The Asia Pacific Network Information Centre (APNIC)
20 years of service to the Asia Pacific Internet community (1993-2013)

Formation and early operations (1992-1995)

For the past two decades, the Asia Pacific Networking Information Centre (APNIC) has served as the Asia Pacific's regional Internet registry (RIR), "charged with ensuring the fair distribution and responsible management of IP addresses and related resources ... [which] are required for the stable and reliable operation of the global Internet".[1] During that period, APNIC has also become an increasingly significant hub of Internet community activity in the region and a respected voice of the Asia Pacific Internet community on the global stage.

Understanding how APNIC formed, the role it serves, and the way it operates requires an overview of the architectural, operational, and administrative aspects of the Internet and the general principles which underpin all facets of Internet development.

Early evolution of IP addressing

At its most basic, the role of the Internet is to move data packets from a source to a destination. To deliver a packet, the Internet needs to know where the destination is (the address) and the best way to get there (the route). Internet Protocol (IP) addresses support these needs by identifying both the network and host.

The original Internet addresses were 32 bits long, with the first 8 bits of the field used for the network part of the address, leaving 24 bits for local addressing. Although more than 4 billion addresses were possible, the fixed 8 bit network part restricted the possible number of networks to only 256.

By the late 1970s, even though the total address space for the "internet experiment" was abundant, it was clear that the time had come to "prepare for the day when there are more than 256 networks participating in the internet".[2]

So, in 1981, the Internet Engineering Task Force (IETF) modified the address architecture to allow for three classes of Internet address. "Class A" addresses allowed for 128 networks with 24 bits of local addressing; "Class B" addresses allowed 16 384 networks with 16 bits of local addressing; and "Class C" allowed 2 097 152 networks with 8 bits of local addressing.[3]

The new Internet Protocol version 4 (IPv4) immediately eased the limitation on new networks joining the Internet, but its "classful" addressing architecture (also referred to as "subnetting") sowed the seeds for two new, interlinked problems that emerged with the growing popularity of the Internet.

Using classful addressing, if a network operator needed to address 200 hosts, then a single Class C network would neatly solve the operator's need. However, if an operator needed to address 2 000 hosts, then one could assign either a single Class B and waste more than 63 000 addresses, or assign eight separate Class C addresses. While the latter solution would not waste addresses, it would add eight new entries to the global routing table.

In the early days of the Internet, these issues were not critical, but as the Internet developed and commercial interest loomed, the tension between the need to conserve addresses and the need to

aggregate routing information led to the next step in the evolution of the addressing architecture, namely the move from subnetting to "supernetting".

Supernetting became a standard in RFC 1519[4] as "Classless Inter-Domain Routing (CIDR)"; however, the issue had first been explored in detail in RFC 1338, published in June 1992, which warned:

> As the Internet has evolved and grown ... in recent years, it has become painfully evident that it is soon to face several serious scaling problems. These include:
>
> 1. Exhaustion of the class-B network address space....
> 2. Growth of routing tables in Internet routers beyond the ability of current software (and people) to effectively manage.
> 3. Eventual exhaustion of the 32-bit IP address space.[5]

RFC 1338 proposed doing away with classful addressing and instead relying on "variable-length subnetting" to allow any size of network allocation. Under this scheme, a variable-length subnet mask (more commonly known as the "prefix") replaces the fixed-length network part of the address. Therefore CIDR allocations can be tailored to closely fit network operators' address needs without waste, while adding only a single entry to the global routing table.

CIDR proved to be a timely and effective solution to what was by then one of the Internet's most serious challenges,[6] extending the life of the IPv4 address pool by two decades while allowing the routing system to scale at a manageable rate. However, it is important to realize that CIDR's success was not solely due to architectural developments, but also relied heavily on responsible administrative practices and inclusive, community-based policy making.

Expansion of the registration function

The Internet depends absolutely on the integrity of its addressing system. But the addressing system can only work if IP addresses are unique, and uniqueness can only be guaranteed by an effective registration system.

In the early days of the Internet, address registration was a straightforward function. Network operators – of which there were few, and all of which were (generally) known to each other – simply asked for addresses, the details of which were recorded by the Internet Assigned Numbers Authority (IANA).

The IANA function was, for many years, a manual task performed by one man – the late Jon Postel.[7] Over time, as this task grew, the IANA responsibility for "numeric network and autonomous system identifiers" was formalized and "a single Internet Registry (IR) was designated: the Defense Data Net Network Information Center (DDN-NIC) at SRI International".[8]

By 1990, the IETF's Network Working Group noted:

> With the rapid escalation of the number of networks in the Internet and its concurrent internationalization, it is timely to consider further delegation of assignment and registration authority on an international basis. It is also essential to take into consideration that such identifiers, particularly network identifiers of class A and B type, will become an increasingly scarce commodity whose allocation must be handled with thoughtful care.[9]

RFC 1174 proposed that the IANA and the IR functions would remain centralized, but that "the IR would also allocate to organizations approved by the Coordinating Committee for

Intercontinental Research Networking (CCIRN) blocks of network and autonomous system numbers, as needed, and delegate to them further assignment authority".[10]

General Internet growth and associated increases in demand were not the only factors that put pressure on the centralized registration function. The nature of a CIDR-based addressing scheme required far greater administrative oversight of address allocations. Because allocation sizes could be of any size, to fulfill the address conservation goal, it became necessary to more carefully analyse the requestors' needs. And because variable-length subnet masking allowed multiple contiguous ranges to be announced as a single route, allocation practices had to allow for networks to grow while fulfilling the address aggregation role.[11] Furthermore, as the complexity of the request and registration process increased, so did the need for regionalized service with greater multilingual support.

RIPE NCC emerges

Meanwhile, in Europe, Internet Service Providers (ISPs) had formed Réseaux IP Européens (RIPE) as "a collaborative organisation ... to ensure the necessary administrative and technical coordination to allow the operation of a pan-European IP network".[12] The first RIPE meeting was held in Amsterdam in May 1989.

RIPE is a community and has no legal structure. However at the fourth RIPE meeting in March 1990, Daniel Karrenberg presented on the community's administrative needs. The minutes note that:

> A discussion followed on the what model should be used, either a centralised or a distributed framework. What became clear from this was the need for some sort of formalised body for performing the functions of a NIC.[13]

By September that year, this discussion had become a formal proposal to create the RIPE Network Coordination Centre (NCC) to support the RIPE community and "function as a 'Delegated Registry' for IP numbers in Europe, as anticipated and defined in RFC 1174".[14] The RIPE NCC formally commenced operation in April 1992.[15]

The APNIC experiment

The Internet's distributed development model has always been based on inclusive collaboration and open sharing. Individuals and organizations have always come together and cooperated to assume the various operational and administrative tasks required to develop and maintain core Internet functions.

One such forum for cooperation – more significant in the Internet's early days than now – is CCIRN, established to provide "a forum for members to agree and progress a set of activities to achieve inter-operable networking services between participating international entities to support open research and scholarly pursuit."[16]

On 10 June 1992, CCIRN held a meeting in Tokyo, Japan,[17] which is particularly notable as a confluence of several emerging factors. This was CCIRN's first meeting in Asia, and those present included:

- Kilnam Chon[18] of Korea Advanced Institute of Science and Technology (KAIST), a leading pioneer of Internet development in Asia
- Jun Murai of Keio University, founder of the Widely Integrated Distributed Environment (WIDE) project, and commonly referred to as the "father of Japan's Internet",[19] and
- several representatives of the RIPE community and RIPE NCC, which had officially launched only two months earlier

The minutes of the meeting note Chon's report that APCCIRN (the Asia Pacific grouping of CCIRN, then being formed under his leadership) had held two preliminary meetings but now needed to hold its first official meeting as soon as possible to start coordinating networking activity in the region. Chon also reported that there were at that time "10-12 countries with network connection" in the region and "two international networks": PACCOM and CAREN.[20]

The meeting heard reports from the RIPE community, including a full report of the fledgling RIPE NCC by its manager, Daniel Karrenberg. Steve Goldstein of the US National Science Foundation noted that RIPE NCC's work was outstanding and set an example for Network Information Centre (NIC) operation "for anywhere in the world".[21]

Jun Murai also reported on progress at the Japan NIC (JNIC[22]). In 1989, Murai had received a large address block (43.0.0.0/8) from Jon Postel as an early test case for IP address delegation. Subsequently, Murai established JNIC – drawing on the support of WIDE, Todai International Science Network (TISN), and others – for domestic IP address and .jp namespace assignments. JNIC assumed management of the delegated address block in 1992. Murai explained at the APCCIRN that it "would be possible to expand the [JNIC] role to cover Asian Pacific, if desired".[23]

From this meeting, the elements were in place for the birth of APNIC.

Seven months later, in January 1993, APCCIRN held its first official meeting in Honolulu, Hawaii, with the Asia Pacific Engineering and Planning Group (APEPG). At this meeting, attendees discussed and accepted a proposed plan for a "NIC for APCCIRN Region (APNIC)" to carry out resource registration, information provision, NOC support, and NIC cooperation. This appears to be the first public discussion of APNIC. The minutes note that it "was decided for JNIC (M. Hirabaru and J. Murai) to carry on [the] APNIC experiment with cooperation of other countries including Australia, Korea and New Zealand".[24]

The "APNIC experiment" also earned a mention in the notes of the March 1993 IETF User Services Area meeting (along with the emergence of the new InterNIC).[25]

Then at the second APCCIRN meeting – held on 8 September 1993, immediately following the INET93 meeting in San Francisco – APNIC was discussed in detail. Murai presented an overview of the global and regional NIC situation and noted the new vision for a "global NIC with regional authority delegated to regional NICs, such as InterNIC in the Americas and RIPE NCC in Europe". KRNIC and JPNIC each presented status reports of their domestic projects. Murai proposed changes to the original proposal and explained:

> If approved by the APCCIRN, this pilot project would help determine how to meet the needs in the region over the long-term. During the pilot phase, prime focus would be on the Internet Registry and Routing Registry functions. Limited attention would be given to informational functions until after a decision on a long-term approach for the region. JPNIC has agreed to provide resources for the pilot project.[26]

The updated proposal[27] was adopted and the APNIC pilot project was chartered to begin operation on 1 September 1993 and end on 30 June, 1994. The APNIC pilot project goals were:

- determine the requirements for a regional NIC and the means to meet those requirements
- implement a regional IP address allocation strategy in accordance with RFC-1466
- provide a testbed for experimentation into network coordination in the Asia Pacific region
- coordinate with local, national, and regional NICs
- experiment with tools used to support NIC operations[28]

The approved document "Asia Pacific Network Information Center Pilot Project Proposal" became one of the first official APNIC documents (APNIC-003). In addition to the goals listed above, this document also notes that the APNIC pilot project would be entirely funded by JPNIC, which had committed 10 per cent of its own budget for the work. APNIC-003 also makes it clear that the pilot project was to be "coordinated under the auspices of the APCCIRN" and that the project staff would provide a mid-term and final report to APCCIRN. At this stage, APNIC's proposed staffing requirements were for a quarter-time manager, a half-time technical support role, and a full time administrative support role. The individuals who had expressed interest in working on the project were:

- Masaya Nakayama, University of Tokyo
- Masaki Hirabaru, Kyushu University
- Taeha Park, KAIST
- David Conrad, Internet Initiative Japan[29]

In the late 1980s and early 1990s, David "Randy" Conrad was a young researcher working at the University of Hawaii, Manoa on the NASA/NSF-funded Pacific Communications (PACCOM) project, which interconnected the networks of universities and research institutions in Japan, Korea, Hong Kong, Australia, New Zealand, and the US.

PACCOM held an annual meeting in Hawaii where the various researchers would meet to discuss Internet issues. It was at those meetings that Conrad met some of the Internet pioneers from the region, such as Jun Murai, Geoff Huston, John Houlker, Robin Erskine, and Kilnam Chon. From this contact, Murai invited Conrad to move to Japan to help launch the Internet Initiative Japan (IIJ). In 1991, Conrad accepted the invitation, moved to Japan, and became IIJ's seventh employee. However, once there, Conrad found that IIJ was facing some delays getting the licences it needed to provide Internet services. "I had spare time," Conrad explains, "and Jun Murai asked if I'd be interested in helping to start up APNIC".[30]

With Conrad as manager, the APNIC pilot project started operations on 1 September 1993. An email from Masaya Nakayama the following day contains details of the first APNIC mailing lists:

- apnic-all@apnic.net (for all those interested in the APNIC pilot project)
- apnic-member@apnic.net (for actual APNIC pilot project members)
- apnic-staff@apnic.net (for the pilot project staff)[31]

In APNIC's early operations, most of its work was based on and around those lists (hosted on a computer at the University of Tokyo). In an article from 1994, Conrad explained how the work was coordinated:

> The staff mailing list implementing most of the APNIC functions currently consists of 25 people from the countries of Australia, China, Japan, Korea, New Zealand, Singapore, Taiwan, Thailand, and the US. This informal group comes to a rough consensus on requests for information and/or address space assignment and fulfills those requests typically within one to two working days.[32]

A JPNIC newsletter article from late 1994 gives more detail of the breakdown of responsibilities, explaining that the "APNIC WG" (working group) – coordinated out of JPNIC and comprising representatives of each national NIC – played the major role in allocating IP addresses. The Korean NIC (KRNIC) was in charge of "information services". And the Australian NIC (AUNIC) maintained APNIC's DNS-related services.[33]

This informal "staff" arrangement was motivated by the "immense size of the Asia and Pacific Rim regions, from the Persian gulf area to the island nations of the South Pacific, and the vast diversity of cultures, religions, and economic situations encompassed in this space," and so "one of the basic

assumptions held by the members of the APNIC pilot project staff ... was that the ultimate APNIC would need to be highly distributed".[34]

On the subject of infrastructure, the pilot project equipment requirements were modest, with the proposal calling for "a single workstation class computer with sufficient disk and network capacity to fulfill the needs of the project".[35] JPNIC provided this machine in the form of a Sun Sparcstation, described as "fully connected to the Internet".[36] The APNIC computer served mailing lists, FTP and gopher archives, the Asia Pacific network database and whois server (which originally ran the InterNIC's rwhois server software), and a DNS server providing referrals to APNIC services, including:

- in-addr.arpa (reverse delegation) services hosted at AUNIC, and
- an "experimental" web site hosted by KRNIC

Again, as Conrad explained at the time, by "distributing the NIC services, the APNIC pilot project has been able to take advantage of talents of personnel at the national NICs and thus does not require extensive expertise to be located centrally at an APNIC facility".[37]

The dominant thinking at this stage in APNIC's formation was that its future was as a functionally distributed organization,[38] with a small central coordinating centre ensuring consistency and continuity. The model envisaged was that APNIC's various operational functions would be contracted to national NICs for fixed periods and rotated through the region.[39] Indeed, an article by Conrad noted that APNIC, "when it becomes permanently established in July of 1994, actually will consist of a group of semi-independent cooperative organizations".[40]

Overtly, this approach was seen as a way of building technical capacity across the region, while also providing a sustainable operational model in the absence of an alternative established funding model. However, this approach could also be seen as a way of defusing the potential political tensions that may arise from permanently settling such a critical function in one part of the region.

The appropriate scope of APNIC's functions was also an active area of discussion during the pilot project. On 10 December 1993, the APNIC staff published a proposal for APNIC to assume the following roles:

1. Allocate Class C network blocks to national registries and multi-national service providers
2. Provide an initial contact point for people interested in internetworking in the Asia Pacific region
3. Promote Asia Pacific internetworking
4. Provide NIC services for nations with no regional NIC
5. Promote the establishment of national NICs
6. Provide a top level information repository
7. Delegate the 202, 203, and 204.in-addr.arpa reverse domain name trees
8. Provide a forum for coordination between regional NICs in the Asia Pacific region[41]

Of these proposed roles, the first and fourth are worth particular attention here, because they suggest a function that is significantly and specifically different to the way APNIC's primary role eventually emerged.

Until the early 1990s, much of the Internet activity around the world had involved some form of national coordination by a NIC (either formal or informal in nature). This of course had a natural fit with the domain name system, which features country code top level domains (ccTLDs). However, as classless, CIDR-based IP addressing was introduced, national boundaries lost much of their significance and address administration practices relied on network topology rather than physical geography. The topological approach to addressing remained for the rest of IPv4's life span and continues as an essential aspect of IPv6 addressing.[42]

Nevertheless, even by the end of the pilot project, APNIC retained a strong focus on promoting the formation of national NICs to join the ranks of Australia (AUNIC), Japan (JPNIC), Korea (KRNIC), and Taiwan (TWNIC).[43] National NICs were seen as a way to mitigate the "limits on the APNIC's manpower, language, and budget resources", and a proliferation of NICs across the region were considered "better able to serve the end users in their particular countries, and also relieve the APNIC of some operational burden by distributing the workload". The final pilot project report stated that "this promotion activity will remain one of the APNIC's prime objectives".[44]

Although the operational relationship between APNIC and national NICs eventually emerged in quite a different form, these considerations can be seen as the root of the crucial, yet sometimes complex, role of National Internet Registries (NIRs) in the Asia Pacific region.[45]

All other priorities notwithstanding, the central thing a regional Internet registry (RIR) needs to justify its existence is a pool of addresses. And so, on 1 April 1994, the IANA publicly recognized APNIC's status by delegating the IPv4 address ranges 202/8 and 203/8.[46]

The end of the experiment – lessons learned

The APNIC experiment formally ended on 30 June 1994. Shigeki Goto (NTT and JPNIC) reported to the CCIRN meeting in Amsterdam that month that APNIC was serving 27 members from 12 countries and had assumed authoritative delegation for the 202 and 203 Class C address blocks. Goto also reported that "unresolved issues include guidelines for establishing national NICs, further service delegations and especially funding".[47]

During the experiment, APNIC was supported by financial and in-kind support from a small group of organizations:

- ¥1,000,000 from Internet Association of Japan (IAJ)
- ¥2,000,000 from JPNIC
- workstations, printers, and various other equipment from NTT
- server PCs and staff time from Internet Initiative Japan (IIJ)
- Sun server, office space, and network connectivity from the WIDE Project[48]

As generous as this support was, sustaining APNIC would require more funding from more diverse sources.

Before IANA delegated address ranges to APNIC, the project typically received up to five enquiries per week. After the IANA delegation, that jumped to "5 to 10 email messages and 1 to 5 fax messages a day", and it was clear that the work rate would grow quickly as the Internet expanded in the region and that running a NIC permanently would require "significant investments in both time and talent".[49]

Furthermore, as Conrad explained:

> Since allocations of network addresses must be carefully considered, with special emphasis placed on ... allocating the appropriate amount of address space in a way that conforms to the requirements of CIDR, the APNIC project staff has had to explain Internet addressing and the global routing table situation many times, sometimes more than once to the same individual. In the AP region, this sort of situation can have added complexity due to language and cultural differences and typically must be handled with some care.[50]

In his characteristically laconic style, Conrad concluded that "running a regional NIC is not for the weak of heart, shallow of mind, or shy of disposition".[51]

The more formally-worded final report of the APNIC pilot project was prepared by Vince Gebes of the AT&T Jens Spin Project in Tokyo, covering all major aspects of the background and operational status of the project. However, the three most significant strategic areas of concern Gebes identified were the needs to:

- define the Asia Pacific region and ensure better coordination of responsibilities between APNIC, RIPE NCC, and the InterNIC
- create guidelines for establishing new national NICs
- finalize funding models and future operations (which Gebes identified as "clearly the most important issue" facing APNIC)[52]

These issues notwithstanding, the APNIC pilot project was considered a success and from 1 July 1994, the work continued as the "interim APNIC" until a more permanent model could be developed.

Community engagement and the challenge of sustainability

As was the case with all major Internet forums and institutions, the birth of APNIC was an expression of community collaboration, with stakeholders from many fields and nationalities contributing time, energy, resources, and talent. Building and sustaining such a community requires more than just mailing list activity, so, in addition to the ongoing registration and informational services, the interim APNIC began planning for its first major public event.

In late 1994, APNIC announced that the first APNIC meeting would be held at Chulalongkorn University in Bangkok, Thailand on 16 and 17 January, 1995. The announcement noted that "Service Providers, national NICs, and other interested individuals are invited to attend and participate".[53] The invitation note is significant: while all RIRs have now developed fee-paying membership structures, their meetings about addressing issues have always been open to all interested participants. Openness and transparency are core values of the broader Internet development process and are cornerstones of Internet address policy.

Furthermore, the first official APNIC address request form encouraged all network operators to get involved in the technical community and the address policy making process,[54] a function for which APNIC would subsequently become the regional forum.

The APNIC 1 meeting was well attended, with 60 registered participants. Some of the more notable attendees include:

- Masaki Hirabaru (JPNIC)
- Sanjaya (PT IndoInternet, Indonesia)
- Robin Erskine (Australian National University)
- Che-Hoo Cheng (Computer Services Center, The Chinese University of Hong Kong)
- Dr Tan Tin Wee (Technet Unit, Computer Centre, National University of Singapore)
- Tommi Chen (Technet Unit, Computer Centre, National University of Singapore)
- Shigeki Goto (JPNIC and NTT)
- Pindar Wong (Hong Kong Supernet)
- Masaya Nakayama (JPNIC)
- Xing Li (Network Center, China Education and Research Network)
- Taeha Park (I.Net Technologies and KRNIC)
- Barry Raveendran Greene (Singapore Telecom and SingNet)[55]

All of these individuals made significant contributions to APNIC's formation and establishment. Several have also continued long and productive relationships with APNIC and, in some cases, have served on the Executive Council or assumed leadership roles on the APNIC staff.

At APNIC 1, Conrad reported on the status of APNIC. At that time, APNIC had one part-time staff member (though part-time in this case meant at least 40 hours per week), supported by 44 others in 15 countries on the apnic-staff mailing list. The organization used office space provided by Keio University and IIJ and computer hardware on loan from IIJ, NTT, and WIDE. In its brief operational history, APNIC had processed 311 address requests, representing 1 082 networks.[56]

However, one of the major issues discussed at this meeting was just how APNIC should continue, in particular, how it should be funded. Conrad explained in frank terms that the APNIC operational model to date had the advantage of being inexpensive, but suffered from the associated "very poor quality control" and "highly variable services".[57]

Conrad reviewed the main options – a donation model (which was unpredictable) versus a fee-based model (charging for either addresses, services, or time) – and compared the models used in RIPE NCC and the InterNIC. Until then, although APNIC had encouraged donations from ISPs depending on size (small US$1 500, medium US$5 000, and large US$10 000), no ISPs had made such a donation.[58]

Apart from inherent instability, the donation-based funding model highlighted the importance of APNIC's perceived independence. For this reason, APNIC made it clear that it would "refuse to accept donations from an organization which [expected] preferential treatment".[59]

Another fundamental stumbling block towards a sustainable model was APNIC's legal status, which had so far been informal and unincorporated.[60]

The meeting reached a general consensus to develop a more stable funding model. RIPE meeting minutes from later that month report Conrad explaining that "APNIC raised the issue of charging for address space or leasing out address space to applicants, at a rate of approx. USD 0.10 per host address.... If it were to be implemented it would generate pressures on other registries to do something similar."[61]

At the same RIPE meeting, Conrad noted APNIC's proposed use of ISO-3166 country codes to aid in defining the region. This decision has persisted and the ISO-3166 designations have become the standard for country identification used by all current RIRs.

In February 1995, APNIC published a formal overview of its organizational structure and operations. The document explains that during the pilot project phase, APNIC derived its authority from APCCIRN (by then renamed to APNG[62]). However, because APNG was an "informal group with no legal authority or claim to represent the entire AP region" it could not provide the interim APNIC with an appropriate legal umbrella. "As such, it was felt by the members of the APNIC consultative committee that APNIC's authority should be derived from the Internet Assigned Numbers Authority (IANA)."[63] This arrangement provided sufficient legal protection, but did not solve the funding problem.

Meanwhile, in response to the growing workload, APNIC took on its first new employee, Yoshiko Chong Fong, a Japanese national and graduate of Computer Science from the University of New Mexico. Chong was hired just before the second APNIC meeting, held in Honolulu with the APNG meeting on 2 July 1995[64]. With little practical experience of Internet addressing, Chong received intensive on-the-job training, starting with the "APNIC meeting in Hawaii, followed by four weeks at InterNIC, one week at an IETF meeting in Stockholm, another two weeks at InterNIC, and four weeks at RIPE NCC in Amsterdam. This had prepared me to become the first hostmaster of APNIC".[65]

Throughout 1995, alongside the normal operational activities, a great deal of APNIC's work revolved around efforts to define and implement a new organizational arrangement and funding model. In September, that work culminated in the release of a new funding plan, based largely on the RIPE NCC model. The plan included an account startup fee of US$1 000 and several payment tiers:

- Internet Service Provider Registries:
  - Large – US$10 000 per year
  - Medium – US$5 000 per year
  - Small – US$2 500 per year
- Enterprise Registries – US$1 500 per year

Registries would be free to select their own payment tier, and the plan stated clearly that APNIC was charging for service levels, not for resources.[66]

The funding plan was originally intended to be implemented on 1 September 1995. However, because the issue of APNIC's lack of legal status remained outstanding, implementation was delayed until "after the third APNIC meeting to be held in Singapore in January, 1996" by which time APNIC would have established "a clear and well understood legal umbrella". Until then, the Internet Society (ISOC) had agreed to act as a legal proxy able to receive funds on APNIC's behalf.[67]

By the end of 1995, APNIC's operations – if not organizational model – were solidly established. The staff, comprised of David Conrad (half time), Masaya Nakayama (half time) and Yoshiko Chong Fong (full time), had made 747 allocations for a total of 45 473 networks. APNIC forecast a 1996 budget of approximately US$247 000, with most increases from the 1995 budget flagged for more staff resources to handle system administration, research and development, and administrative functions.[68]

APNIC's other major achievement in 1995 was to lead the creation of the Asia Pacific Regional Internet Conference on Operational Technologies (APRICOT), which has now become the major Internet operators' forum for the region. According to the APRICOT website, "David Conrad ... was the instigator and prime motivator to make APRICOT the Internet Technical and Operations meeting for the Asia & Pacific region".[69] From 1996 on, the first APNIC meeting of each year has been held with APRICOT, bringing together the best of the region's operational and address policy community members.

Though much remained to happen before APNIC evolved into its current form – and moved to its current location in Brisbane, Australia – the achievements of its first few years were significant. Many individuals made valuable contributions, many of which were voluntary[70]. However, in the words of Kyoko Day (who in 1996 became APNIC's next full time employee):

> There is one thing I know for sure. Without David Conrad, APNIC did not have a ground base to start. He was only 28 when he took over a pilot project. He worked day and night. His devotion and commitment made a big difference. He took time to listen to the voices of the key people in the community but maintained APNIC core values: neutrality and impartiality.[71]

Beyond the experiment: Permanence, professionalism, and place in the community

After a little more than two years of operation, the dawn of 1996 saw APNIC at a crossroads. Though it had found acceptance within the regional community and had built the foundation for

reliably providing critical services, it lacked a clear path for consolidation and growth. The close, supportive relationship APNIC enjoyed with JPNIC had been essential for its establishment, but was not appropriate for APNIC's long-term evolution into a neutral, independent provider. Nor was it appropriate for JPNIC's interests to continue to fund registry activities for the entire region.

Of more immediate concern, the arrangement for ISOC to receive funds on behalf of APNIC and provide a limited legal umbrella did not come to fruition, forcing APNIC to delay the launch of its charging scheme and fee structure.[72] To secure its long-term, independent existence, the time had come for APNIC to incorporate.

In the meantime, APNIC had begun to solicit contributions, with the understanding that any money contributed would be deducted from an organization's service fee when the fee structure was finally implemented.[73] In the 1995 financial year, APNIC received US$114,000 in contributions.[74] This represented generous support from many organizations, but it was not a level of funding that could sustain APNIC's operations, let alone support expansion.

As is so often the case, personal relationships played a large part in the next phase of APNIC's development. Primarily through David Conrad, APNIC was forming strong relationships with key individuals across the region. These included those already mentioned, such as Jun Murai, Toru Takahashi, and Masaya Nakayama in Japan and Kilnam Chon and Taeha Park in Korea. They were soon joined by others, such as Tommi Chen (Malaysia); Che-Hoo Chong and Pindar Wong (Hong Kong); Sanjaya (Indonesia); and Tan Tin Wee, Barry Greene and Laina Raveendran Greene (Singapore).[75]

Given APNIC's formation in Tokyo, many were keen for it remain there. To this end, JPNIC coordinated work on a proposal to incorporate the organization in Japan. Yoshihiro Obata, who at the time was a project manager for InternetKDD (developing global transit for Japanese networks), contributed to this effort. As he recalls, though, there were various factors working against APNIC's staying in Japan, but:

> The big challenge for Japan to propose APNIC's incorporation was local tax. Unlike the new company law in Japan, we had a law that allows only a choice of non profit no tax or profit with tax. The restrictions for non profit [were] too serious and it was nearly impossible to get an approval for APNIC.[76]

While those in the rapidly growing Internet community understood the significance of a regional Internet registry, that understanding had not yet penetrated far enough outside the community for APNIC to easily secure administrative or bureaucratic flexibility. Laina Raveendran Greene also recalls the general lack of governmental interest in APNIC and its mission in those early days:

> The main challenge was getting government support to gain non-profit benefits for APNIC, due to the lack of awareness of the key role the Internet played in national infrastructures. The Internet was still seen as an R&D network and APNIC with its informal structure was not taken seriously. [Many governments] did not take APNIC seriously, at least not until [they] needed IP address allocations for building their own national IP network.[77]

Raveendran Greene, employed by Singapore Telecom (SingTel), helped APNIC as a policy adviser from 1996 (in the lead up to its incorporation) to 1998. Around the same time, she founded the Asia Pacific Policy and Legal (APPLe) Forum and was the founding Secretary General of the Asia Pacific Internet Association (APIA). Both of these organizations received significant early support from APNIC and cemented strong relationships with David Conrad.

Conrad, working with Raveendran Greene and her husband, Barry Greene, was himself instrumental in forming the Asia Pacific Regional Internet Conference on Operational Technologies (APRICOT). Following the model of the North American Operators Group (NANOG), APRICOT was set up to be, and continues as, the major forum for "key Internet builders in the region to learn from their peers and other leaders in the Internet community from around the world".[78]

The first APRICOT was held in Singapore in January 1996. Barry Greene (then also with SingTel) convinced his employer to support the event, and Harish Pillay secured sponsorship from the Singapore Computer Society.[79] This work set in place a tradition that continues to this day, whereby the first APNIC meeting of each year is held alongside the annual APRICOT meeting.

And so, the third APNIC meeting was held in Singapore in January 1996 with APRICOT 1. At this meeting, as a step toward a permanent legal existence, Conrad presented a proposal to incorporate APNIC.[80] This would give it the ability to enter contracts in own right and thus overcome the problem that many organizations had in dealing with and making payments to a non-legal entity. Under the proposal, "APNIC, Inc." would be established to provide registration services, under contract, for a membership service fee. Although it would be a private company, its books would be open and publicly available.

The structure proposed for APNIC Inc. comprised:

- members, which would be organizations paying for APNIC services
- a board of directors, elected by the membership
- an executive directorate, hired by the board of directors to provide APNIC services, operating under the direct administration of the members via the board

Membership service levels were proposed to be self selected. However, as an incentive for larger organizations to select an appropriate membership level, Conrad proposed corresponding tiers of voting rights, whereby large members would receive four votes; medium members, two votes; and both small and non-ISP membership categories would receive one vote each. As an aside, it is worth noting that voting rights apply only to general organizational and budgetary oversight; matters of RIR address policy remain open to all interested parties and are determined by consensus rather than voting.

The original site of incorporation was to be New Zealand, selected as a "neutral, stable country that is entirely non-threatening".[81]

The APNIC meeting accepted the proposal to incorporate. But again, it was not to be quite so simple.

Raveendran Greene worked with Conrad to develop the proposed bylaws and corporate structure for APNIC. She also introduced APNIC to legal advisers in Singapore. Unfortunately, their research revealed some complications with New Zealand incorporation. For one thing, although APNIC's operational site had not yet been determined, New Zealand incorporation would require a staff presence in New Zealand. Furthermore, although APNIC would generally enjoy non-profit status, the proposed arrangement would raise complicated tax problems for New Zealand based members.

With New Zealand, therefore, no longer a feasible option, and given the lack of specific governmental interest in APNIC, Raveendran Greene recalls that "we decided to incorporate in [the] Seychelles to take advantage of tax benefits and flexibilities offered to set up APNIC as a regional organization".[82] For cost and logistics, this appeared to be the best option available. For political perception, "we also created the title 'Director General' for David Conrad, so he would be

taken a little more seriously around the region by key organizations such as APEC, ASEAN, OECD, etc.".[83]

Ultimately, on 30 April 1996, APNIC Ltd was registered in the Seychelles as a non-profit corporation with an authorized capital of US$5,000 (represented by 5,000 US$1 shares of identical rights), under the sole directorship of David Conrad.[84]

The Memorandum of Association and Articles of Association are quite normal and generally unremarkable; however, a handful of important provisions allows the director to create a "special committee" defined by by-laws. Under those provisions, the director can appoint members and delegate certain powers to that committee. The members of the special committee are then able to elect a council empowered to exercise all the delegated powers.[85]

Decoding this corporate arrangement, what we normally refer to as APNIC is, in fact, the special committee of APNIC Ltd, established on 18 May 1996.[86] APNIC members are the members of the special committee and the Executive Council (EC) is the special committee council.

As described in the by-laws, the objects of the special committee known as APNIC are:

a. to provide the service of allocating and registering Internet resources for the purpose of enabling communications via open system network protocols and to assist in the development and growth of the Internet in the Asia and Pacific Rim region;
b. to assist the Asia and Pacific Rim Internet community in the development of procedures, mechanisms, and standards to efficiently allocate Internet resources as a service to the community as a whole;
c. to provide educational opportunities to further Members' technical and policy understanding of the industry;
d. to develop public policies and public positions in the best interest of the Members and to seek legislative and regulatory consideration of issues of general benefit to the Members, where and when appropriate;
e. to serve as the administrative, managerial and operations arm of APNIC Ltd. ("the corporation"), and to transact all activities, functions and affairs on behalf, and in the name, of the corporation.[87]

To pursue these objects, the by-laws also establish the structure of APNIC as comprising:

a. Members, who are the governing body of APNIC;
b. the Executive Council, which acts on behalf of APNIC;
c. the Secretariat, headed by a Director General; and
d. one or more Sub-Committees designated by the Executive Council, if any.[88]

Although there has since been one significant change to the corporate arrangement (the change of registration jurisdiction, to be detailed later), these by-laws created the membership-based organization we know as APNIC today.

With a legal identity and structure finally in place, APNIC held its fourth meeting alongside the INET96 meeting in Montreal, Canada, in July 1996. At that meeting, the inaugural Executive Council of APNIC was appointed, comprising:

- Geoff Huston (Australia, Chair)
- Jun Murai (Japan, Treasurer)
- Tze Meng Tan (Malaysia, Secretary)
- Sanjaya (Indonesia)
- B.A.C. Abeywardana (Sri Lanka)

The bootstrapping provisions of the by-laws required that two of the inaugural EC members would serve until the first Annual General Meeting (AGM), while the remaining three would serve until the second AGM. New EC members from that time on would be elected and would serve two year terms.[89]

As Geoff Huston (the first chair of the APNIC EC) recalls, the appointees drew lots to determine the term allocation.[90] As a result, Huston, Murai, and Tan were appointed for 18 month terms. Sanjaya and Abeywardana were elected for 6 month terms.

Also during 1996, APNIC moved its secretariat headquarters from the United Nations University to the Tokyo Telecom Center, into office space provided by the WIDE project at no charge. By that time, APNIC's server facilities were off-site at the KDD Otemachi Building, the same location as Japan's primary Internet exchange point (NSPIXP-2). APNIC's equipment consisted of "two service machines and a router with connectivity to the APNIC Secretariat provided by a 128 Kbps link," also provided free of charge by the WIDE Project.[91]

The other significant development in the secretariat that year – reflecting the maturity of APNIC as an organization and the growth in administrative demand – was the appointment of Kyoko Day as business manager. This brought the secretariat staffing to three full-time and two part-time staff, but even so the workload was stretching resources.

At the APNIC 5 meeting, held with APRICOT in Hong Kong in January 1997, the APNIC secretariat reported on the service statistics for the previous year, noting that the APNIC hostmaster, serving 108 members in 24 countries, "received approximately 100 requests, 50 non-request related questions, and over 250 pieces of other email per month" over the course of 1996. The minutes record discussion of "critical staffing limitations" in Japan, noting that:

> APNIC is currently understaffed with all staff members working significantly more that 40 hours per week. Difficulties in hiring additional staff [are] due to APNIC's requirements (networking knowledge and English fluency) and the traditional Japanese employment system.[92]

Further complicating APNIC's continued existence in Tokyo, the secretariat was investigating serious concerns that APNIC may become liable for "51.7% tax on net income in Japan". JPNIC was lending assistance, pursuing tax exempt status for APNIC, but the combination of recruitment problems and the uncertain tax situation led to a call for the secretariat to "prepare a report on the cost of doing business in various locations", to be submitted to the APNIC Executive Council by 31 March 1997.[93]

Another significant discussion to emerge from APNIC 5 related to confederation memberships. Until that point, confederations of ISPs were treated identically to other members. However, it was noted that with the self-determined membership category, it was hypothetically possible for all members to join a single confederation at the "small" membership level, thus reducing APNIC's annual membership income to US$2,500. While no decision was reached on the model to be used, the members did agree that a confederation membership category, with a different fee structure, was necessary.[94]

APNIC 5 also featured the first formal election for EC positions, with Dr. Xing Li (China) and Prof. Dr. Srisakdi Charmonman (Thailand) elected to replace Sanjaya and B. A. C. Abeywardana.

In particular, the election of Xing Li can be seen as a watershed moment in the Asia Pacific Internet. When APNIC first formed in 1993, the amount of TCP/IP networking in China was negligible (indeed, the future of that protocol was not even certain, with ISO/OSI also a contender for nascent Chinese internetworking[95]). As an aside, an FAQ from November1992 urges people to

not send email to China, because of the difficulty and prohibitive expense that local Chinese would incur in receiving the message.[96] But by April 1994, Prof. Qian Hualin, Deputy Director of Computer Network Center (CNC) reported the IP connection from the National Computer Networking Facility of China in Beijing to the Internet as "partly working" and providing access to "many information, databases, public domain sites on the Internet using this 64k link". Since then, Internet development in China has only continued to build momentum.

Because of China's relatively late entry to the Internet, it had little impact on APNIC's formation, but from the election of Xing Li to the EC in 1996, the Chinese Internet community has played a major role in APNIC's development and will continue to help shape APNIC's future.

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As noted above, the already overstretched staff had been tasked to report back to the EC with comparative business costs of various locations across the region. To complete this task, they turned to the consultancy firm KPMG. In addition to the specific needs of APNIC, KPMG was to consider general issues of "democracy, stability, and good IT infrastructure and training".[97] Accordingly, KPMG Tokyo sent out an request for proposals to a range of their offices in the AP, one copy of which arrived in Brisbane, Australia, on the desk of KPMG consultant Ross McConachie.

McConachie knew the business environment in both Japan and Queensland (the Australian state of which Brisbane is the capital); however, he did not at the time know much about the Internet. Fortunately, his colleague, John Earls did. In Earls's previous position he had worked with disabled people, teaching them computer programming and developing their skills on the Internet. This gave him a level of exposure to the Internet that few business consultants of the time could boast. At McConachie's suggestion, Earls approached the Queensland Premier's Department (where Earls had also previously done some IT work).[98]

At that time, Brisbane and the surrounding areas made up the fastest growing region in Australia. The Queensland government (which in the following year unveiled its "Smart State" strategy) was keen to foster an IT industry and was – unlike many other governments around the region – particularly interested in securing APNIC's presence, offering a five-year payroll tax exemption.[99] Earls, on behalf of KPMG, put together a package highlighting the other advantages of Brisbane.

In the end, the APNIC secretariat compared the costs and benefits of nine cities from around the region, namely:

- Auckland, New Zealand
- Brisbane, Australia
- Hong Kong
- Jakarta, Indonesia
- Kuala Lumpur, Malaysia
- Melbourne, Australia
- Singapore
- Sydney, Australia
- Tokyo, Japan

Ultimately, the secretariat reported that:

> Based on cost-of-living surveys done by CRG, and taxation and other business related costs provided by KPMG Peat Marwick and Arthur Andersen, and given the fact that APNIC membership fees are considered non-taxable income in Australia, the Secretariat determined that the cost of doing business would be lowest in Brisbane, Australia.[100]

Choosing the city was just the starting point. Migrating an organization and its operations is major undertaking. Once again, personal connections helped enormously. David Conrad turned to Australian contacts he had been involved with in his PACOM and APNIC work, including David "Bambi" Hughes, Hugh Irvine, Joanne Irvine, Chris Chaundy, and, of course, Geoff Huston.

Hughes – formerly of AARNet, but who at the time was operating an ISP close to Brisbane – recalls:

> In 1995 I ran the QUESTnet conference and invited Randy Conrad to speak. He came in from Tokyo to present. From there I started to help out with APRICOT and ended up writing a delegate registration system for the event. From memory that was for [Hong Kong] and Manila in 97 and 98. When Randy was looking to relocate APNIC out of Tokyo I was on the ground in Australia and offered to help. When Brisbane was chosen I did some hunting around for office space which resulted in the Park Rd location. I also helped coordinate some of the office fit-out to help keep costs in check.

Changing of the guard

With APNIC firmly established and the conditions for its stable growth secured, David Conrad now felt his work was done. He announced that he would continue to serve APNIC until his replacement was found, but that he did not intend to relocate to Brisbane with the organization he had created. While uncertainty, a grueling workload, and political distractions had clearly taken a toll, at the APNIC 7 meeting in Manila, Philippines in January 1998, Conrad took the unusual step of candidly raising and dismissing the many rumours about his decision to resign.[101]

Brushing aside suggestions of political maneuvers, organizational instability, or immigration issues, Conrad explained: "I am an engineer, not a business person. I enjoy building things, not running them. I promised myself that once APNIC reached its goal of having 6 months operational budget in the bank, I can go back to doing interesting things."[102]

In his closing comments to the meeting, Conrad noted that APNIC had "reached a level of stability that allows it the luxury of relocation", that this "would not have been possible without support by JPNIC, WIDE, IIJ, KRNIC, and the rest of the AP Internet community". Furthermore, despite "the instability in the region's economies," Conrad said, "APNIC is structurally and economically sound and can adjust to the membership's needs".[103]

Conrad explained that he had attempted to make APNIC open ("anyone can become an APNIC member"); transparent ("no hidden agendas or secret societies"); and independent ("no biases or non-business dependencies"). To Conrad, given "APNIC's international nature, this seemed the most appropriate course of action". But, he added, "the membership can change this if they desire". Conrad concluded his remarks with the personal observation that the APNIC community should "be wary of unnecessary politics… APNIC should be a service organization, not a political battleground".[104]

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By the end of 1997, the APNIC staff consisted of full-time employees David Conrad, Kyoko Day, Yoshiko Chong, and Yoshiko Tobata (temporary) and part-time assistant Natsuko Minamisawa. [105] Of these, only Kyoko Day intended to move to Brisbane.

However, around this time, one of the original RIPE NCC staff, Anne Lord, heard that APNIC was considering a move from Japan to somewhere else in the Asia Pacific region. Lord had formed a

close relationship with Yoshiko Chong when the latter trained at RIPE NCC. Though she had since left RIPE NCC to join an English ISP, she recalls that:

> This seemed an interesting opportunity to explore, so I got in touch with David Conrad... He subsequently offered me a job at APNIC as a Senior Hostmaster and *the* Trainer. My move was never really a planned move as such but it was fantastic as it allowed me to use the experience gained at the RIPE NCC from those early days as a hostmaster, to use experience gained in the commercial world working with routers and BGP, and to apply some of that understanding and experience to the APNIC environment.[106]

To join Day and Lord in Brisbane, APNIC also recruited Paul Gampe as Senior Systems Administrator, Connie Chan as Membership Officer, and Fabrina Hossain, as Hostmaster. Chong stayed on in Tokyo (leaving APNIC at the end of 1998).

The move to Brisbane began in February 1998 and was completed by August. Because most of APNIC's facilities in Japan were provided as in-kind support, the relocation costs totalled less than US$40,000.[107]

The move did require that APNIC be re-registered as an Australian company. This took place on 5 February 1998, with the creation of APNIC Pty Ltd (Australian Company Number 081 528 010). The by-laws of the Seychelles company were recreated almost identically for the new Australian company. However, because existing memberships were all contracted to the Seychelles company, it would take 12 months to transition the full membership to the new corporate structure.

KPMG, which had helped APNIC with the relocation, was now tasked to help recruit a new director general to replace David Conrad. The consultant, John Earls, advertised the position widely, receiving 30 applications, culminating in a shortlist of 15 candidates for screening interviews. The interviews took place in three Australian cities, as well as Singapore and the United States, eventually leading to a shortlist of six.[108] As it turned out, Earls had prior knowledge of several candidates, but there was one candidate he remembered particularly well. In his previous work teaching programming to disabled people, Earls had sought out a service provider willing to contribute support. As he recalls:

> I found Pegasus, which was part of [the Association for Progressive Communications] APC and had Green links. They were based in the old, disused whaling plant in Byron Bay with a staff of two and a bit. The second person, the system operator, was Paul Wilson. Pegasus gave us a free connection. The year, I think, was 1989.

Paul Wilson was one of the founding staff members of Pegasus Networks, the first independent ISP in Australia. Pegasus was also a company with a strong social commitment and development focus: "It acted as a 'gateway' to emerging online networks working the fields of environment, labour, peace, women's and the human rights movement… Pegasus Networks was active in establishing connectivity to countries in South East Asia and Indo-China."[109]

Wilson became CEO of Pegasus in 1992 and held that role until 1997. During that period, he helped to found the Association for Progressive Communications (APC), and served for several years as an APC Council and Executive Board member. During the 1990s, Wilson also "consulted on various Internet projects for the United Nations and other international agencies, including the International Development Research Centre (IDRC)". He was "a principle consultant on IDRC's Pan Asia Networking (PAN) Program, a program aimed at introducing and developing Internet services in developing economies of the region". His development work included projects in Mongolia, Vietnam, Cambodia, Maldives, Nepal, Bhutan, Papua New Guinea, China, and several countries in Latin America.[110]

Hugh Irvine, one of the pioneers of the commercial Internet in Australia and another longstanding contact of David Conrad, had helped with APNIC's office search. He recalls, during that process also suggesting Wilson as a potential replacement for Conrad.[111]

The EC members Toru Takahashi (Chair), Geoff Huston, and Che-Hoo Cheng interviewed Wilson in Brisbane (joined by Anne Lord and Kyoko Day of the staff). On 27 July 1998, Takahashi announced publicly that Paul Wilson would become the new APNIC Director General, noting that for his first six months, he would be assisted by Dr. Tan Tin Wee (APNG Chair) to help ensure a smooth introduction.[112]

On 3 August 1998, Wilson joined his staff of Kyoko Day, Anne Lord, Paul Gampe, Connie Chan, and Fabrina Hossain in APNIC's new office at 33 Park Road, Milton (an inner suburb of Brisbane), thus completing the transition. Without interrupting normal services, APNIC had found a new home, new leadership, and new staff. A new address protocol and a new century were just around the corner.

Creating a community of members

As noted earlier, when APNIC was first formed, the expectation was that countries in the Asia Pacific region would form national NICs and that APNIC would primarily allocate "Class C network blocks to national registries and multi-national service providers" and provide "NIC services for nations with no regional NIC".[113] This was quite different from the expectation in the RIPE region, where membership was organized around separate network identities, known as Local Internet Registries (LIRs). Furthermore, as experience with CIDR led to development of new best practices in addressing,[114] there was little technical justification for an additional layer of registry administration.

However, for linguistic and historical reasons, several Asia Pacific economies preferred a national registry model. JPNIC and KRNIC had played vital roles in establishing APNIC, and they were soon joined by TWNIC (Taiwan, 1994), APJII (now IDNIC, Indonesia, 1996), and CNNIC (China, 1997) as APNIC members.[115] To be consistent with the language of regional and local Internet registries, the national NICs became referred to as National Internet Registries (NIRs), but within the membership structure, NIRs were originally considered to be "confederations" of members.

As ISPs began to become more globalized, with operations spanning multiple countries, APNIC accepted ISP confederations beyond the national NIC structure. With this structure, very large ISPs could "maintain independent network allocation pools", which was not otherwise allowed under the normal membership categories.[116] Unfortunately, the confederation system also introduced problems, namely, a lack of policy consistency across the entire membership, an increase in administrative complexity for the APNIC hostmaster, and the potential for unfair disparities in fees under the self-selected membership tiers. APNIC attempted to address these problems by releasing the "Confederation Requirements, Fees and Policies" document in August 1998, which codified special procedures for confederations members, allocation requests, and address administration. The document also created a one-off per-address service fee for confederation members in addition to the normal annual membership fees.[117]

Despite these measures, the confederation category remained problematic, so in December 1998, the APNIC EC supported a decision to suspend the formation of any new confederations. This decision applied only to ISP confederations, not NIRs. Two years later, APNIC proposed (at the APNIC 10 meeting) that this suspension become permanent.[118] However, voting on the proposal hit procedural snags and the issue remained in limbo for several years.

Ultimately, though, ongoing collaboration and discussion among the NIRs and the APNIC Secretariat proved fruitful, resulting in new formation criteria and operational policies for NIRs being adopted at the APNIC 14 meeting in Kitakyushu, Japan, in September 2002.[119] These documents recognize the important role that NIRs play within their local industry and their need to operate in ways that "take account of local cultural differences", while at the same time providing for harmonized addressing policies across the region and "neutral, open, and transparent" operations. Crucially, the NIR policies insist that APNIC will only recognize NIRs that are accepted as such by their own community and achieve formal endorsement from a relevant government body.[120]

At the following APNIC meeting (APNIC 15, held in February 2003 in Taipei) the APNIC EC officially approved VNNIC's application to serve as the NIR for Vietnam.[121]

Despite some other preliminary approaches over the years, the next NIR did not form until March 2012, when the Indian Registry for Internet Names and Numbers (IRINN) was formally recognized during the APNIC 33 meeting in New Delhi, India.[122]

NIRs play a special role in the APNIC community, unmatched in the other RIR's (except, to a lesser degree, in the LACNIC region). NIRs are membership-based, service organizations. They have a public registry role in their own region, and so their functions and interests are, in many ways, analogous to APNIC's regional role. Unlike most ISPs, NIRs are able to devote significant resources to address policy, research, and measurement. As a result, NIR staff have always made highly visible contributions to APNIC at all levels of its operations. For example, many NIR staff have served as Special Interest Group (SIG) chairs, while many others have provided important content in the form of policy proposals, research analysis, technical updates, and more. The NIRs have always been well represented on the Executive Council, working as a strong voice for large sections of the community in overseeing APNIC's operations. And NIRs are frequent hosts and sponsors of APNIC meetings and other events.

Most APNIC members, however, are not NIRs. APNIC membership is open to all individuals and organizations, but in practice most are ISPs and organizations that use Internet number resources in their networks.[123] However, "as Internet resources become increasingly important, other organizations, such as domain registries, government regulators, Internet content providers, and the education community are joining APNIC in increasing numbers".[124]

The APNIC website lists 93 organizations as "founding members".[125] By the start of 2013, APNIC membership had risen to more than 3,500. However, as Paul Wilson explained in the introduction to the 2012 Annual report, despite "two decades of exponential growth in membership numbers", the Secretariat managed to satisfy the corresponding growth in demand for services with linear growth in staffing.[126]

It should be noted that APNIC's service region shrank slightly in 2005, when AfriNIC emerged as the new RIR for the African region and took over responsibility for the previously APNIC-served territories of Comoros, Madagascar, Mauritius, Mayotte, Reunion, and Seychelles, leaving APNIC now responsible for 56 economies. However, this change had little impact on APNIC's membership base.[127]

Refining the membership structure

Sustained growth in membership and demand for services has, over the years, been accompanied by ongoing refinement of the membership structure and fees.

The late 1990s and early 2000s presented tough challenges for the Asia Pacific region. The Asian Economic crisis contributed to a general downturn in the industry and slowing of the membership growth rate. Nevertheless, even during this decline, resource demand continued to climb and in 2001, for the first time, APNIC allocated more IPv4 address space than the RIPE NCC.[128] In the following year, APNIC's total allocations exceeded those of both RIPE NCC and ARIN.[129]

Likewise, whereas the Executive Council had previously directed APNIC to hold six months' worth of operating expenses in reserve, in 1999 the Secretariat exceeded the requirement and had built a 12 month reserve. The Executive Council then updated their direction, insisting that APNIC maintain the 12 month reserve to allow it to provide "a secure base for APNIC to consolidate its position and embark safely on longer term projects for the benefit of the membership and the regional Internet community".[130]

In 2000, the previously self-determined membership tier selection came under review and a proposal was accepted to "base the minimum membership category on the amount of address space held". During that year, while the total membership number grew by a then record 52 per cent, the medium, large, and very large categories all grew by at least 100 per cent.[131]

In 2001, the membership structure was further refined and expanded. Adding a new "associate tier" and removing the account start-up fees helped lower the bar to entering the APNIC membership. New categories of Very Small and Extra Large were also added to provide more options to accommodate different sizes of organization. At the same time, a two-year consultation period culminated in APNIC introducing a new membership agreement, to make "clearer statements of the democratic principles underlying APNIC's activities" and help strengthen the central role of the policy development process.

These changes coincided with the fifth anniversary of the APNIC membership structure, which the community celebrated at the APNIC 12 meeting in Taipei by formally recognizing the founding members. More than 25 of the 93 founding members were present at APNIC 12 to receive certificates acknowledging the contribution they had made in helping APNIC establish and grow successfully.[132]

Despite the changes, the fee structure remained a topic of considerable discussion in the following years. The APNIC 21 meeting in Perth in 2006, featured the first of many sessions dedicated to fees at subsequent meetings. Likewise, there was considerable discussion of fee-related issues on the APNIC Fee Structure Working Group mailing list, addressing "perceived problems and inequities in the fee structure for NIRs ... and concerns about the sustainability of the overall structure".[133] In response to these concerns, the APNIC Executive Council commissioned a study by KPMG.

In a detailed report, KPMG concluded that:

> KPMG's analysis clearly shows that the impact of the foreign currency movements, and the general impacts of movements in the Consumer Price Index (as a proxy for inflation), represent risks to APNIC which must be addressed. It is also clear that these factors have resulted in a significant reduction in the real costs of APNIC membership, and that an adjustment in fees should be seen as a response to an erosion in income, and not as a fee increase resulting from escalating costs.
>
> We believe there is a justification for an immediate increase in the members' fees, and not to do so would expose APNIC to financial risk.[134]

The report set out the main factors the consultants had considered. One of the most significant problems was that APNIC fees were charged in US dollars, but the majority of APNIC's expenses were in Australian dollars. The long-term, fluctuating decline in the US dollar exchange rate made

APNIC's budgeting process unpredictable and led to a more than 40 per cent "deterioration in APNIC's AUD revenues" from 2000 to 2007. Furthermore, the membership fees had not changed (not even been adjusted for inflation) since they were first introduced in 1996, "narrowing [the] gap between revenues and expenses" to the point where APNIC was on track to incur its first deficit. The report also noted that without fee reforms, APNIC would have increasingly limited ability to meet members' expectations for "greater and better services".[135]

Supported by the independent report, the Executive Council proposed at APNIC 24 (New Delhi) that the fee structure should be modified by setting fees in Australian dollars and that fees should be increased by seven per cent. However, the proposal was rejected at the meeting. In the discussions that followed, it emerged that the sticking point was the seven per cent increase, but that there were no strong objections to switching to Australian dollars. On 11 October 2007, the Executive Council – relying on its specific power under section 4 of the APNIC By-Laws to establish membership fees – "determined that APNIC would set the fees in Australian dollars, but without the 7% fee increase".[136]

A further refinement to the fee structure was approved in 2009, to start in 2010, comprising:

- A 50 per cent discount on membership fees to those in the United Nations designated list of Least Developed Countries
- The introduction of a continuous formula to determine membership fees, applied to both current and historical IPv4 address holdings. A separate continuous formula is applied to IPv6 holdings, and the greater of these two determines the membership fee payable.
- Removal of per-allocation fees for NIR and Confederation Members. Instead, NIR and Confederation Members will pay a premium of 190% above normal membership fees.
- A change in procedure so that resource holdings are now assessed on the member's anniversary date

By 2010, APNIC's financial performance had returned to strong annual operating surpluses.

Serving the members – training, support, and communication

Core services

As an RIR, APNIC's core services have, of course, always been based on distributing and registering IP addresses and AS numbers and managing the related reverse DNS delegations (which allowing mapping from an IP address to a domain name, using the in-addr.arpa domain for IPv4 and ip6.arpa for IPv6).

In 1999, APNIC announced development of a new service to members in the form of an RPSL-based routing registry service so that operators could publish their routing policies and get better global views of Internet routing.[137] The APNIC Internet Routing Registry (IRR) launched in 2002 (along with the database upgrade to RIPE Whois v3) and assists with route filtering, network troubleshooting, and router configuration.[138]

Internet addresses are finite resources. Managing them properly requires technical competence and up-to-date knowledge. Therefore, those who use the resources cannot be mere consumers, nor can the resources be considered as simple commodities to be bought and sold in an open market. Unfortunately, this does mean that RIRs' services are often complex to administer and can be daunting to inexperienced members. So, to function properly, an RIR must support its

membership, both by helping members understand the resource policies and by creating the forum for experience sharing and ongoing policy development.

Before moving to Australia, most of APNIC's energy was committed to delivering core registration services (and, as discussed, to establishing permanent, sustainable operations). But with the security of its new base and under Paul Wilson's direction, APNIC became able to start building a broader suite of membership services, dedicating more resources to training, technical development, and communication.

Training

Previously, APNIC staff had helped train members though the hostmaster function. From 1998, work began to compile a comprehensive course that would explain the main principles, policies, and procedures for managing address space. The new course was launched at the APNIC 8 meeting in Singapore in March 1999 and subsequently held in four other locations. Later that year, APNIC's first dedicated training manager, Champika Wijayatunga, joined the APNIC staff.[139] In the following years, he would be joined by several other colleagues, who would travel to all parts of the region and work with members, operators groups, and other organizations in an important capacity building role.

In 2003, APNIC's training programme had expanded to four major courses: three levels of Internet resource management and a comprehensive DNS workshop. The training team customized the material to different events and worked closely with other organizations and industry experts to deliver courses across the region. That year, APNIC entered a cooperative agreement with the respected Asian Institute of Technology (AIT) to further extend the reach of APNIC's training services.[140] Since then, APNIC has entered into several other cooperative agreements, and has collaborated with most major Internet forums in the Asia Pacific.

In 2006, APNIC held 38 sessions in 17 locations. But to reach an even broader audience, the training team began trialling web-based training delivery.[141] Online training became a full service offering in 2008, with the launch of an IPv6 training module.[142]

Training is well established as one of APNIC's most significant activities. In 2012 alone, the training team held 73 face-to-face courses in 33 locations for 2,347 participants; they delivered 24 IPv6 courses for 858 participants; and they supported 93 online courses for 932 participants.[143] As an extension to the training activities, APNIC has also begun formally offering engineering assistance services on a cost recovery basis, with fees structured to take account of the economies in which the services are used. Furthermore, all training materials, course details, and archives are now consolidated and publicly available on a dedicated website.[144]

In July 2011, Philip Smith – one of the most active and respected members of the Asia Pacific community, and one of the most experienced Internet trainers in the world – joined the APNIC staff as Director of Learning and Development.[145] Under his leadership, the training team continues to grow in scope and reach, forge partnerships, and contribute to Internet development in the region.

Service delivery

Another important requirement for serving a diverse region is maintaining a diverse staff. Indeed, as discussed earlier, the need to ensure diversity was one of the factors motivating the Secretariat's move from Tokyo to Brisbane. After only three years in Brisbane, the Secretariat staff had grown from six to 32, and it had begun to reflect the diversity of the membership with 14 of the region's

languages spoken. In 2002, this resource was put into action with the launch of multilingual helpdesk services.[146]

Although the Secretariat staff had always worked with general goals of improving member services, in 2005 that goal was translated into more formal strategic direction via the "Putting Clients First" project, which aimed to streamline and simplify service delivery to members and other account holders. This was a wide-ranging project, covering workflows, practices, and assumptions. It lead to considerable redevelopment of tools, forms, and supporting information, as well as many changes to the structure of APNIC's hostmaster services. One of the first major public changes in 2005 was to extend the APNIC helpdesk with a live chat system to deliver web-based interactive help, and thus allow simple advice and guidance outside the more structured ticketed request system.[147] In 2006, helpdesk support became even more accessible when APNIC launched a VoIP telephony system for all members, allowing free phone calls to the helpdesk.[148]

MyAPNIC

However, one of the most important ongoing developments in membership services was the launch in September 2002 of the MyAPNIC website. MyAPNIC significantly streamlined account administration, billing, and resource services and, in subsequent versions, would add features such as electronic voting (which was first used for the ASO Address Council election in 2005).[149] MyAPNIC remains under constant development: it received an entirely new design in 2009[150] and, by 2012 supported one-click IPv6 allocations to NIRs and had nearly 6,000 registered users.[151]

MyAPNIC is secured by APNIC-issued certificates, leveraging work that had started as early as 1999 with a pilot project to secure interactions with members. The pilot was a far-sighted effort to develop simple resources for encrypting and signing email and authenticating access to the website and database. At the time the project was launched, the Secretariat also made a brief reference to what may ultimately become the most important implication for certification, noting that "it is intended to eventually apply to certification of resource allocations",[152] (a topic to be discussed under "Technical Leadership", below).

Sending the message

APNIC's web presence has always been the most publicly visible way for APNIC to communicate with members, the Asia Pacific region, and the global Internet community. The main APNIC website was originally developed by KRNIC as a small, static, handmade site. Over the years, the site evolved to handle the large quantity of content generated around APNIC's services, meetings, and mailing lists. Several facelifts and reviews notwithstanding, the most significant change came in 2009, with a completely redeveloped site driven by a robust content management system.[153]

Along the way, the main site has been complemented by several specialized sub-sites, such as:

- MyAPNIC, launched in 2002 as the primary site for secure account administration and resource management (discussed above)
- ICONS (the Internet Community of Operating Networking Specialists), launched in 2005 as an interactive, wiki-based resource to promote open exchange of information, including a discussion forum, documents, presentations, and links[154]
- Apstats, launched in 2007 to graphically display live, interactive reports of APNIC's resource and membership statistics[155]
- APNIC Training, launched in 2013 to bring together all of the APNIC training team's course materials, planning resources, and archives (discussed above)[156]

Beyond the website, APNIC has published a regular newsletter, *Apster*, since 2001. Apster was launched at the APNIC 12 meeting in Taipei, originally as a quarterly publication for the Asia Pacific Internet community, sent to all members and other subscribers.[157] Since 2008, *Apster* has moved to two issues per year, and since 2011 it has been supplemented by shorter, more frequent, *Apster Bulletins*.[158]

Hearing the message

At the same time that APNIC was building its ability to reach out to the community, it also began to build more formalized ways to receive feedback from members and other stakeholders. KPMG's John Earls recalls that when Paul Wilson first took the reins at APNIC he asked if Earls had any advice for him. "I told him he couldn't go wrong if he focussed on members' needs," says Earls.[159]

Acting on this advice, the Secretariat once again engaged Earls (through KPMG) to conduct a "detailed, open-ended survey of members and others from the wider Internet community". The survey took the form of both questionnaires and face-to-face interviews, many of which were conducted at APNIC meetings. In the interests of full transparency and accountability, the Secretariat published both Earls's report and a response by the Secretariat, endorsed by the Executive Council. This work provided a foundation for a strategic planning process, and it led directly to the first expression of APNIC's mission statement: "Addressing the challenge of responsible Internet resource distribution in the Asia Pacific region".[160]

The process also set a template for regular future surveys and further cemented the already close relationship between Earls and APNIC. The APNIC Member and Stakeholder Survey has now been conducted in 1999, 2001, 2004, 2007, 2009, 2011, and 2012. Earls, under the imprimatur of KPMG, conducted the first five surveys. However, following his retirement, the Secretariat turned to another respected independent consultant, Professor Ang Peng Hwa of the Singapore Internet Research Center, who conducted the 2011 and 2012 surveys.[161]

In addition to their value in refining APNIC's normal services and perception, the surveys are a mechanism for exploring candid views on new and emerging issues. For example, the third survey, in 2004, explored member and stakeholder views in "response to recent developments in the Internet environment such as WSIS [World Summit on the Information Society] and greater deployment of IPv6".[162]

APNIC Open Policy Meetings

Following the model of RIPE NCC, APNIC's operations, from the start, featured open meetings to discuss technical issues, operational experience, and develop membership and address policies. As has been seen from APNIC's formation and early history, bringing people together in the same place can create a richer social cohesion than virtual networking can achieve. Through connections and casual conversations, ideas are sparked and actions set in motion.

Since APRICOT formed in 1996, it has always been joined by an APNIC meeting. This relationship still holds strong today. However, as APNIC matured, it was no longer sufficient to rely on only one meeting per year. For one thing, though the mailing lists discussions have equal status as face-to-face meetings, there has always been an expectation that important issues would be discussed at meetings, and an annual policy cycle was not sufficient for a complex and rapidly evolving policy environment.

In response to this need, APNIC moved to a biannual model in 2000, with the first meeting held alongside APRICOT in Seoul, in March, and a standalone, re-branded, APNIC Open Policy Meeting (APNIC 10) held in Brisbane, in October.[163] The new wording of "Open Policy Meeting" was designed to clearly affirm that the APNIC processes are indeed open. While there are some issues – such as membership fees, by-laws, and Executive Council elections – that are necessarily members-only, all issues of address policy and discussions of operational knowledge and experience are open to any interested party. Furthermore, all address policy matters are decided by consensus – not vote – and all voices have equal standing in the discussion.

These features are consistent with the participation model responsible for the Internet standards, technical development, and other administrative arrangements. Often referred to as the "Internet Model" of development, it is inherently open, transparent, and inclusive, and widely considered to be the foundation for the Internet's success.[164] The integrity of the participation model is essential to APNIC's legitimacy and existence. Therefore, the Secretariat has devoted considerable efforts and resources over the years to support the model and expand the avenues for participation.

Not all interested parties will ever be able to attend a meeting. This is particularly so in a region with many developing economies and small ISPs. From the start – and still today – the mailing lists[165] have been the simplest and most accessible way for anyone to join APNIC discussions. Anyone may subscribe to the policy-related lists and comments on the mailing lists are accorded the same status as comments made in face-to-face meetings.

Nevertheless, the meetings are important gatherings of motivated individuals focussed on common goals, so anything that makes the meetings more accessible to more of the community is welcome. Two of the greatest barriers to meeting participation are cost of travel and language. APNIC took important steps to reduce those barriers in 2002 by introducing simultaneous interpretation at the meetings and streaming live video of the sessions. Then, in the following year, APNIC further improved participation options by introducing live transcripts – projected during sessions, and streamed across the Internet. The transcripts greatly improve meeting accessibility. Apart from helping non-native English speakers more effectively follow discussions, the archived transcripts provide a rich source of detailed policy discussion.[166] APNIC meetings are now also routinely attended by groups of stakeholders at remote participation hubs around the region.

The other major development in broadening participation, which started in 2003, came with the support of the World Bank infoDev for a fellowship programme, funding "key staff from organisations developing or providing Internet services within the developing economies" to attend APNIC Open Policy Meetings.[167]

Policy development in the APNIC community

The 1998 Annual Report noted that a major priority was to better document the APNIC address space management policies.[168] So, in 1999, all of APNIC's "primary allocation and assignment policies were brought together in a single document". After a long process of engagement and consultation, the Executive Council approved the document "Policies for Address Space Management in the Asia Pacific Region", which came into operation on 1 January 2000.[169] This action clarified the status of the existing APNIC policies, but the question of exactly how new policy should be created was still largely undefined.

In March 2000, the APNIC 9 meeting took place in Seoul. This meeting featured major developments in APNIC policy making, namely the introduction of Special Interest Groups (SIGs), to "raise and discuss issues of policy and operations in specific areas" and Birds of a Feather (BOF) sessions, to "allow those with a common interest to participate in less formal discussions".[170] The

SIG and BOF approach follows the Working Group and BOF model entrenched in other forums, such as the RIPE community and the IETF. (APNIC does also use Working Groups, though these are small groups, specifically tasked by a SIG to convene for a specific purpose, report back to the SIG, then disband.[171])

Efforts to clarify and formalize APNIC policy making continued through into the following year. While the meeting structures and policy development process had evolved naturally from the consensus-based traditions of the Internet community, they were explicitly stated and documented for the first time in 2001, in the form of guidelines for SIG chairs and presenters and the "APNIC Document review policies and procedures".[172]

The ongoing work in this regard culminated in 2004 when the community adopted the "APNIC policy development process" document, setting out the steps required to submit, discuss, and determine policy proposals. The five step process requires:

- Public discussion through the appropriate channels at least four weeks before the start of an Open Policy Meeting
- Consensus (defined as general agreement as observed by the meeting Chair), both at the relevant SIG session and then the Member Meeting
- An eight week public discussion period after the meeting
- Confirmation of consensus by the relevant SIG Chair
- Endorsement by the Executive Council[173]

SIGs develop their own brief charters, and their work is coordinated by chairs and co-chairs, who are volunteers from the community, endorsed in the role by their peers.[174]

Over the years, the APNIC community has supported the following SIGs:

- Policy (originally called "Address Policy")
- NIR
- Database
- DNS operations
- Internet eXchange (IX)
- IPv6 Technical
- Routing

However, as APNIC's operations and services have matured, and as other related operational forums have risen in importance, it was clear that several of the SIGs were no longer required. At the APNIC 32 Conference[175] held in Busan, South Korea, August-September 2011, the community decided to disband several inactive SIGs, leaving only Policy and NIR as currently active. In announcing the closure of the SIGs, APNIC's Senior Community Engagement Specialist, Srinivas (Sunny) Chendi, explained that subscriptions to the SIG mailing lists would be closed, but that the archives of the discussions would remain permanently archived and accessible. He also noted that much of the work previously handled by these SIGs was now taking place in APOPs (the Asia Pacific Operators Forum), APIX (Asia Pacific Internet Exchange Association), and the APRICOT Peering Forum.[176]

Many APNIC community members have made major contributions of time and effort to the SIG process over the years. In particular, SIG Chairs and Co-chairs work hard to ensure that consensus-based processes remain open, inclusive, and fair. Chairs and Co-chairs serve as individuals, not as representatives of their companies. The following have served as the Policy SIG Chairs and Co-chairs:

- Takashi Arano, Chair 2000-2005
- Seung-Min Lee, joint Chair 2001

- Yong Wan Ju, Co-chair 2003-2004
- Kenny Huang, Chair 2005-2007, Co-chair 2003-2005
- Toshiyuki Hosaka, Chair 2007-2008, Co-chair 2005-2007
- Eugene Li, Co-chair 2006-2007
- Dong Yan, Co-chair 2007
- Randy Bush, Chair 2008-2010, Co-chair 2008
- Jian Zhang, Co-chair 2008-2009
- Terence Zhang, Co-chair 2009-2011
- Ching-Heng Ku, Co-chair 2009-2010
- Gaurab Raj Upadhaya, Chair 2011
- Andy Linton, Co-chair 2011- current
- Skeeve Stevens, Co-chair 2011- current
- Masato Yamanishi, Co-Chair 2011- current

The NIR SIG was variously called the "NIR meeting" the "Open NIR meeting" and the "NIR BOF" before being formalized as a SIG at APNIC 16 in 2003. The past and present Chairs and Co-chairs of the NIR SIG in all its forms are:

- Seung-Min Lee, Chair 2000-2001
- Maemura Akinori, Chair 2001-2005
- Chia Nan Hsieh, Co-chair 2003-2004
- David Chen, Co-chair 2005-2008
- Izumi Okutani, Chair 2005- current, Co-chair 2005
- Billy MH Cheon, Co-chair 2008-2009
- Ching-Heng Ku, Co-chair 2009-2010
- Wei Zhao, Co-chair 2010-2011
- Ji Young Lee, Co-chair 2011-2012
- Jessica Shen, Co-chair 2012-current

From IPv4 to IPv6

In recent years, one of the dominant topics in the global Internet community has been the need to promote IPv6 deployment. In the midst of the panel discussions, launch days, and education campaigns, one can easily be forgiven for forgetting that IPv6 addresses have been available for almost 15 years.

On 27 July 1999, APNIC announced that IPv6 services were available, following IANA's delegation of IPv6 address blocks to all RIRs and subject to the "Provisional IPv6 Assignment and Allocation policies and with our own procedures". The announcement went on to explain that "because of the provisional nature of the policy document, we expect that IPv6 policies and procedures will evolve with experience".[177]

Work on IPv6 policy did, indeed, begin to evolve immediately, with a high level of coordination between all the RIR communities. In 2002, the provisional policy was replaced with a new common global IPv6 address policy.[178] The initial demand for IPv6 addresses was far from overwhelming, though it was slightly stronger in the Asia Pacific than in the other regions.

Meanwhile, for most of the Internet, it was still very much an IPv4 world.

As noted previously, APNIC's IPv4 policies were first fully consolidated in 2000, but they remained under active development in response to the evolving needs of both large operators (such as cable

and GSM networks) and small providers and networks. Some of the more significant changes to IPv4 policy in this period included:

- (2000) Reduction of minimum allocation size from /19 to /20. Start of allocations from former Class A address blocks.[179]
- (2001) Introduction of portable assignments to small multihomed networks. Introduction of special assignments to Internet exchange points.[180]
- (2002) Introduction of a "critical infrastructure" category to allow assignments to root servers, global top level domain servers, country code top level domain servers, IANA, RIRs, and NIRs.[181] Publication of special guidelines for (among others) virtual hosting services and cable, DSL, and GPRS operators.[182]

Although it had always been anticipated, the eventual exhaustion of IPv4 gathered momentum as a major concern in the mid-2000s. Ever since IPv6 was first available, APNIC had been involved in various promotional activities, including research, technical training, and awareness raising campaigns. Unfortunately, IPv6 allocations remained at a low level. To further contribute to the public understanding and accelerate appropriate responses, APNIC held a major panel discussion during APNIC 22 in Kaohsiung, Taiwan, in September 2006.[183] The session, titled "IPv4 exhaustion: What's the real story?" featured Paul Wilson, Tomoya Yoshida, Maemura Akinori, and Geoff Huston discussing the current research on IPv4 exhaustion and examining the "responses needed to cope with the exhaustion of the free pool". The panel discussion ranged over questions such as the likely date for IPv4 exhaustion, analyses of potential scenarios as the exhaustion date drew near, and likely operational responses to a post-IPv4 environment. There has been much speculation in the addressing community about a possibly chaotic run on the final supply of IPv4 blocks. Addressing this concern, Maemura-san pointed to the need for a coordinated policy response that minimized unfair outcomes as the final IPv4 address blocks ran down and ensured a globally consistent approach.[184]

The challenges of IPv4 exhaustion remained a dominant issue within the APNIC and other RIR communities over the coming years. But it was the not the only discussion of its type. Resource consumption was also a hot topic in relation to Autonomous System Numbers (ASNs). Geoff Huston – who had served many years on the Executive Council before joining APNIC staff as an Internet research scientist – had analysed how ASNs were being consumed and concluded that the free pool could be exhausted by 2010. Fortunately, the IETF had proposed a transition from 2-byte to 4-byte ASNs.[185] Accordingly, the APNIC community adopted a policy to begin the phased introduction of 4-byte ASNs, starting in 2007. This transition was to prove far easier than the IPv4 to IPv6 transition in every respect.[186]

Returning to the IPv4 question, the APNIC community discussed the issue at great length during the APNIC 24 meeting in New Delhi in 2007, resulting in the following public statement calling for widespread IPv6 deployment:

> The APNIC community resolves as follows:
>
> We recognise that at current rates of allocation, the remaining free pool of IPv4 address space will be consumed within the next 2 to 4 years.
>
> We agree that this situation requires a concerted effort by this community working for the common good, to seek, examine and adopt responsible measures for the management of remaining IPv4 address space. We recognise that during this period, we will be learning and adapting, and that address management policies may also change to adapt to new circumstances.

> We recognise the critical importance of IPv6 to the future success of the Internet, and will actively promote the adoption of IPv6, and focus our efforts towards comprehensive deployment of IPv6 in the Asia Pacific region.
>
> We reassert our support for open, bottom-up and consensus-based decision making, but we also call upon the leading senior and expert members of this community to provide strong leadership in the search for solutions to these issues of IPv4 address management and transition to IPv6, both within the Asia Pacific region and globally.[187]

As early as 2003, the APNIC region held more IPv4 address space than the RIPE region.[188] In 2007, networks in China became the largest consumers of IPv4 addresses in the region, yet it was clear that huge potential for Internet expansion remained.[189] In 2008, regional demand for IPv4 services was continuing to accelerate and APNIC was consistently subject to more IPv4 demand than all other RIRs. With the regional expansion of several higher capacity technologies, such as (3G, xDSL, cable, and WiMax), APNIC introduced a new procedure to automatically escalate large requests (greater than /15) to "senior APNIC management review to ensure adequate safeguards are in place for correct stewardship of the number resources".[190]

That same year, APNIC introduced the IPv6 Program as a new initiative to help community members transition smoothly to IPv6. In launching the program, APNIC urged operators and service providers to "begin planning for this transition as soon as practically possible so they are able to provide IPv6 support and IPv6 services by 2010". The IPv6 Program is primarily an outreach program with multiple objectives, including gathering statistical data, monitoring technical developments, researching best practices, reporting back to the community, and collaborating with national and regional organizations.[191]

Policy discussions in 2008 continued to be dominated by issues of IPv4 consumption, with several proposals arising, motivated by different aspects of the topic, such as changes to the IPv4 minimum allocation size, methods to fairly deal with the final /8 address block, methods to efficiently use historical resources, and – in the most significant break with prior address policy principles – concepts for providing a sanctioned approach to address resource transfers.[192] The latter proposal was adopted in 2009, when a policy change removed the previous restrictions on transferring IPv4 address allocation and portable assignment registrations between current APNIC account holders, opening the door for a new type of APNIC service.[193]

Understanding why IPv6 uptake has been slow for long is a key part of effectively promoting its deployment. To this end, the IPv6 program leveraged the 2009 member and stakeholder survey to seek hard data on IPv6 deployment attitudes and operational readiness within the community. The survey revealed that 40 per cent of respondents were at least committed to deploying IPv6. However, most respondents pointed to a clear role for governments to "support IPv6 deployment activities by various means, such as by requiring IPv6 compliance within their own infrastructures". Armed with this data, the IPv6 Program elevated "government" as a key stakeholder group, increasing efforts to present at "significant Governmental events, holding roundtables, and arguing the case for IPv6".[194]

By 2010, with IPv4 exhaustion now looming as an imminent certainty rather than a distant possibility, the global Internet community, while increasingly aware of the problem, still lagged in applying the solution. To make the process as easy possible, APNIC launched the "Kickstart IPv6" policy, which allows existing IPv4 holders to automatically receive an IPv6 allocation through the MyAPNIC website and kickstart their IPv6 deployment. During 2010, APNIC made 402 kickstart allocations to more than 25 economies, including 12 economies receiving their first IPv6 allocations.[195]

At the same time, through the IPv6 Program, APNIC took part in the Asia Pacific IPv6 Task Force (APIPv6TF) and was elected to serve as the task force secretariat for two years.[196]

The global RIR community (through the NRO) and IANA had been determined to ensure that the final IPv4 allocations should be distributed fairly among the five regions. The policy agreed upon was that five final IPv4 /8 address blocks would be reserved, one for each RIR. In late January 2011, two unreserved /8s remained. In response to high resource demand, APNIC requested those two unreserved blocks. IANA approved APNIC's request on 31 January 2011, thus triggering the distribution policy. IANA made the final allocation of IPv4 from the global pool to the RIRs on 3 February 2011.[197]

NRO Chair, Raúl Echeberría, called it "an historic day in the history of the Internet, and one we have been anticipating for quite some time". He continued, explaining that the "future of the Internet is in IPv6. All Internet stakeholders must now take definitive action to deploy IPv6".[198]

ICANN CEO, Rod Beckstrom made the point that this was a planned event. "Nobody was caught off guard by this," he said. "The Internet technical community has been planning for IPv4 depletion for quite some time. But it means the adoption of IPv6 is now of paramount importance, since it will allow the Internet to continue its amazing growth and foster the global innovation we've all come to expect."[199]

The end of IPv4 allocations at IANA was not the end of IPv4 allocations at the RIRs, as each registry still held its own pool. But the end of normal allocation policies was rapidly approaching. It was no surprise that the demand levels in the Asia Pacific region that triggered the global distribution policy also led to APNIC being the first RIR to reach its final IPv4 block. At the announcement of the final IANA allocation, Geoff Huston had explained: "This region is home to not only some of the largest populations in the world, but also the fastest-growing economies. Nearly all Asia Pacific economies are either in a strong developmental position, or they are accelerating at a rapid pace."[200] On 15 April, just two months after the final IANA allocation, APNIC made its last regular IPv4 allocation, activating the new policy that had been set in place for the final stage of IPv4 allocations.[201]

IPv4 and IPv6 are not directly compatible protocols, meaning that as long as IPv4-only services continue to have a presence on the Internet (and that could be decades), IPv6 network operators will need to have at least a small number of IPv4 addresses to provide access to the full Internet. For this reason, the RIRs developed policies to preserve their final /8s as long as possible and "allow new entrants to maintain a connection to legacy networks while deploying the new IPv6-based Internet".[202] At APNIC, the primary IPv4 policy document now includes the following wording: "As of Friday, 15 April 2011, each new or existing APNIC account holder is only eligible to request and receive delegations totalling a maximum /22 worth of address space from the APNIC IPv4 address pool."[203] The amended IPv4 policy should extend the life of APNIC's final /8 by several years – and APNIC recycles addresses returned by closed members to boost the remaining pool – but the end of IPv4 allocations will eventually come.[204]

The end of IPv4 allocations, however, does not mean the end of IPv4 services at APNIC. All holders of existing IPv4 allocations will continue to need registration and other related services. Similarly, the resource certificates discussed previously are likely to become more important in the future.

But perhaps the biggest transformation in APNIC's service offerings is the shift of emphasis from allocation to transfer. Previously, APNIC policies only allowed transfers of address space in cases of mergers, acquisitions, and takeovers.[205] However, the member and stakeholder survey of 2012 identified a clear need for APNIC "to monitor and report transfer activity and develop procedural

guidelines for completing resource transfers".[206] APNIC has since established a sanctioned mechanism to allow transfers of IPv4 addresses:

- between current APNIC account holders
- between current APNIC account holders and organizations in other RIR regions
- from holders of historical IPv4 addresses without an APNIC account to current APNIC Members

In the first two cases, the intended recipient of the addresses must justify a need for the address resources by providing "a detailed plan for the use of the transferred resource within 24 months".[207]

The provision allowing interregional transfers is compatible with provisions in the other regions. In October 2012, APNIC processed its first such transfer as an APNIC member received addressed from an organization in the ARIN region.[208]

APNIC also launched a broker registration service, providing a list of compliant address holders "who have agreed to abide by all APNIC policies in facilitating transfers for APNIC address holders". This is purely a referral service and APNIC states clearly that it "does not endorse any individual broker, but the list is provided so Members can identify those brokers that have entered an undertaking with APNIC and expedite their transfer processes".[209] By mid-2013, four organizations – all in the USA – had registered with APNIC as brokers.[210] As a complement to the broker registration, APNIC also offers a service for potential address recipients to seek pre-approval of their IPv4 address needs. Pre-approved recipients have the option to be publicly listed on the APNIC website, and many have accepted that opportunity.[211]

By early 2013, almost 48 per cent of APNIC members held both IPv4 and IPv6 address space – compared to RIPE (62%), LACNIC (54%), ARIN (38%), and AfriNIC (32%).[212] However, recent research suggests that by June 2013, 1.29 per cent of Internet users (approximately 29.3 million people) prefer "to use IPv6 when presented with a dual stack object to fetch".[213] So, although regular IPv4 allocations have come to an end, it is far from the end of the IPv4 era, either for APNIC as a registry or it members as network operators.

Technical leadership

The nature of APNIC's role naturally extends beyond registry services, to working closely with others in promoting technical innovation and operational excellence. It necessarily finds itself as one of the collaboratively oriented focal points for some of the most talented Internet engineers in the region and is, in turn, responsible for knowledge sharing at the global level. Moreover, as a neutral and authoritative organization, it is uniquely able to coordinate important technical projects for the good of the Internet.

A prime example of this, is the role APNIC has played in helping to improve DNS infrastructure.

In late 2002, APNIC announced a new trial project, working with the Internet Software Consortium (ISC), to deploy new instances of the F-Root server across the Asia Pacific region. Under the arrangement, APNIC would fund the sites, which ISC would operate using BGP anycasting techniques.[214] Although technical limitations restrict the number of DNS root servers to 13, there is no such limit on the instances of those servers that can be deployed via anycasting. More instances of the root servers means better DNS performance in the region and greater resilience in the system.

In 2003, APNIC entered a similar agreement with Autonomica (now Netnod) to jointly deploy I-Root servers.[215] The following year, APNIC helped establish new root server instances in Brisbane, Jakarta, Kuala Lumpur, and Singapore, bringing the total of new instances in the region to 10. Expanding the project further, APNIC also agreed with RIPE NCC to start deployment of the K-Root in 2005.[216]

During the launch of three mirror sites in India 2005, Paul Wilson described the deployments as "a positive example of Internet community coordination," noting that they "involved the private sector, not-for-profit organisations, and government bodies working together to improve DNS stability and Internet response times for developing countries in South Asia".[217]

There are now 26 APNIC-supported root server instances in the Asia Pacific region.[218] The need for large scale deployments has now been met. However since 2002, APNIC has been developing a small scale root server deployment package that requires only one router and one server. The first trial of this project, in Dhaka, was successful, pointing the way for smaller, cheaper sites to be deployed in low traffic areas, such as "small island and developing economies".[219]

A growing legacy of technical development

APNIC has always supported Internet technical development in practical, hands-on ways. For example, it has always supported staff involvement in standards development in the IETF processes, and knowledge exchange in operator groups, and other technical forums.

But as it has matured as an organization, APNIC has also been able to drive and participate in many important strategic technical developments. APNIC started work on a digital certificate authority in 1999, first to secure member interactions in general, then to support the MyAPNIC service. But in 2005, it began applying that technology to certifying Internet number resources, following the model provided by RFC 3779. With the end of IPv4 addressing beginning to appear on the horizon, and the possibility of address trading emerging as a common practice, APNIC considered resource certification as an important way to protect the stability of Internet address registration models.[220]

A considerable amount of trust is involved in the Internet routing system. Along with other developments, such as DNSSEC, resource certification can help replace trust with certainty and strong security. In pursuit of this goal, APNIC started working with the other RIRs (through the NRO), the IETF, and security experts, to conduct a resource certification trial. Also of note, the IETF's Secure Inter-Domain Routing Working Group (SIDR), which was chartered to develop standards relating to securing inter-domain routing protocols, was co-chaired by APNIC's Geoff Huston.[221]

The first phase of the APNIC Certification project went public in 2008, when the MyAPNIC website was upgraded to include GUI-based access to resource certification.[222] The next major milestone came in 2010, when all RIRs became able to produce Route Origin Authorization documents, linking address holdings with routing authorization.[223]

In the brave new world of IPv4 address trading, the need for address resource security will be more acute than ever before. In this context, APNIC's resource certification initiatives could make a major contribution to the ongoing security and stability of Internet addressing.

Some other examples of APNIC's technical leadership include the following:

- Since 2006, APNIC has worked actively with the community and other RIRs to take administrative actions aimed at improving the routability of newly allocated address space (primarily, by identifying and communicating filtering problems) and cleaning up poor nameserver configurations.[224] In 2010, this work was formalized as the Resource Quality Assurance project, to "minimize routability issues through a combined program of communication, training, and testing".[225]

- APNIC's George Michaelson served as co-chair of the Cross Registry Information Service Protocol (CRISP) working group within the IETF.[226]

- APNIC contributed to the IETF's Registration Data Access Protocol (RDAP) working group, and now runs an RDAP service to help address some of the shortcomings of Whois.[227]

- Geoff Huston, APNIC's Internet Research Scientist, has been one of the world's leading authorities on the depletion of IPv4 addresses. Likewise, he modelled the depletion of 2-byte AS numbers and championed the transition to 4-byte numbers.[228]

- All APNIC's online services were available via native IPv6 by 2009.[229]

- With a growing focus on security, APNIC started a phased project in 2009 to implement DNSSEC "to establish authenticity and integrity of the domain system data" (in-addr.arpa and ip6.arpa"). By 2011, DNSSEC implementation was complete, meaning APNIC members can now "digitally sign their DNS records".[230]

- Starting in 2008, APNIC extended the the RIPE NCC test Traffic Measurement (TTM) project by helping to establish and operate 12 servers around the AP region. This work is essential for network diagnostics, troubleshooting, and planning.[231]

The Member and Stakeholder survey of 2009 revealed the five highest priorities for APNIC investment. Topping the list was "research and monitoring activities".[232] As a response, in 2011, APNIC's research and development team launched "APNIC Labs", directed by Chief Scientist, Geoff Huston, initially focussing on global measurements of BGP, IPv4 exhaustion, and long-term IPv6 trends.[233]

The quality of APNIC's research has been widely recognized and its measurements are considered to be authoritative. The data that APNIC Labs gathers and analyses is important for long-term strategic planning and address management, and it is regularly presented to major international forums such as the OECD, APECTEL, and national and regional IPv6 summits.[234]

A commitment to development

As important as the root server deployments have been, the real key to the development of the Internet in the Asia Pacific has been the cooperation and openness of the various operators groups across the region. As discussed above, APNIC helped establish and continues to coordinate with APRICOT, the main forum for operational knowledge sharing across the region. But at a national and sub-regional level, many Network Operator Groups (NOGs) drive the work of network building. Over the years, APNIC has built strong cooperative relationships, with the following organizations:

- Asia Pacific Networking Group (APNG)
- The Asia Pacific Operators Forum (APOPS)

- Australian Network Operators Group (AusNOG)
- Japan Network Operators Group (JANOG)
- New Zealand Network Operators Group (NZNOG)
- The Pacific Network Operators Group (PACNOG)
- South Asian Network Operators Group (SANOG)[235]

Many other organizations with a networking or development focus also benefit from APNIC's support. The benefits often flow both ways, with many organizations hosting APNIC training or outreach events. A common approach that APNIC pursues to cement these relationships is to negotiate a Memorandum of Understanding (MoU) with the other party.

By way of example, until the early 2000s, although there was significant Internet activity in South Asia, APNIC did not enjoy the same level of engagement in that part of the region that it had long benefited from in Oceania and the other parts of Asia. This changed, thanks to a strategic focus on building relationships in South Asia. In 2004, APNIC signed MoUs with the ISP associations of India, Pakistan, Bangladesh, and Nepal, leading to increased training, meeting, and knowledge sharing events in that part of the region.[236] The higher levels of APNIC engagement in South Asia no doubt contributed to the eventual formation of the Indian Registry for Internet Names and Numbers (IRINN) in 2012.

APNIC is not only concerned with the obvious areas of Internet operations, but is also committed to supporting applications of Internet and ICT innovations that can improve life in the less developed areas of the region. This commitment was supported by the views of the membership, as revealed in the Member and Stakeholder surveys.[237] In May 2002, APNIC collaborated with the International Research Development Centre (IDRC) and the United Nations Development Programme's Asia Pacific Development Information Programme (UNDP-APDIP), to establish a new research and development grant fund. The PAN Asia ICT R&D Grants Programme supported small research and development projects related to Internet development in the Asia Pacific region. It was designed to fund practical, innovative solutions to social, economic, and environmental problems in the developing world. From 2002-2006, PAN Asia grants supported "a diverse range of projects, including health initiatives, alternative networking techniques, crop monitoring projects, disaster avoidance systems, and a variety of open source software developments."[238]

In 2006, the PAN Asia ICT R&D Grants programme was paused for a thorough evaluation. Ultimately, it was not renewed. However, in its place, in 2008, the IDRC, APNIC, and the Internet Society – with additional support from dotAsia – launched the Information Society Innovation Fund (ISIF) to provide small grants and awards to "help advance local and regional projects aimed at introducing, improving, and applying Internet technology for the benefit of Asia-Pacific users and communities".[239]

The first round of ISIF grant funding took place in late 2008, funding 10 projects up to US$30,000 each for work commencing in 2009. In 2011, ISIF introduced a programme of awards "to acknowledge the important contributions ICT innovators have made with creative solutions to the social and economic development of the Asia Pacific region".[240] The ISIF website features descriptions of all the grant and award recipients.

A major expansion of the ISIF programme took place in 2012, when ISIF joined with AfriNIC's FIRE programme and LACNIC's FRIDA programme to form the Seed Alliance to "promote innovation and support Internet Development on a wider scale". The Seed Alliance was launched on 31 March 2012, with AU$1.3 million in funding from the IDRC. Later that year, the Swedish International Development Cooperation Agency (Sida) also contributed AU$1.5 million in funding over the following three years.[241]

Coordination and governance in the Internet ecosystem

The functions of "Internet governance" have existed far longer than the term itself. Address registries – along with standards development forums – are foundational components of the Internet ecosystem. All of APNIC's activities, including the events surrounding APNIC's formation, fit within the broader classification of Internet governance.[242] Today, the term is more often applied to activities at the interface of governmental interest and technological administration; however, even within that restricted definition, APNIC's involvement can be traced back to its early period.

In the mid-1990s, the Clinton administration began work to divest its formal authority over the domain name, root server, and Internet numbering systems. This process, coordinated by Clinton adviser Ira Magaziner, involved proposals and lengthy consultations with various stakeholders. APNIC was originally represented in this process by Laina Raveendran Greene, who travelled to Washington to meet with Magaziner and discuss views and concerns within the Asia Pacific region.[243] Raveendran Greene also invited Magaziner to attend the third APRICOT meeting, where he took part in an open meeting with the APIA Board and members. Many prominent members of the APNIC community were part of this discussion, including Jin Ho Hur, Pindar Wong, Toru Takahashi, Tommi Chen, Barry Greene, Li Xing, Bill Manning, Izumi Aizu, and David Conrad.[244]

In June 1998, the US government issued a white paper, seeking public comments on a proposal to replace the exiting IANA structures with a new body. The boards of APNIC, ARIN, and RIPE NCC jointly responded to the US government's discussion papers on forming a new IANA, proposing that the RIRs establish an "Address Council" to define addressing policies and advise the new IANA on addressing-related issues.[245] RIR staff and board members were involved in the subsequent consultations. The new IANA was created as function of the Internet Corporation for Assigned Names and Numbers (ICANN), which was formally established in September 1998[246], and soon after that the RIRs signed a memorandum of understanding to form the Address Supporting Organisation (ASO) to provide address policy advice to ICANN.[247] APNIC performed the secretariat function for the ASO in its first year of operation – a role that subsequently rotated through the various RIRs.[248]

Beyond the political realm, coordination of technical administration has always been an active issue for the RIRs. Many address resources had already been distributed around the world before the RIRs formed. When ARIN started operation in 1997, it inherited the InterNIC database of so-called legacy addresses, regardless of the region in which the addresses were deployed. To provide more uniformity and reduce administrative confusion, in 2000 the RIRs started a major project to redistribute the legacy address space records along regional lines.[249] This became known as the "Early Registration (ERX)" project. APNIC was already building experience of such work, through the smaller transfer of address records formerly held by the Australian Network Information Centre (AUNIC)[250] and this proved useful in conducting the ERX project, which ran until 2005.

Legacy transfers such as these were a symptom of a system that was still in the early phases of its evolution and expansion. RFC 2050 – the primary guiding document for RIR operations – envisioned RIRs operation in "large geopolitical regions, such as continents... Service areas will be of continental dimensions".[251] Under that definition, three RIRs were insufficient, but work was already underway to mobilize the African and the Latin American and Caribbean communities, and the existing RIRs were deeply involved in supporting that work. In 2001, APNIC and the other RIRs, through the ASO, developed the "Criteria for establishment of new Regional Internet Registries", which was accepted by the ICANN Board as a "statement of essential requirements for

the recognition of new Regional Internet Registries (RIRs)". In accordance with those criteria, ICANN formally recognized the Latin America and Caribbean Network Information Centre (LACNIC) as the fourth RIR during the ICANN meeting in Shanghai in 2002.[252]

More work remained to established a registry for Africa, but it came to fruition in 2005 with the full emergence of the African Network Information Centre (AfriNIC). APNIC joined with the other existing RIRs to contribute $US100,000 to help kick-start AfriNIC's operations and also provided in-house operational training to AfriNIC's senior engineer.[253]

The RIR system is designed to accommodate differing regional needs, while retaining a generally consistent global approach to address resource management. While it is perfectly acceptable for the specific details of policies to vary at the regional level, the RIRs are collectively responsible for providing an overview of address policy. To this end, in 2001 APNIC, ARIN, and the RIPE NCC developed a comparative policy overview to catalogue the commonalities and regional variations in policy.[254] Originally, this concerned primarily IPv4 and ASN policies, but they had also started to coordinate development of new IPv6 policies.[255]

The IPv6 work culminated in a new globally common IPv6 address policy in 2002, intended to simplify access to IPv6 address space and stimulate deployment. The policy also increased the minimum allocation size to /32 and recommended fixed assignment sizes to provide for more efficient routing and network design. APNIC's 2002 annual report calls out the efforts of two members of the APNIC community – Takashi Arano and Kosuke Ito – who travelled extensively to RIR meetings "to present status updates and were instrumental in coordinating the global discussions."

By 2003, the term "Internet governance" was becoming common, and governance issues were increasingly common drivers of APNIC activities. As part of the ICANN Evolution and Reform process that began in early 2002, the RIRs developed a set of "general principles they regarded as important to managing the Internet numbering system". While they supported ICANN and its open framework for coordinating critical functions, the RIRs acknowledged that ICANN's existence could not be guaranteed. Therefore, the RIRs proposed "a new coordinating body, the Number Resource Organization (NRO), which would serve as a unified point of contact for joint RIR communication and ensure ongoing stability of number resources".[256]

The NRO came into existence in October 2003, as the four existing RIRs (APNIC, ARIN, LACNIC, and RIPE NCC) signed a memorandum of understanding (NRO MoU) setting out the NRO's role, namely:

> Serving as the coordinating mechanism of the RIRs to act collectively on matters relating to the interests of the RIRs, as delegated to the NRO by the unanimous written agreement of the RIRs.
>
> Undertaking any joint operational or external activities delegated to the NRO by the RIRs.
>
> Entering into appropriate cooperative agreements with representative Internet coordination or administrative bodies (including any national, international or public sector entity), on such terms as the NRO Executive Council deems appropriate, in order to coordinate the activities of the NRO with the activities of those of those bodies.[257]

Under the terms of the NRO MoU, the NRO would be the body through which the RIRs negotiated with ICANN. It would be a "lightweight body" with no staff, and Secretariat functions rotated through the RIRs. Each RIR CEO would sit on the NRO Executive Council, and the NRO would fulfil the role of the ASO in the ICANN structure. Paul Wilson served as NRO Chair for its first year.[258]

The NRO formed in response to the creation of ICANN. However, the other looming feature on the Internet governance landscape was the emergence of the World Summit on the Information Society (WSIS), which held its first meeting in Geneva, Switzerland, in December 2003. As the APNIC 2003 annual report notes, "While the Internet itself was not initially a specific focus of the meeting, issues of Internet coordination (or "governance") gained increasing importance during the conference process".[259] These issues would continue to grow in prominence over the coming years and remain a dominant activity for APNIC.

APNIC and the other RIRs kept a close watch on WSIS throughout 2004, as it moved towards its second phase, planned to be held in Tunis in 2005. The Working Group for Internet Governance (WGIG) was formed, on which the RIR community was represented by LACNIC Executive Director Raúl Echeberría.[260] Furthermore, the NRO provided inputs to the WSIS process, to "promote a better understanding of the current addressing system and how it serves the technical needs of the Internet and provides opportunity for all interested parties to participate".[261] However, the full significance of the WSIS process, and the impact it would have on the Internet community, was still a year away from crystalizing.

Meanwhile, in the International Telecommunications Union (ITU), Internet governance discussions were gaining more traction. Unlike Internet development organizations, the ITU is not an open forum. However, APNIC was by then an ITU-T sector member, allowing Paul Wilson to attend a workshop in February 2004 and "explain issues of IP addressing, address management, policy development, and the role and responsibilities of APNIC".[262]

By now, while the definition of Internet governance remained elusive, discussions about the concept were firmly on the RIRs' radar. APNIC began investing more time and resources on Internet governance issues, including providing in-kind support to UNDP-APDIP's major project on Internet governance, called the Open Regional Dialogue on Internet Governance (ORDIG).[263] In the preface to APNIC's 2005 Annual Report, Paul Wilson wrote:

> Talk of Internet governance seemed to be everywhere [in 2005]. The first World Summit on the Information Society (WSIS I) in 2003 may have escaped the attention of many people, but by the start of 2005, the momentum was gathering for WSIS II to become a major activity of the year.
>
> As WSIS came to end, with the announcement of the Tunis Agenda, APNIC and the other RIRs, through the NRO, were pleased to see our roles recognised and our processes commended. Yet many other questions about Internet governance remain to be answered.[264]

The same 2005 Annual Report also expressed the view that "2005 will be remembered by many as the year that Internet governance discussions took centre stage". For many within the technical community, the build-up to the WSIS II meeting in Tunisia in November 2005 was intense. Through the NRO, APNIC worked with the Internet Society, ICANN, the IETF, and several other organizations to prepare the "Internet Pavilion" at the Summit's ICT4All exhibition as a way of increasing knowledge of the Internet model of development.[265]

The outcome of WSIS II was a document known as the "Tunis Agenda", which adopted the WGIG's definition of Internet governance as "the development and application by governments, the private sector, and civil society, in their respective roles of shared principles, norms, rules, decision-making procedures, and programmes that shape the evolution and use of the Internet". The Tunis Agenda also noted that the "existing arrangements for Internet governance have worked effectively to make the Internet the highly robust, dynamic and geographically diverse medium that it is today". However, the document left many open questions about the future of Internet governance and called for "an enhanced cooperation model" and "the reinforcement of specialised

regional Internet resource management institutions to guarantee the national interest and rights of countries ... to manage their own Internet resources, while maintaining global coordination in this area".[266]

In a statement on behalf of the NRO, Axel Pawlik (NRO Chair and Managing Director of RIPE NCC) remarked:

> The outcome of the Tunis Phase of the WSIS is very significant and quite remarkable.... We are very pleased that the policy development processes of the Regional Internet Registries (RIR) have been recognised and reinforced by the Tunis Agenda. Over the coming months and beyond, we will continue our ongoing efforts to reach out to governments, as well as to other stakeholders, in order to exchange views on the Tunis outcomes and to develop priorities for the future....
>
> We have been pleased with the opportunity over the past several years to participate in the WSIS, and are looking forward to participation as a full partner in future dialogues.[267]

However, the ability of the RIRs to fully participate in intergovernmental processes is not always assured, especially in forums with no tradition of multistakeholder involvement. Fortunately, APNIC's ability to participate in high level international discussions was enhanced in February 2005 when the United Nations Economic and Social Council (ECOSOC) approved APNIC's application for "special consultative status", making APNIC an official, UN-recognized non-government organization. As Paul Wilson explained at the time:

> With the WSIS, the United Nations has become a central forum for discussions on Internet governance, and this role is likely to continue. Our status as an accredited NGO shows that APNIC's contribution has been recognised, and will help to ensure that the views of APNIC's members and stakeholders are heard.[268]

By far the most significant outcome of the Tunis Agenda was its call for the Internet Governance Forum (IGF) to continue the work of WSIS and host global discussions of public policy issues related to Internet governance. Furthermore, the Agenda specified that the IGF should be "multilateral, multi-stakeholder, democratic and transparent".[269] The IGF's original mandate was for five years, but this has since been extended, making the IGF one of the major ongoing events in APNIC's annual planning cycle. Although the IGF has no decision-making powers, APNIC and the other RIRs remain vigilant of the need to ensure that the technical community's structures, processes, and institutions are properly represented in IGF discussions. As such, their presence at all IGFs is a given.

Many other major Internet governance events have taken place since then. Some of the more notable examples include:

- In late 2006, the NRO, ICANN, and ISOC jointly hosted a new Internet Pavilion, this time at the ITU Telecom World event in Hong Kong. The pavilion featured "multimedia presentations on RIR history, the NRO, and IP addressing and routing, as well as printed materials on technical and RIR-specific issues".[270]

- In 2008, Geoff Huston spoke at the OECD Ministerial Meeting on the Future of the Internet Economy, in Seoul. APNIC has since collaborated on the Internet Technical Advisory Committee, which was officially recognized by the OECD in 2009 and continues to work on issues of Internet economy.[271]

- At APNIC 25, in Taipei in 2008, APNIC hosted its inaugural Internet governance meeting, "Partnership toward IGF in Asia".[272]

- In 2009, APNIC took part in the ITU World Technology Policy Forum, as an ITU-D sector member. At that forum APNIC responded (on behalf of all RIRs) to the Telecommunication Standardization Bureau questionnaire on IPv6 address allocation.[273]

- Also in 2009, APNIC worked with ICANN, ISOC, and other Members of the NRO at the ITU Telecom World in Geneva to reach out to a wider set of stakeholders.[274]

- APNIC co-organized an IPv6 session at the APECTEL 40 meeting in Cancun, Mexico, 2009 and has worked with APECTEL on other events since then.[275]

- In 2010, APNIC was co-organizer of the Asia Pacific regional IGF (APrIGF) in Hong Kong.[276]

- Through the NRO, APNIC participated in three ITU Internet-related processes in 2010, discussing matters including IP addressing and cybersecurity. These were the IPv6 Group, the World Telecommunication Development Conference (WTDC), and the ITU Plenipotentiary (PP-10). Additionally, APNIC encouraged multi-stakeholder input into ITU IPv6 discussions by holding a community consultation at APNIC 29, in which the ITU participated.[277]

Many in the Internet technical community see the ITU as a potential threat to the established, open Internet model of development. However, APNIC has, over the years, sought open engagement as a path to mutual understanding. It was one of the first Internet organizations to become an ITU Sector member (in 2003) and has kept open channels for dialogue, especially about Internet governance and IPv6. APNIC's 2011 Annual Report notes that "APNIC is optimistic about the increased collaboration between the ITU and the global Internet community, particularly following the ITU Plenipotentiary Conference in late 2010. This interaction opened a clear path for the ITU to collaborate with the global Internet community".[278]

APNIC's engagement in ITU processes was further on display in 2012, in the build-up to the ITU's World Conference on International Telecommunications (WCIT-12). APNIC used the opportunity of the WCIT to engage and strengthen relationships with Asia Pacific governments and help them "support the multi-stakeholder Internet governance model". Throughout this process, APNIC contributed a series of articles distinguishing the Internet and telephony models, helping to better inform discussions about updates to the International Telecommunications Regulations (ITRs).

However, not all members of the community have been optimistic about the willingness of the ITU to embrace the Internet community's view. And in the end, the WCIT ended in controversy and confusion, prompting the following blunt statement from the NRO:

> The Number Resource Organization, representing the world's five Regional Internet address Registries, issues the following statement from Dubai, the site of the recent World Conference on International Telecommunications. The conference has clearly not met expectations of many ITU Member States, and with this unfortunate outcome now clear, we feel compelled to put the following observations on record.
>
> The Number Resource Organization is concerned about aspects of the WCIT-12 meetings, which have just ended in Dubai, particularly with events in the last days of the conference. Neither the content of this conference, nor its conduct during this critical final period, have met community expectations or satisfied public assurances given prior to the event.
>
> Internet stakeholders around the world watched the WCIT preparations closely, and were hopeful, throughout those processes, of two things: that WCIT would have no bearing on the Internet, its governance or its content; and that the event would allow all voices to be heard. The ITU Secretary

> General himself made these assurances on multiple occasions, and reiterated them in his opening remarks to the conference.
>
> Regrettably, expected WCIT discussions on traditional telecommunication issues were eclipsed by debates about Internet-related issues. The intensity and length of these debates revealed clearly the depth of genuine concern about the proposals, and also the determination of those who brought them to the meeting.
>
> Perhaps more importantly, an open multi-stakeholder conduct of the WCIT conference did not eventuate. Plenary sessions of the conference were webcast, but contributions were allowed only from official Government delegates and ITU officials, relegating all other stakeholders to an observer role.
>
> Furthermore, an important number of critical negotiations occurred in small groups accessible only to Member States; and key experts and other stakeholders were unable even to observe them.
>
> The NRO strongly supports the principles established in 2005 by the World Summit on the Information Society, which call for Internet Governance to be carried out in a multi-stakeholder manner, and we note that these represent the view of the global community as expressed through the UN system itself.
>
> The NRO has also participated in many ITU conferences and study groups over the years, at very substantial cost, in genuine efforts to build relationships between our communities and to demonstrate the value of multi-stakeholder cooperation and collaboration. The NRO will continue to participate in the ITU, itself a member of the UN system, in expectation that its processes can evolve visibly, and much more rapidly, towards these accepted principles.[279]

In the 2012 Annual Report, Executive Council Chair, Maemura Akinori, while praising the work of APNIC to support participation at the meeting warned that the "result of the recent WCIT seems to represent that the essence of the evolved Internet is still very difficult for various people to understand".[280]

APNIC today – ready to address new challenges

From its humble beginnings, first as an informally funded skeleton staff using borrowed equipment and offices in Tokyo, to a fresh start and almost entirely fresh staff in Brisbane, APNIC has steadily grown into a mature, well-established, highly professional service organization. APNIC has generally enjoyed high staff retention rates; nevertheless, of the original Brisbane staff, only two – Paul Wilson and Connie Chan – remain. Around them has grown a diverse and dynamic organization with more than 60 staff.[281]

Looking back over the first decade of this century, Maemura Akinori (Chair, and one of the longest serving members, of the Executive Council) wrote:

> In 2000, the number of global Internet users was 400 million. In 2010, this number had grown by five times to 2 billion. In this decade, this growth in the user base has seen the Internet penetrate into the very fabric of society, and people have come to rely on it much more than ever. For APNIC, it was also a decade of growth. Membership has grown by five times, and the budget, by ten times.[282]

For its first 13 years of operation, APNIC had operated with a relatively flat organizational structure. However, by the end of 2006, the Secretariat comprised almost 50 staff and was in need of more "effective delegation of decision making and clearer areas of responsibility". In response, Paul Wilson and Human Resources Manager Louise Tromp brought in a new staffing structure based on "areas" (providing direction and coordination), which are supported by functional "units"

(which execute and deliver projects and services).[283] While the number and composition of areas has changed since then, this remains the organizational model.

In 2013, the seven areas are Business, External Relations, Human Resources, Learning and Development, Public Affairs, Services, and Technical, reflecting APNIC's service focus and strategic orientation.[284]

Physically, APNIC is well equipped to address the challenges of the coming decade. After finally outgrowing its original Brisbane home, on 20 December 2010, APNIC relocated to a state-of-the-art new building, designed for the most sustainable possible operations[285]. The building is consistent with the principles of the "ecoAPNIC" project, which the Secretariat adopted in 2006 as a way to challenge standard business practices and reduce waste, costs, and APNIC's ecological footprint.[286]

The move was not only necessary, but as it turned out, fortuitous. Less than a month later, severe flooding struck Brisbane and caused major disruptions in many areas, including APNIC's former address. Fortunately, APNIC's new premises were unaffected by floodwaters, though staff were forced to work from home until the surrounding area was cleared.[287]

Maemura Akinori wrote later that he would remember 2011 for the many natural disasters that struck the Asia Pacific region – the Christchurch earthquake, the Touhuko earthquake and tsunami, and the floods in Bangkok, Myanmar, and Brisbane. Despite the tragedy of these events, he wrote that they brought to mind for him the "importance of information infrastructure" and that "APNIC's Business Continuity Plan worked beautifully without any major outage of services while the new office was closed".[288]

APNIC had long operated redundant services in co-location facilities, and has points of presence in other parts of the region, so its physical infrastructure was never threatened, but the intensive business continuity planning process which took place in 2008 and 2009[289] paid dividends by minimizing the disruption of a major local emergency.

As Paul Wilson observed in the preface to the 2012 Annual Report:

> Our first decade was spent establishing a set of reliable services for the region, in distributing Internet number resources, and in training and education about our core activities and responsibilities. Those services continue, and remain at the core of APNIC activities.
>
> Our second decade was spent in enhancing and extending those services, on technically strengthening and "hardening" all aspects of our infrastructure, and extending education and outreach into new areas, most notably to Governments.[290]

So what will APNIC's third decade hold? Much remains to be seen. Many technical and administrative challenges remain, the successful deployment of IPv6 and the smooth management of a new IPv4 paradigm are chief among them. Meanwhile, unpredictable forces and powerful interests surround Internet government issues.

But APNIC as an organization has never been more professional, nor more resilient. As a community, it has never been stronger. As one of the oldest and most established Internet organizations in the world, APNIC appears ready to continue addressing the challenges that lie ahead.

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As an aside, RFC 1338 proposed solutions to only the first two of the three problems identified. The third problem, that of IPv4 exhaustion, was addressed much later with the specification of IPv6.

[6] The argument could well be made that many of the Internet's most serious problems are symptoms of its unprecedented popularity and success.

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Note, this article – written by various RIR staff members – contains a more detailed overview of the RIR system in general; the establishment of APNIC, ARIN, and the RIPE NCC; and the emergence of AfriNIC and LACNIC.

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