

# PNG TRAINING Final Report

**3 January 2021** Reporting on the following grants: Technical Cybersecurity, and Incident and Network Management Training (TAF-APNIC Foundation) Regional PNG Technical Network Management Training (APNIC Foundation)

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> Participants in 'Technical Cyber Security, and Incident and Network Management Training' workshop (Papua New Guinea, 2019)

### **EXECUTIVE SUMMARY**

"The Asia Foundation (TAF), in cooperation with the Foundation of the Asia Pacific Network Information Centre (APNIC Foundation), will deliver a program of work to help reduce network inefficiencies, and enhance cybersecurity and incident response capability in Papua New Guinea (PNG)".<sup>1</sup>

The Internet and its ecosystem in PNG are still formative. At the beginning of the period covered by this report, PNG's international Internet connectivity comprised a single undersea cable and satellite services. However, PNG was poised on the edge of a boom in connectivity that would result in increased availability and reduced cost for the Internet over the project reporting period and well into the future.

As the Oceanic region's second-largest economy by both population and land area — second only to Australia — PNG has faced and overcome many technical challenges to provide communication and Internet services to its population. The operational environment in PNG continued to evolve through the course of the project and continues to evolve today. Since the Foundation's first engagements in 2018, the deployment of more infrastructure such as the subsea cables that serve international and domestic traffic has increased national connectivity by an estimated 1,000-fold over a two to three-year period<sup>2</sup>.

Kacific Broadband Satellites' first communications satellite, Kacific1, entered commercial service in March 2019, supporting customers in PNG with high-throughput Ka-band satellite services. Then the AUD 96.4 million Coral Sea Cable landed near Port Moresby and began operations in July 2019.

This revolution in connectivity continued with work on the USD 200 million 5,457 km (about the width of the United States) Kumul Submarine Cable Network (KSCN), now completed.

Scheduled to be commissioned in July 2020, the domestic Internet platform links 14 provinces and two national data centres in Port Moresby and Madang. Adding another 8 Tbps to PNG's connectivity, KSCN, will connect to Jakarta through Indonesia's national backbone submarine cable network and further connect to Asia to form another, new international Internet gateway.

#### The grants

The first project's program of work comprised three streams:

- 1) Technical training in network management best practices: A series of APNIC Foundation-led workshops for government and telecommunications industry staff to understand, manage, and use Internet infrastructure, resources and techniques to address local network latency issues. It will cover: Domain Name System (DNS); IPv6; Internet routing, traffic protocols and engineering; and network security protocols.
- 2) Technical training in cybersecurity and incident response capabilities: building on the existing technical support for the National Information and Communications Technology Authority (NICTA), to support PNGCERT. It comprised two components:
  - i. Technical assistance to PNGCERT, including training on cybersecurity, incident response and malware issues, as

well as facilitating operational linkages with neighbouring Computer Emergency Response Teams (CERTs).

- **ii.** TAF-APNIC Foundation facilitated PNGCERT dialogue with telephony and Internet Service Providers (ISPs), and other stakeholders to enhance industry linkages. TAF will also facilitate high-level PNGCERT industry discussions with the intent to mature PNG's national cyber incident management
- 3) Chief Executive/Chief Information/Chief Operation Officer level ('C-level') industry dialogue: TAF-led dialogue to generate industry buy in and support to improve strategic local infrastructure, particularly for a NICTA-hosted neutral Internet Exchange Point (IXP) to improve local network efficiency, and to develop consensus on local caching options and arrangements.

This final report responds to and provides detail on the following two activities (as of 31 December 2020): Technical training in network management best practices and technical training in cybersecurity and incident response capabilities. The third activity was managed and conducted by the Asia Foundation.

In March 2019, a second grant agreement (Regional PNG Technical Network Management Training) was agreed on. This

This is the original text taken from the DFAT Grant Order

<sup>&</sup>lt;sup>2</sup> https://www.researchgate.net/publication/334507297\_Connecting\_Papua\_New\_Guinea\_-The\_ Dawn\_of\_the\_Digital\_Era <sup>3</sup> This is the original text taken from the DFAT Grant Order

focused on delivering training outside of Port Moresby and the following two main goals<sup>3</sup>:

- Further developing the knowledge and capabilities of PNG's Internet network operators and managers by helping them understand and manage Internet number resources, as well as effectively utilize appropriate Internet technologies and techniques; and
- 2) Deploying Internet technical experts and staff with specialized knowledge on local network latency issues to PNG to engage with key stakeholders, discuss their specific technical issues, and provide best current practice information and guidance.

### **Funding received**

Grant 1. Technical Cybersecurity, and Incident and Network Management Training: Enhancing National Cybersecurity and Network Quality of Service in Advance of Papua New Guinea's Hosting of APEC (USD 343,354)

Grant 2. Regional PNG Technical Network Management Training (USD 100,408)

#### **Successful outcomes**

The two grants supported an extensive program of activities covering network training workshops and support for security and technical staff through 2018 and 2019. These grants were funded by the New Zealand Ministry of Foreign Affairs and Trade (MFAT); the Australian Department of Foreign Affairs and Trade (DFAT); in coordination with The Asia Foundation (TAF) (United States) and were executed and delivered by the APNIC Foundation in association with APNIC and PNG's NICTA.

Supported by these grants, the technical training and assistance project began in August 2018 and delivered 24 events over an 18-month period. These included seven workshops in the run-up to the APEC Summit.

The initial scope of work arose from the demands expected to be placed on PNG's Internet by the need to support the 30th Joint Ministerial Meeting of the Asia-Pacific Economic Cooperation (APEC) Ministers in Port Moresby on 15 November 2018 and the

26th APEC Economic Leaders' Meeting three days later.

The project was designed to respond to local demand for robust Internet connectivity by improving local capacity around network management and operations. The activities conducted also supported the ongoing establishment of the Cybersecurity Emergency Response team (PNGCERT) and the IXP in Port Moresby (PNGIX).

#### The 24 events delivered were:

- Three community consultations (two in Port Moresby and one in Lae) to provide local input and guidance on the most productive training focus.
- 17 technical workshops in response to the community consultations.
  - Two technical assistance visits for the local IXP.
  - Two technical assistance visits for PNGCERT.

The grants also provided funding for members of the PNG Internet technical community to participate in conferences,

workshops, and other activities designed to increase their exposure to international best practice and to build professional relationships.

The list of beneficiaries included participants from a wide range of organizations, such as private sector service providers, universities, and government departments, among other stakeholders.

The training workshops targeted the technical staff of local ISPs, mobile operators, government offices, universities, and private sector organizations to promote best practices in network management and operations. The workshops covered routing, network management and security, DNS/DNS Security Extensions (DNSSEC) and information security.

The technical assistance visits provided support and training for the newly formed PNGCERT, with a particular focus on incident response. Importantly, the project also drew PNGCERT into regular dialogues with other CERTs in the region, as well as ISPs, mobile operators, and other key service providers.



The Foundation also provided technical support and training for PNGIX to encourage greater ISP participation in the neutral IXP and development of the IXP community.

A TAF-organized, high-level cybersecurity dialogue with government policymakers was held from 26 to 28 September 2018 in parallel with the APNIC Foundation technical training. This and other TAF activities — including a final TAF-led virtual cyber event held in November 2020 — are not covered by this report.

Targeted at not only APNIC's 31 Members in PNG, (including ISPs and mobile operators), but also technical staff at a range of government departments, businesses, and academic organizations, the workshops were conducted in Port Moresby in 2018 and then expanded in 2019 to include the northern city of Lae.

### Wide range of project beneficiaries

Participants from nearly 100 organizations engaged in project activities, providing significant insight into the size and complexity of the PNG Internet and the industry supporting it.

In total, around 250 individual technical staff (386 registered in total, 22% female participation) from 96 organizations benefitted from the training opportunities provided, with some attending up to six workshops.

This report describes some of the priorities and challenges faced by the PNG Internet community and the challenges and activities the APNIC Foundation undertook to provide training,

build community, and assist in the establishment of PNGCERT, the PNGIX and finally, PNGNOG..

The initial 2018 community consultation acted as an advance, initial engagement, informing better decisions about the project and logistics while allowing the APNIC Infrastructure and Development team and APNIC Foundation trainers to anticipate and better understand the needs of potential participants and the community in general.

Speaking directly with Internet community members as the first step in the project planning served several purposes: from evaluating training needs to generating the project's profile and raising interest in the upcoming opportunities for training.

> The initial series of meetings and the follow-up online consultations in the form of an online survey developed by third-party research firm SurveyMatters, also provided an opportunity for industry experts to engage with significant senior managers in a range of positions in the PNG technical community. These meetings provided a platform of support for investment in human capital and a recognition of the needs and advantages of best practice Internet engineering.

Then, in 2019 an additional consultation in northern Lae estimated demand for technical training in the second largest city and offered an opportunity to further support and investigate the opportunities at the University of Technology (Unitech), the nation's leading educator of network engineers and the domain name registry for .pg.

As each of the workshops was conducted, reporting by trainers and local organizers in addition to post-event surveys

demonstrated that the benefits were significant and ongoing, although more needs to be done to maintain momentum. As the industry develops and evolves, the project team was able to tailor offerings and identify community members eager to expand and improve the PNG Internet, while also exposing where existing arrangements and infrastructure may be insufficient to support the kind of active growth seen in other developing economies.



The project — the largest technical training program APNIC has been involved in at a national level and the largest provided to

any Pacific economy to date — was a significant development opportunity for the PNG Internet community. The intensive training and support not only helped local operators prepare for the APEC meeting but also ensured the technical community was prepared for the increased bandwidth provided by the new Submarine Cable and other investments.

This initial project in the lead up to the APEC Summit highlighted the support for and need to further engage the local technical community in a program of capacity building, particularly to support the upcoming arrival of the new Coral Sea submarine cable (PNG's second undersea cable) and enhanced Ku Band satellite services. This led to a second series of workshops, webinars, and engagements being held in 2019/2020.

In addition to the events in PNG, the project provided fellowships to the most committed trainees that attended and completed the highest number of workshops. These fellowships allowed recipients to travel and participate at a workshop of their choosing at APNIC 46 in Noumea, New Caledonia (four sponsored participants), and APRICOT 2020 in Melbourne, Australia (seven sponsored participants).

These activities were all intended and designed to deliver longterm impacts to the Internet in PNG.

Internet network operators, the newly formed CERT, and the recently launched IXP, all benefitted from the intensive technical capacity building. In August 2019, an additional round of Community Consultation allowed the project team to evaluate how far the community had come in the first phase of the project. This consultation demonstrated the benefits were significant and ongoing.

As new international bandwidth has helped boost the capabilities of the local Internet, PNG's first IXP in Port Moresby continues to grow; PNGCERT is working with the international CERT community while settling into its new offices at NICTA; and the local technical community has formed a Network Operators Group (NOG), and announced plans for its first community event — PNGNOG. At a meeting in early July 2020, the community came together to form a nine-member Steering Committee, and elect a Chair, Co-Chair, Treasurer, and Secretary in addition to appointing another nine volunteers to a Program Committee. The Steering Committee was to meet fortnightly to undertake the required preparations to establish PNGNOG as an association, and the Program Committee was to investigate the need and opportunity for an ongoing series of training and events.

While the project's activities successfully responded to many of the immediate needs of the technical community, the community consultations and the monitoring and evaluation of the project identified a range of additional future challenges and yet to be met needs. The project outcomes include the recommendations highlighted in the next section of this report. A full set of recommendations are provided along with detailed specific recommendations arising from the technical assistance measures for PNGCERT and PNGIX. These recommendations serve as an important and key outcome of the project's activities.

### **Future challenges**

"While the project's activities successfully responded to many of the immediate needs of the technical community, the community consultations and the monitoring and evaluation of the project identified a range of additional future challenges and yet to be met needs."

#### Summary of project recommendations

 Locally driven community training: Continuing and increased investment in professional — operationally relevant — training at the local level for network engineers and network technical staff including support for local universities, technical colleges, and other training partners.

- Increased activity to promote online resources: Incentives may be required to encourage participants to complete basic training online before doing more advanced faceto-face training. The deployment of more tailored and advanced blended learning options may increase the return on effort in the current environment.
- Infrastructure planning and investment: With the successful completion of Kumul Submarine Cable Network System 1, further expert advanced support is needed for planning and development of Internet infrastructure, especially in the development and operation of more complex network deployments over hybrid topologies, expansion of services and coverage, and local traffic management (for example, IXPs). It is recommended to time training sessions strategically to support planning and implementation stages.
  - Cybersecurity training and engagement: To support the cybersecurity demands of PNG's networks, especially those in the government sector, a fully resourced plan for continuous training and engagement must be developed, with particular emphasis on and support for PNGCERT.
  - Greater focus on governance for PNGIX: A neutral IXP needs careful implementation to ensure equitable and fair operations free from potential conflicts of interest. A business plan designed for long-term viability should be in place at the Port Moresby site before establishing an IXP in Lae.

### **METHODOLOGY AND RESULTS**

The three separate community consultations held at the start and then twice during the project were key to its success. They allowed the local community to have direct input into what training they received but also to give feedback on how the training was going.

Project delivery responded to training and capacity-building needs highlighted in a series of three community consultations - two in Port Moresby during 2018 and 2019 and one in the northern city of Lae in 2019. These consultations — managed by local project coordinators — informed the project team, providing local input and guidance to what capacity-building activities would be the most effective in reaching the objectives agreed in the grant process.

The consultations were followed by 17 technical training workshops covering network routing, information security, network security, and DNS/DNSSEC, plus four technical



Percentage of people registered for more than one workshop

assistance engagements supporting PNGIX and PNGCERT. Workshops were conducted in Port Moresby in 2018 and in both Port Moresby and Lae in 2019/20.

In total, 250 individuals from 96 organizations benefitted from the training opportunities provided, with some attending up to six workshops each. Efforts to promote gender diversity achieved a 22% female participation rate across the course of the engagements.

Led by these community engagements, the project has been the single largest technical training and assistance effort at the national level in APNIC's 20-year history. At the same time, it provided training opportunities and content never before seen in the Pacific's second largest economy.

#### Background

The Asia Foundation (TAF) was the primary recipient of funds granted by DFAT and MFAT. The APNIC Foundation worked with TAF to design and execute the project in a flexible manner to adaptively work toward the project's goals.

TAF is a non-profit international development organization with offices in 18 economies. Informed by deep local expertise, TAF addresses critical issues affecting Asia by strengthening governance, expanding economic opportunity, increasing environmental resilience, empowering women, and promoting international cooperation.

Although initially responding to a direct need to develop cybersecurity capabilities in the PNG Internet technical community in support of the 2018 APEC Summit, the first and subsequent grant was intended to provide ongoing support to the PNG Internet community and industry.

The New Zealand and Australian government disbursements were used effectively by the APNIC Foundation with support from APNIC and in association with the PNG communications regulator the NICTA.

#### Planning

At a high level, the project's activities were to build capacity in the PNG technical community, to engage and support cybersecurity (CERT) activities, and to engage in a series of consultations to support strategic goals and address concerns among the participants in the PNG Internet ecosystem.

There was a very compressed timeframe between project approval and the deployment of the first training workshop in Port Moresby. During that time, the Foundation team recruited a local coordinator ahead of an initial community consultation process and identified technical experts to deliver APNIC training materials alongside APNIC trainers.



PNG Netsec workshop (2018)

The project team developed a comprehensive list of topics for discussion and a corresponding set of questions to guide various aspects of the interview process.

The project team used the APNIC Member database as an initial basis for the invitation list to coordinate a series of face-to-face visits led by the first community consultation team. This offered the project an active and engaged list of potential candidates for interviews. Then in August 2018, a team of experienced technical experts accompanied by an APNIC Member Services representative travelled to PNG. Together with a local coordinator, they conducted community consultations involving face-to-face meetings. In addition to collecting quantitative data based on the comprehensive set of questions and topics for discussion, each of the consultation team members individually reported their findings back to the APNIC Foundation in written reports.

Quantitative data collected during this interview process exposed the key demographics, skill levels, and capabilities of the local operators. The Foundation was able to leverage the experience of the APNIC Infrastructure and Development team in the design and analysis of the data collection and to design a set of training materials to be delivered in the first workshops.

The consultation provided insights into the local Internet community directly to those who would deliver the early training sessions, but also provided valuable insights to the project coordinator and the APNIC Training team to devise the lesson plans and lab equipment.

An online registration process was organized for all training workshops to facilitate the logistics. The registration links were not open to the public but were sent to the organizations

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that participated in the consultations to nominate and support participation by their technical staff. A local coordinator followed up with the confirmation of registered participants to make every possible effort to fit the workshop capacity. The project team in Australia was in charge of training materials and lab design, as well as travel arrangements for trainers, and communications.

After each workshop was delivered, the project team held a survey to assess the quality of the training provided and capture feedback to improve future events, monitor trainers' performance, and assess changing needs, for the purposes of continuous improvement. Each trainer was also asked to submit a written report after every event.

Additional follow-up activity was conducted at different project intervals, to monitor progress and consolidate reporting.

### **IMPLEMENTATION**

Across the entire series of workshops, the same challenges recurred despite adaptations by the project team. Venue and travel logistics placed a strain on resources and caused frustration in delivery.

Stringent and proactive management of registrations were effective sometimes, but at other times seemed to be overtaken by other events.

Despite job titles such as Systems Administrator, ICT Trainer, and Senior Technical Officer (ICT), some participants had few of the basic SysAdmin and other core technical skills, with some lacking even the awareness that they did not have these skills.



The 2019 community consultation acted as a significant milestone for the project team to assess the impact of the training conducted before the APEC Summit in 2018 and

to incorporate feedback received for continuous improvement. Although significant challenges remained, during this consultation it was reported that more of the ISPs were evaluating and planning to deploy sophisticated network solutions in line with best practices to address global challenges. Some were already investigating how to deploy IPv6 in their networks and using advanced security services from APNIC such as Resource Public Key Infrastructure (RPKI) and Route Origin Authorizations (ROAs) that can provide overall network security — a concept virtually unrecognized by the PNG community in 2018.

Similarly, spurred by these key changes in the PNG ecosystem, more ISP's were connecting to PNGIX as organizations began to realize the cost-benefit of this critical infrastructure.

Throughout the life of the project, the project team faced many of the challenges typically faced in a developing economy, from adverse governmental travel advisories creating occupational health and safety burdens, to minor frustrations and annoyances with event and venue logistics, in particular, the poor Internet connectivity in some venues that affected planned activities.

Finally, developing an engagement strategy with a technical community that was yet to organize around a NOG — and not previously exposed to such extensive training offered externally — had its own challenges. Organizations and individuals were challenged to manage the time commitment required for training considering competing priorities, despite the benefits of information exchange and collaboration.

Accordingly, the project team had to build its own capacity to respond to these challenges and over the period has developed and adjusted procedures, practices, and approaches that enhance both delivery and outcomes for the PNG community.

#### **Responsive approach to training delivery**

While there was a strong emphasis on training for capacity building, there was a parallel effort to identify and build a selfreliant community of technicians who can continue to develop technical aspects of the Internet in PNG.

Despite the challenges, the project successfully executed a series of engagements with the PNG technical community and built linkages between PNG and other communities of expertise and best practice in the region.

### Participants level of expertise



#### **Responsive approach to challenges**

Over the 18-month span of delivery, there were significant changes to the level of knowledge and needs of the PNG Internet

The consultation process had established that much of the PNG Internet comprised relatively simple networks with a single upstream provider and often few or no peers.

Although PNGIX had been established as a peering point for operators, there was relatively little use by smaller players whose network connections were provided primarily through the national wholesaler, and there was little need for complex architectures and routing solutions. As a result, only the mobile operators had any complexity in their networks. The project team did not have the opportunity to engage the engineers from the satellite operators.



With the growth of incoming connections expected from the subsea cables and new satellite services, it was imperative the community begin to understand the benefits and management needs of more complex architectures.

The project team found it was difficult for managers and other respondents to properly assess the needs of their staff as they had little exposure to the modern best practice themselves and were so familiar with the architectures that have evolved locally, that they could not accurately predict what might be needed as they move to a more sophisticated network environment.

The project team adopted a broad perspective in evaluating and responding to the capacity-building needs of a local economy, and in addition to the immediate training needs associated with the hosting of the APEC Ministerial, they also designed a program to:

- Encourage institutions to adopt technical best practices
- Encourage the formation of a NOG
- Support PNGCERT
- Support the operation of PNGIX

Over the course of the project, continuous improvement mechanisms for course curriculum and event logistics were implemented based on feedback received via the reports developed by both the local coordinator and the workshop trainers after each event, as well as online evaluation surveys completed by workshop participants to assess the training delivery.

These provided a compendium of 'lessons learned' and experiences that were discussed and analysed by the project team and the APNIC Infrastructure and Development team.

Curricular, messaging, and event logistics were progressively adapted in response to these learnings.

Event logistics in PNG proved to be an ongoing challenge through the entire project as local event facilities were not always familiar with the needs of such an intensive, interactive training program. As part of the initial consultation process and in support of project planning, the local coordinator found ten possible event venues in Port Moresby. Venues were visited and reviewed against a list of technical and logistical requirements. IT training centres were initially selected to host the events, due to their location and set up, but later, hotels were used to host the events to provide better catering for the participants as well as to improve access to projectors and other technical support for the workshop rooms.

Similarly, tracking online registrations vs. attendance was an intractable challenge despite highly proactive supervision: waiting lists, reminders, active follow-up of registrants and their employers to ensure attendance, skipping days, and lack of solid prerequisite knowledge were all recurring themes through the workshops.

This seemed to apply whether invitations were sent directly to the community via subscriber forms to express interest, through



management contacts identified from the consultation process, or where NICTA agreed to operate as a go-between to inform and invite prospective engineers from government.

As the project had a clear commitment towards increased diversity, the lists of registered participants were reviewed to: 1) Serve as many organizations as possible, limiting the number of participants from one organization to a maximum of 3 (including at least one woman); 2) Encourage organizations to nominate and support women to register and complete courses; and 3) Actively engage with candidates via the waiting list to send last-minute invitations if confirmed participants cancelled at the last minute.

The first community consultation team recorded very strong preferences for face-to-face training and throughout the project there were efforts to encourage the use of online training via the APNIC Academy, which provides a full program of live and computer-based training opportunities.

#### Assessing status and needs

In 2018, the APNIC Foundation CEO made an introductory visit to Port Moresby at the beginning of the project before the full consultation team arrival in August that year. As core project partners, the APNIC CEO visited NICTA offices, and NICTA representatives in turn, visited the APNIC offices in Brisbane, Australia.

At the start of the project delivery phase, the Foundation hosted a meeting with representatives of the PNG government, the Australian government and other project partners. This meeting included an overview of APNIC and the Foundation's plan to execute the grant. To gain a full understanding of the situation in PNG, the project kicked off with a round of consultation meetings with stakeholders to gather qualitative and quantitative data. This first round of discussions took place in Port Moresby, the capital, and the site of the planned APEC Ministerial meeting.

Following the initial consultation, the project team worked with regional experts and the APNIC Training team to devise a program of activities designed to develop capacity in the PNG Internet community in support of the APEC meeting and the ongoing support of PNG society and industry.



All PNG-based APNIC Members were invited to meet with a team that included a local coordinator familiar with the work of APNIC and the Foundation, an APNIC staff member, and two regional technical experts who were familiar with the bulk of the course content APNIC provides.

Following the consultations in 2018, the APNIC Foundation commissioned the Melbourne-based research agency, SurveyMatters, to collate the information that had been gathered about the needs and outcomes from these activities, and to design and implement an online survey that could capture the existing information to be used for a further community consultation initiative that was conducted in April 2019.

An online survey instrument was designed as an anonymous survey, using the set of technical topics and interview questions that were asked in the 2018 PNG community consultations. A total of 76 surveys were completed, providing a good basis for initial analysis and for further collection of responses over time.

The 2019 consultations were similar to the first round of consultations, but with an expanded list of contacts gained through the 2018 activities. This afforded an opportunity to meet with organizations and individuals who were interviewed the year before and to bring in those who did not respond or were not invited to the first round of consultations.

In addition, as part of the 2019 consultations, a project coordinator visited the northern city of Lae in response to requests that training be extended to this major industrial centre servicing the PNG highlands. The purpose of this consultation was to gauge the level of skills and the needs of local Internet network engineering staff and to assess whether enough interest existed to make a program of local workshops viable.

Respondents in all three consultation phases ranged widely from large network operators and telecommunications carriers to smaller and more agile ISPs as well as representatives from government and the higher education sector, private sector companies, and a small number of civil society organizations. After internal discussions with the APNIC Training team, a decision was made to focus training on core routing skills and network security. Despite their lack of basic skills, respondents were equally willing to add even more sophisticated training such as Multi-protocol Label Switching (MPLS) and Software Defined Networking (SDN) as they could see a growing need in their network.

Although the DNS was not highlighted as a subject of interest in the 2018 Consultation, by 2019 interest in this fundamental Internet service had grown as respondents had recognized the need and importance of training in DNS and subsequently DNSSEC. This training was then provided by the project.

#### **Consultations analysis**

The evidence collected by the consultation team paints a picture of an industry that has achieved a great deal despite significant capacity and geographic challenges. PNG's modern, deregulated, and structurally separated regulatory environment is hampered by critical skills gaps and lack of exposure to industry best practice.

In total, survey respondents indicated there were 395 Network Engineers employed in organizations in PNG, with an average of 5.6 engineers per organization. Many of these were university degree qualified or had a certificate or diploma. There are very few organizations who reported that their Network Engineers have no formal qualifications.

There was a total of 573 network technicians and support personnel, with an average of 8.2 per organization. Again, many of these had a university degree or a certificate/diploma.

However, as might be expected, a larger number of network technicians had no formal qualifications.

In-country training providers are rare in PNG with only two companies offering paid training courses. Vendor training opportunities tended to be restricted to point of purchase or offered with other upgrades. This makes it almost impossible for small companies to supply adequate training for its staff. Generally, there were no coordinated training programs for staff, even in large organizations.

Nearly half of respondents (49%) either could not remember the last time they participated in formal technical training or had not undertaken formal training in the past two years. While around a third had attended a training course in the last year, most indicated they either could not remember the last time they attended a technical training course or that any technical training occurred more than a year ago.

Consequently, the consultation team discovered that most managers and staff were lacking in exposure to the extent that they were unclear on what training they would actually 'need'.

#### Strong preference for in-person training

To determine the best approach for training delivery, the 2018 Consultation team surveyed and discussed a range of preferred training formats. Overwhelmingly the respondents showed a strong preference for in-person training over online formats.

This was further confirmed during the 2019 online survey, although the researchers noted a marked change

in acceptance for online delivery modes between the two periods with online options becoming more acceptable over the course of the project.

The SurveyMatters results showed that most respondents (66%) prefer to complete training through face-to-face training workshops. While 55% also indicated a preference for a mix of face-to-face and online training, online-only training was not favoured, with only 18% selecting this format.

When asked their preferred length of time to attend training, most Network Engineers and Network Technicians (62%) indicated five days, with a further 26% showing a preference for three days of training. Interestingly, respondents who indicated they were Managers or Leaders of organizations reported a preference for five-day training courses for their employees, with 73% selecting this time length.

#### Number of registered participants per workshop topic/subject



During the consultation, there were several discussions about which days training should be held. Most companies were very flexible with days of training, even opting for weekend training. In reality, this would be impractical as a significant proportion of the population recognize the Sabbath on Saturday.

Throughout both Port Moresby consultations, respondents spoke often about the need to conduct training in the northern city of Lae. NICTA also indicated a keenness for training to be held outside of Port Moresby. The Foundation was able to undertake a consultation in Lae in 2019 with additional funding and workshops conducted, with much better attendance outcomes than in Port Moresby.

#### Security an abiding concern

When a second consultation team travelled to PNG in 2019 it was an opportunity to assess what progress was being made, to evaluate changes to the local Internet ecosystem, and find areas for improvement for training delivery. With the APEC Forum behind it, the technical community was tackling a new environment brought on by the increased international bandwidth.

Respondents remained very interested in cybersecurity training and were more advanced in their understanding of modern Internet techniques and tools. The level of awareness for RPKI was higher with some seeking help to set up ROAs — a core digital certificate for Internet routing security.

By this time, most of the ISPs were connected to PNGIX. Large numbers of start-up ISPs were investigating the new opportunities. Some established providers were even starting to think about how to deploy IPv6 in their network.

When presented with a list of training topics they thought would provide them with the most value, nearly twothirds of respondents selected Network Security, with a further 41% indicating that Network Monitoring and Management training would offer value. It should be noted that respondents could only choose the two most important topics, and of the 9% who chose an 'Other' response, most said that all training topics were valuable.

The consultation team noted that Network Design and Network Architecture skills seemed very low with most interview respondents having experience in a very narrow field. As a result, modern networking technologies and best practices were a set



of 'unknown unknowns' to many technical staff running the Internet in PNG.

"...modern networking technologies and best practices were a set of 'unknown unknowns' to many technical staff running the Internet in PNG."

The enthusiasm toward sponsored training in PNG was encouraging. The purpose of the consultations was to optimize outcomes by better matching the training offerings to real needs. What was not identified in the first round of consultations was the inconsistent level of understanding and command of some basic concepts among participants, which were considered by the trainers as prerequisite. Many participants conducted their work using proprietary solutions, so they had limited or no prior exposure to general Systems Administration skills using Linux command line syntax. This meant that trainers had to review some basic concepts, which took time away from the proposed curriculum, and staff sent for training were often underprepared to take full advantage of the challenging practical exercises.

In Lae, the consultation confirmed there was demand for the training opportunities the project had to offer, but that the skill level was more suited to basic to intermediate level training. As a service town, Lae tends to be staffed by basic support personnel with technical engineering work taking place in Port Moresby.

# ACTIVITIES

### The table below shows the activities conducted during the project.

Event name	Date	Duration (Days)	Total Participants	Female Participants	Location	Trainers
PNGTRAINING WS 1 Routing	21/08/2018	4	23	6	Port Moresby, PNG	Mark Prior
APNIC 46 Conference Cybersecurity fellowships and training	06/09/2018	8	4	N/A	Noumea, New Caledonia	Adli Wahid
PNGTRAINING WS 2 Routing	18/09/2018	3	24	2	Port Moresby, PNG	Mark Prior
PNGTRAINING WS 3 Network Security and Management	2/10/2018	3	24	4	Port Moresby, PNG	Jonathan Brewer
PNGCERT WS 1 Information Security for System Administrators	8/10/2018	3	25	2	Port Moresby, PNG	Jamie Gillespie
PNGTRAINING WS 4 IP Routing	9/10/2018	4	25	2	Port Moresby, PNG	Mark Prior
<b>PNGTRAINING WS 5</b> DNS	17/10/2018	3	30	1	Port Moresby, PNG	Champika Wijayatunga
PNGTRAINING WS 6 DNS	23/10/2018	2	32	4	Port Moresby, PNG	Arth Paulite
PNGTRAINING WS 7 Network Security	29/10/2018	4	30	5	Port Moresby, PNG	Warren Finch
PNGCERT WS 2 Information Security for System Administrators	5/11/2018	3	35	9	Port Moresby, PNG	Jamie Gillespie

PNGTRAINING WS 8 IP Routing	6/11/2018	4	34	5	Port Moresby, PNG	Mark Prior
PNGTRAINING - Webinar #2 DDoS Attack Prevention	25/06/2019	-	25	-	-	-
<b>PNGTRAINING WS 9</b> Information Security for System Administrators	3/07/2019	3	26	8	Port Moresby, PNG	Jethro Tambeana Jamie Gillespie
<b>PNGTRAINING WS 10</b> Information Security for System Administrators	27/08/2019	4	35	5	Lae, PNG	Jake Flint Jamie Gillespie
PNGTRAINING WS 11 IXP and Routing	9/09/2019	3	34	6	Port Moresby, PNG	Bani Lara Sharat Samit
PNGTRAINING WS 12 Advanced Routing	14/10/2019	4	27	7	Port Moresby, PNG	Mark Prior Bani Lara
PNGTRAINING WS 13 Routing	21/10/2019	4	20	4	Lae, PNG	Mark Prior
<b>PNGTRAINING WS 14</b> DNS & DNSSEC	18/11/2019	4	34	6	Port Moresby, PNG	Arth Paulite Sheryl (Shane) Hermoso
PNGTRAINING WS 15 DNS & DNSSEC	27/01/2020	5	30	7	Lae, PNG	Philip Paeps Swapneel Patnekar
<ul> <li>APNIC 49/APRICOT 2020:</li> <li>Network &amp; Infrastructure Security</li> <li>Virtualisation &amp; Cloud Computing</li> <li>Routing Infrastructure &amp; Security Operations</li> <li>Introduction to SDN</li> <li>Networking Monitoring &amp; Management</li> </ul>	12/02/2020	-	1 2 2 1 1	-	Melbourne, Australia	-

## **BUILDING COMMUNITY**

Support for the development of PNG's technical community was a key goal of the project. This included assistance and training for a range of entities including PNGCERT, PNGIX, PNGARNET, .PG and ultimately PNGNOG.

#### **PNGNOG development**

Encouraging the local technical community to share their experience and collaborate through a NOG in PNG has paid off in PNG with the formation of PNGNOG. It began as an informal social event organized in conjunction with one of the workshops and then formalized at a meeting in early July 2020 where interested parties met to form a Steering Committee and Program Committee. Ongoing support and encouragement of this initiative is required to ensure it moves beyond this formative phase into an ongoing, viable community of technical engineers able to share through mailing lists, training, and events. ideas and intent of best practice, not only those working for the same organization.

With this intent, the APNIC Foundation was able to provide support for several PNG community members to participate in regional community events via a Fellowship program open exclusively to them.

The candidates were carefully selected by a team of reviewers from the list of participants based on their performance and engagement during the training delivered by the project. Four sponsored participants attended and took part at APNIC 46 in Noumea, New Caledonia in September 2018 and seven fellows travelled to APRICOT 2020/APNIC 49 in Melbourne, Australia in February 2020.

These opportunities are an invaluable tool in developing capacity in economies such as PNG where organizations would typically find it difficult to fund travel throughout the region.



#### Fellowships

The project provided fellowships throughout its duration to allow members of the PNG community to attend activities that provide the opportunity to engage and learn from recognized international experts and to share their experiences on returning home.

This fosters their personal and professional development. The effect is amplified when they return home and share their experience with peers and colleagues in their own organizations. If sharing occurs through a NOG community event or mailing list, the effect is amplified again as all members of the NOG are exposed to the



# **IXP ENGAGEMENT**

APNIC had previously supplied technical assistance to support the creation of PNGIX before the commencement of this project, and as a result, the Foundation closely followed developments at the IXP since its earliest conception.

PNG's first neutral IXP was established in May 2017 and was actively supported and hosted by NICTA, the PNG regulator.

In August 2019, the project funded a technical assistance visit to Port Moresby. The consultation also included visits with several training institutes and a visit to the exchange itself.

Good improvement in the cooperation of members was observed, with more rack space being taken up and growth in IX traffic having reached a reported 5 Gbps. Caching and sharing of caches are a major reason ISPs are keen to connect to an IX. As the caches fill, more traffic is served locally reducing international bandwidth requirements along with improved speed and latency.

#### **Technical operations**

Overall, equipment levels at the site had improved following the installation of a standby diesel generator, a battery bank for UPS, and plans for the installation of an NTP server taking place since the last engagement. The IXP needed a redundant router, which APNIC agreed to supply along with a network switch. APNIC also agreed to assist with the implementation of graphing automation tools to provide visibility of traffic statistics showing aggregated traffic and Member-specific traffic.



# **CERT ENGAGEMENT**

As with PNGIX, APNIC's support for PNGCERT predates the activities funded by this project. In early November 2017, NICTA organized a two-day workshop in Port Moresby focused on establishing a national CERT in PNG. The 'PNGCERT stakeholder working group, which was established after this workshop, included the APEC Secretariat, PNG Police, other government agencies, network operators, and central banks.

The initiative to create a CERT in PNG accelerated in January 2018 with APNIC's Director General and Senior Internet Security Specialist attending the launch of PNGCERT in Port Moresby on 30 January 2018.

PNGCERT engagement also included support for CERT staff to travel to New Caledonia to participate in a FIRST Technical Colloquia (TC) and the CERT Workshop, and the APNIC 46 conference.



#### **PNGCERT Functions**

Coordinating the management of national cybersecurity incidents.

- Promoting cybersecurity situational awareness with respect to global or regional incidents.
- Advocating capacity building through the introduction of Best Practices and measures in the promotion of cybersecurity.
- Coordination and collaboration with international counterparts in managing or addressing cybersecurity incidents regarding enhancement of cybersecurity.
  - Overall promotion of secure systems and networks for its constituency.

#### **Evolution of the security context**

There was a significant increase in international activity and support for CERTs in the Pacific through the period of the project.

The following four context changes were noted to have affected the project:

 Increased government support for CERTs: The PNG government and NICTA have supported PNGCERT by providing new, dedicated office space. While the project's technical training and support have played an important role in CERT development, government support along with strong engagement from the local technical community is key

### **Evolution of the security context**

- 1) Increased government support for CERTs
- 2) Increased connectivity
- 3) International research and support for policy development
- 4) International funding for cybersecurity activities

for future sustainability and integration with national digital strategies and growth.

#### 2) Increased connectivity:

Continued improvements in connectivity and the increased bandwidth that comes via developments to mobile networks, submarine cables and satellites have highlighted the need for increased effective cybersecurity strategies to the PNG government, to maximize the positive benefits and manage new and increasing cybersecurity threats.

**3)** International research and support for policy development: International aid continues to play a key role in supporting research and analysis so that national policy development and investment in infrastructure can respond to evolving cybersecurity threats, challenges, and problems. Support to develop in-house research capabilities is key so that research outcomes are used and adopted at a national level.

#### 4) International funding for cybersecurity activities:

In the Pacific, there was increased funding and engagement around cybersecurity activities from a variety of international agencies. These required additional efforts to coordinate activities for the benefit of PNGCERT and the communities it collaborates with. Activities by the International Telecommunications Union (ITU), New Zealand's MFAT, the European Union, Interpol, the Asia Pacific Telecommunity, and the UK's Foreign and Commonwealth Office all increased, while the World Bank, the Asian Development Bank, JICA, USAID and a range of other development agencies already funding Internet development in the region have added or expanded their investment in cybersecurity.

#### **Technical assistance format**

The face-to-face technical assistance was particularly successful because it allowed the project to provide technical security training to CERT representatives in a responsive format that was also open and collaborative. While the travel cost of such technical assistance is high and they are difficult to organize, they are more collaborative, more productive, and have a longer-lasting effect. The three main advantages of adopting this approach were:

1) The technical assistance allows for capacity building in a tailored, open source, vendor-neutral approach for the tools and technologies used. These highly customized/personalized opportunities to transfer knowledge directly to those in the CERT enable the creation of a very low-cost set up and maintenance of the tools required for CERT operations. This format allows the trainees to participate and engage and

continue their work after the training, supporting their own decision-making processes more actively.

- 2) The technical assistance allowed cybersecurity personnel from APNIC to meet face-to-face and build the trusted networks that are essential to the functioning of the CERT community.
- **3)** The technical assistance provided the best feedback loop for the trainers to continually develop and improve their training, especially when providing advanced technical material.

The January 2018 workshop included training in threat landscapes and provided an overview of common types of security incidents and impact analysis. It also provided training in CERT operations policies and procedures as well as information on supporting systems and advisories, and vulnerability monitoring.

The technical assistance from 19 to 20 September focused on support for PNGCERT's needs in hardware and software, including an assessment of their Incident Reporting (IR) support infrastructure (mail, ticketing, and so forth); the setting up of email with PGP Keys; and a demonstration of how encryption/signing works.

Accounts were also prepared for receiving threat feeds and tasks were assigned for updating the website. Contact was also made to a few security groups and regional CERTs to introduce the PNGCERT team.

• PNGCERT started to receive threat feeds from the ShadowServer Foundation.

- PNGCERT also received an NDA document from team Cymru, which needed to be signed before they could receive threat feeds.
- They received an acknowledgement from ThaiCERT and started to receive the daily newsletter containing security news updates; some of this could then be shared with the wider PNG community.





### **OUTCOMES**

By 2019, a survey indicated the vast majority (88%) of respondents had attended one of the APNIC PNG training workshops in 2018, and 80% intended to attend again in 2019. Respondents rated the training positively with 95% indicating they were either good or excellent.

Indicating a potential way forward given the current travel restrictions due to health concerns, 71% of respondents had heard of the APNIC Academy for online training, however, only 15% had used the online training offered through the Academy.

The Foundation activities have served to provide some exposure to technicians working in the PNG Internet. Some will be inspired and continue to seek opportunities to test their knowledge and practice their networking skills while others will allow what they have learned to decline.

There are hopeful signs that a core community of enthusiastic and increasingly skilled technical staff was identified by the project. Participants in the final Lae workshop had an informal 'meet and greet' to discuss the creation of a NOG, followed in July 2020 with a first formal meeting to begin formation of a formal organization.

Cultivating this embryonic community and growing linkages between them, the IXP and the CERT is a formula for sustainable growth. Add a growing interest and commitment to the DNS, and PNG will be positioned to take advantage of the new communications infrastructure commissioned over the past three years.



# **MONITORING AND EVALUATION**



337 **Total participants** completed the workshop evaluation - **1** Not at all 38 -**28** — Somewhat Somewhat Theoretical Operational knowledge gained knowledge gained 279 265 Yes, greatly Yes, greatly

**Overall workshops satisfaction** 350 300 250 200 150 100 50 0 My overall The content There was experience of the of the course sufficient time to cover the content training is positive was appropriate Strongly Agree Agree Neutral Disagree Strongly Disagree

# **GLOSSARY OF TERMS, ABBREVIATIONS, AND ACRONYMS**

2FA	Two Factor Authentication, a security mechanism
APNIC	Asia Pacific Network Information Center
APRICOT	Asia Pacific Regional Internet Conference on Operational Technologies
ARNET	Academic and Research Network
BGP	Boundary Gateway Protocol
CERT	Computer Emergency Response team
DFAT	Australian Department of Foreign Affairs and Trade
DNS	Domain Name System
DNSSEC	Domain Name System Extensions
FIRST TC	Forum of Incident Response and Security teams Technical Colloquia
ICANN	Internet Corporation for Assigned Names and Numbers
IPv6	Replacement protocol for IPv4
IXP	Internet (traffic) Exchange Point

NOG	Network Operator Group
MFAT	New Zealand Ministry of Foreign Affairs and Trade
NICTA	PNG's National Information and Communications Technology Authority
NREN	National Research & Education Network
NTP	Network Time Protocol
PNGNOG	PNG's Network Operator Group
PNGIX	PNG's Internet Exchange
PNGCERT	PNG's Computer Emergency Response team
ROA	Route Origin Attestation
TAF	The Asia Foundation
RPKI	Resource Public Key Infrastructure
Upstream	Service provider between a local network and the Internet



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