight about the ACE project. This piece of writing summarizes the background, impact, and outcomes of a National Science Foundation project in order to help the NSF receive future funding from congress. This assignment was extremely helpful because it forced me to translate all of the scientific terminology into simple and direct language. After pushing past the learning curve, I was able to put my background in communications and public relations to work. A majority of the work I completed during this internship involved design. I used the Adobe products to create multiple maps to illustrate the different international network connections for ACE and TransPAC3. These visuals make it much easier to the impact and outreach of IN@IU's projects. I also created a display poster for the TransPAC3



project. This poster illustrates and briefly explains the significance of the TP3 project. This poster will hang in the Cyber Infrastructure Building along with the other GlobalNOC project posters. It will also be used at conferences and events as a visual promotional tool. Along with the poster, James Williams needed digital visuals to assist him in his presentations at these same events. Therefore, I created a Prezi presentation, the next generation of PowerPoint, for Williams to use during his presentations. While most of the tasks I completed over my internship were requested, the press release I and the other intern collaborated on initially started as a mere suggestion to Williams. Before this internship, I had no idea IU was the leading institution in international networking. Therefore, we decided something needed to be done to improve awareness on the IU Bloomington campus about its International Networking program. After completing research and interviews, we wrote a press release to be submitted to the Indiana Daily Student. We also hope to send this news release to other Indiana newspapers.

This internship was a great experience because it allowed me to advance my communication and design skills while gaining knowledge on an extremely complicated topic. Because I want to work in public relations after graduation, any writing practice is valuable. The experience I gained writing company highlights, press releases and presentations will be a crucial skills I can translate into any type of communications job. My experience with the Adobe products also greatly improved because of the many illustrations and poster I created. Before this internship, the design segment of PR is where I most lacked experience. Now, my experience with the Adobe products will help me to be a more competitive and well-rounded applicant for future jobs. While I did gain very valuable practice with communications work, the most important lesson this internship taught me was to step out of my comfort zone and learn new things. It is so easy to be intimidated by fields you do not understand or language you are unfamiliar

with. However, this internship forced me to be uncomfortable and learn new information, showing me that being unsure is too often an excuse not to challenge yourself.

Alisa Wiersema  
IN@IU – Intern Reflection  
April 13, 2012

When I entered college I thought Journalism was limited to writing, broadcasting and essentially telling people what was going on in the world around them. However, within my first few weeks as a college student, I was quickly taught that there is more to Journalism than simple information dissemination, but rather that there was in fact, quite a bit of strategy involved in the very essence of communication. I found this intricacy fascinating but did not feel as connected to the practice of journalism as I expected. I enjoyed my classes thoroughly but wished there was a way for me to practice communication in action rather than simply writing about it. Luckily, when I began having these issues I enrolled in an introductory course in Public Relations. After creating my first communications plan I knew I found passion in my education; not only was I able to write, but I also had the ability to see my efforts materialize into results, while learning from a variety of people and situations.

Since then, Public Relations has taught me much about the professional world, the non-profit sector, agency relations, and now, international networking. My internship at Hirons & Company during the summer of 2011 showed me that a diverse clientele builds up professional experience, while simultaneously refining a person's education. I can definitely say that working with International Networking at Indiana University for the past few months allowed me to accomplish both of those aspects.

Initially, I did not expect to have the amount of creative freedom in a technologically-based field, but this internship actually provided me with the most creative liberty I have had to date in any work experience. Not only were there actual creative assignments, but also, I was able to execute these creative strategies on my own with few limitations. Alongside with another intern, I was able to create revised business cards, a professional IN@IU poster, write an upcoming article about the program, and

design a professional presentation, all the while learning about the topic of International Networking. The variety of assignments truly helped me understand the impact of what International Networking at Indiana University contributes to not only our university and nation, but to the world. It is incredible to know that a university in the middle of Indiana can aid people across the world in their communication and research endeavors, and it makes me proud to have attended such an institution. I would have never guessed that as a senior in college I would be exposed to a topic that seems so unrelated to my field of study, but I am so grateful to have had this opportunity because it embodied what Public Relations is all about—consistently learning from your clients and audiences.

Upon conclusion of this internship, I was offered (and accepted) admission to Georgetown University's Communication, Culture and Technology (CCT) Graduate Program, and I have a feeling that my involvement with International Networking at Indiana University greatly helped my placement in the program. When I applied to Georgetown, I was unsure if I had any kind of technological experience to associate with CCT. Now, I feel confident about pursuing this area of study because I feel that I am better informed about the process of creating and maintaining international networks and partner relationships than the average, college educated person. I can tell that this area of research will be (and already is!) incredibly important in the near future as it parallels the process of globalization.

As a graduating senior and upcoming graduate student, I hope to apply this newfound understanding of International Networking in the area of Public Affairs. I am certain that the types of relationships created through international networking will help politicians and other public figures have a common ground in creating projects together, rather than antagonizing one another on a global level. I believe that having the understanding about how countries all around the world are able to unite over research and academia is comforting and valuable. It is good to know that countries can work

together on projects that do not center on conflict and communicate with one another productively.

## OpenFlow Instruction for DANTE and APAN

Steven Wallace, Director – InCNTRE

[ssw@indiana.edu](mailto:ssw@indiana.edu)

As a result of the TransPAC3 supplemental funding, InCNTRE was able to improve its “OpenFlow in A Day” workshop and deliver the workshop, as-well-as consulting on how to conduct the workshop, to representatives of DANTE and APAN. Exact delivery dates are listed below.

In addition to actual delivery of the workshop, the funding allowed the method of delivering the workshop to be changed from using limited capacity server equipment located on the IU campus to using Amazon Web Services virtual machines. This greatly reduced the risk of “network problems” interfering with the workshop.

The fees for using the AWS VMs only apply to the time they're actually spun up to support the workshop, and, in theory, any number of VMs can be created allowing the workshop to meet a varying number of participants. This is quite cost effective and allows for significant variation in the number of participants (limited only by the number of instructors).

The workshop materials, both the slides and the Amazon Machine Images, were made available to DANTE and APAN for their use in conducting their own workshops and are available to others. The dates and pointers to the slide decks used for these workshops are found here:

31-Oct-2012 Dante (slides <http://tinyurl.com/Dante-OF-training>)

16-Jan-2013 APAN (slides <http://tinyurl.com/TIP2013>)

As an unexpected benefit, we were also able to leverage workshop improvements to offer a cost effective, cost reimbursed workshop to SURFnet on 7-Mar-2013.

The agenda for the workshops included the following:

- OpenFlow use cases
- OpenFlow's origin
- ONF overview
- SDN overview
- OpenFlow overview
- OpenFlow (more detail)
- OpenFlow 1.0 vs. 1.1+
- OpenFlow QoS
- Hands on exercises
  - + learn switch
  - + manual rule insertion
  - + FlowVisor virtualization

The workshops and content development were both prepared/conducted by Steven Wallace ([ssw@indiana.edu](mailto:ssw@indiana.edu)).