

The Domain Name System: Engineering vs Economics

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Abstract

Over the last few years much attention has focused on the Domain Name System, as its functionality, so essential to Internet integrity, seems to have shifted from engineering utility to controversial cash cow. The Internet evolved as a self-governing community: its transition to a self-regulatory industry in Australia will depend upon whether “industry” means restricted to supply-side interests only, or whether it can evolve to mean something as inclusive and diverse as the community itself. This paper traces some of the turbulent history of Internet governance in Australia.

1. An Engineering Problem

Computers, routers and other Internet devices have names for human convenience but they pass traffic between each other using numerical addresses. In the late 60’s, 70’s and early 80’s, when the Internet was basically the collaborative US government and research network ARPANET, the mapping of names to addresses was via a file, HOSTS.TXT, updated by email and collected using FTP every few days. As the networks began to grow, this method caused name duplicates, inconsistencies, load and timeouts on the master machines and was clearly not scaleable.

To help resolve these difficulties Paul Mockapetris wrote RFCs 882 and 883 (Nov 1983) and RFCs 1034 and 1035 (Nov 1987) describing a new Domain Name System to automatically map between machine names and numbers.

Machine names are hierarchical, e.g. **yalumba.connect.com.au** has the levels:

yalumba	the local name
.connect	the company
.com	the commercial sector
.au	Australia, the “top-level” for this domain name

.au is our country-code (CC). There are two-letter abbreviations for all countries. Other top-level domains (TLDs) are not countries but functional or organisational categories: **.com**, **.edu**, **.gov**, **.mil**, **.net**, **.org** and **.int**. These names are fairly arbitrary—Australian sites do not necessarily have to use **.au** names and commercial sites do not necessarily need **.com** or **.com.au**.

2. A Hierarchy of Responsibility

DNS files on well-known computers define who is responsible for authoritative (correct, trustworthy) information for the level one step below. For instance, the primary source for **.au** describes the locations of authoritative information about

its second-level domains: **com.au**, **net.au**, **gov.au**, **edu.au**, **org.au**, **asn.au**, **csiro.au**, etc. The computers for (say) **org.au** define who is responsible for its third-level domains, such as **isoc-au.org.au**.

Responsibility for the running of a domain is “delegated” to each domain below it. Acceptance of that delegated responsibility is also acceptance of the obligation to maintain the policy and logical consistency of the domain. This involves a “duty of care” in two areas: rigorous, accurate, technical administration and thoughtful compliance with the intent of the domain functionality.

The top of the tree of responsibility is IANA, the Internet Assigned Numbers Authority, run by Jon Postel. He delegated country-code domains in the early days of the Internet to network-knowledgeable individuals, as trustees for their country domains. Such work was fairly tedious and routine, but it was essential that it be done, and done carefully, for the viability of the whole Internet. The country code **.au** was delegated in 1984 to network pioneer Robert Elz, from Melbourne University.

3. The First Links

In Australia the first general-use computer network was ACSnet, which used MHSnet software to pass email, ftp and Usenet News between Computer Science departments and research organisations like CSIRO.

In September 1988 a report for the Australian Vice-Chancellors Committee (AVCC) and other academic and research bodies recommended the establishment of a national network. In March 1989, Geoff Huston from ANU was appointed Technical Manager of the fledgling AARNet project.

The design was simple and radical: multiprotocol routers in state hubs connected by leased lines (initially 48kbps) to the national hub in Canberra, thence to the international link. Individual sites were responsible for the management of their own connections to the AARNet routers.

In a mere three weeks in May 1990, Huston and his deputy Peter Elford travelled all over Australia turning on the hubs while staff at the end-sites worked frantically to connect to the new network. AARNet went live. Huston became responsible for the second-level domains **edu.au** and **gov.au**. Elz continued to manage **.au**, **net.au**, **org.au** and the ACSNet domain, **oz.au**.

AARNet permitted access to the first commercial Australian Internet service provider in 1992. This was connect.com.au Pty. Ltd., started by network engineer Hugh Irvine with Joanne Davis and Ben Golding. The domain **net.au** was delegated to Irvine in 1994, and was administered free of charge by Connect for some years as a service to the Internet community.

In August 1995 Michael Malone, from the Perth ISP iiNet, was delegated responsibility for the new second-level domain **asn.au** for associations and non-profit groups, also administered free of charge.

4. The Other Address Hierarchy

Domain names map to IP addresses, but how are IP addresses managed? Until the early 90's the InterNIC (funded by US taxpayers) would allocate blocks of numerical addresses to be used to uniquely identify network hosts within a domain. In 1993 the

National Science Foundation sought to devolve this function to regional, self-funded IP address registries, operating in accordance with RFC 1466.

In September 1993 Geoff Huston applied to IANA for a large block of addresses “on behalf of the Australian network community”, with the ultimate goal of seeing a national IP address registry set up, both for regional autonomy and for efficiency (allocations from the US were taking weeks). It was to be “a totally independent entity, which operates within the broad structure of a not-for-profit service operation, and applies a single community policy in an open and fair manner”.

The address space, in older terminology, was equivalent to 64 Class-B blocks, over 4 million individual host addresses; an enormous amount at a time that large allocations were becoming increasingly rare due to the potential exhaustion of the IP address space.

By mid-1994 Huston, Hugh Irvine and AARNet engineer Andy Linton were considering how such a registry could be set up. They decided the fastest way would be to set up a shell company, then bring on additional directors from the Australian network community to design the structure, articles and administrative details in consultation with the community. It was hoped that this would keep the address block free of potential ownership by AARNet, the AVCC or any other body (Telstra had already been suggested as a future AARNet owner).

This was to be the Australian Internet Registry, AIR: initially for IP address administration but, if successful, a potential future home for Australian domain name administration. It was an engineering solution to what appeared to be an engineering problem.

5. AARNet Blues

1994 had been a year of turmoil in the self-awareness of the Australian Internet community. Keep in mind that the first widely-deployed Web browser, the elegant Mosaic, had appeared only in 1993 and was still relatively unknown at this stage—Web sites numbered only in the tens to hundreds, while Internet nodes, using text-based email, telnet, ftp and Usenet News, numbered in the millions.

But even text-based communication was growing exponentially and the pressure for network expansion was never-ending. The AVCC had previously refused to accept a corporatised business plan that could have subsidised AARNet expansion, so they had limited funding for AARNet and no strategy at all to deal with its popularity.

Late in 1993 substantial funds had been promised by the government to upgrade AARNet. Major forces such as Telecom (Telstra) and IBM submitted proposals that had only indirect association with AARNet but succeeded in diverting a large percentage of the funds to projects that appeared to be extensions of their own corporate research. The AVCC were outmanoeuvred and AARNet, under mounting pressure, was denied desperately-needed resources.

In 1994 AARNet access was opened up further to VARs (service providers) under a volume (per-MByte) charging scheme, and it was proposed that from 1995 full volume-charging for universities and research institutes would also begin. The prospect of volume-charging to recover costs was violently argued, especially in the newsgroup `aus.net.aarnet`, which had previously been a fairly civilised source of information exchange.

6. AIR Goes Up in Flames

It was in this edgy atmosphere in late September 1994 that a journalist, who had been passed highly misleading information about the AIR scheme, published a story that “control of Internet addressing and name allocation has been privatised, which means Australian Internet users may soon have to ‘lease’ their addresses for an annual fee. The Australian Internet Registry (AIR) has ‘assumed responsibility’ for all Internet protocol (IP) address and domain name allocation. . .”

It didn’t matter that domain names had nothing to do with AIR—speculation abounded that it would “sell domain names” and that in future names and addresses would be charged for, possibly at one dollar (!) each. The AIR directors released a press statement explaining the true situation, that the scheme was for public governance and that fees had not been proposed, but it was too late.

The newsgroup exploded with wild accusations and vicious personal attacks. The accuracy of the report was not questioned. The AIR directors were on holiday or did not read News, so were unaware of the turmoil until some days after it began.

Robert Elz wrote a stinging rebuke to the madness, and the newsgroup settled down. . . but the damage was done. The community had shown that the ideals of trust and cooperation, so essential to the engineering that powered the Internet, had collapsed before the social phenomena of rampant self-interest, paranoia and pack hysteria.

7. The Lost Opportunity

Under extreme pressure from the AVCC the directors withdrew their proposal. The AIR experiment ended and an extraordinary opportunity was lost for self-governance. Personal relationships were fractured and the Australian Internet community had inflicted a terrible injury on itself, one that has taken years to even begin to heal.

AARNet was an embarrassment to the AVCC. They had neither the funds, the imagination nor the will to run the Australian backbone. Talks escalated with Telstra in late 1994. The prospect of AARNet going to the despised telco generated another eruption of furious argument on the lists and newsgroups—some AARNet staff left at the time, in part because of this issue—but in May 1995, AARNet management was transferred to Telstra. It was the end of an incredible era for Australia that had begun almost exactly five years before.

The address block issued by the InterNIC on behalf of the Australian network community was claimed by the AVCC and passed on to Telstra. Because no independent registry existed, no sensible or transparent allocation policy for provider blocks was defined. As a result, owners of addresses from this block who are not Telstra customers (other than a few large ISPs) may encounter future problems with address portability and global routability. Telstra allocated to itself around one quarter of the address block and the non-Telstra portion was exhausted by February 1997.

APNIC (the Asia-Pacific Network Information Centre) started as a pilot project in late 1993 based on volunteer labour and donated facilities from a number of countries. It evolved into the independent IP address registry so desperately needed by the Asia-Pacific region. APNIC has recently moved its headquarters to Australia but retains a strong regional focus.

8. Governance Goes Commercial

From 1983 the National Science Foundation, NSF, had the responsibility of managing the non-military part of the Internet infrastructure in the US. In 1985 NSF and its contractors began the development of a backbone called NSFNET, while ARPANET was gradually phased out. NSF set up an agreement with Network Solutions Inc (NSI) from January 1993 which permitted it to perform registration services on behalf of NSF.

From October 1995 NSI charged for domain name registration, US\$100 (plus \$50 per year ongoing) of which 30% was reserved for an as-yet unallocated “Intellectual Infrastructure Fund” (in early 1998 this had to be retrospectively legalised because it was equivalent to imposition of a tax). All over the world lists and newsgroups went ballistic but, as the company introduced better administrative practices after a very bumpy start, the outrage died down and people started to accept that name and address governance of the Internet had gone commercial.

In fact, people started to notice that not only had it gone commercial but also that, for NSI at least, it had become a substantial source of income. What had been a cooperative engineering facility became in many peoples’ eyes a new cash cow: and what was worse, they weren’t getting their share!

9. Meanwhile Back at the Ranch

By late 1995 the administration of **com.au** domain names was under enormous pressure as business finally woke up to the potential of the Internet. Robert Elz was still personally handling it and the backload and delays were increasing. He also took a holiday at this time and the temporary replacement permitted many domain-names through that should have been rejected under the policy rules.

This resulted in an inconsistency that has led to serious disagreements since then, as it naturally seems unfair to later applicants whose similarly variant names are rejected. This was a fundamental lesson in the importance of consistency, the dangers of badly thought-out policy variations and their often horribly long-term consequences.

Three years ago, at the AUUG’95 conference, a small group of people decided to start a mailing-list dedicated to discussion of Australian Internet matters, especially name and address governance and the setting up of an Australian version of ISOC, the Internet Society. The list was called inet-issues and, though it is almost defunct today, it had an interesting minor role in restarting public communication on these problems which, due to the traumas of the previous 12 months, had essentially ceased.

Slowly, painfully, some public discussion on the issues restarted. Most contributors were now strongly aware of the dark side of mailing-list communication. It is one of the most successful and inclusive forms of public discussion yet devised, but it is also vulnerable to serious abuse by people who choose not to follow the rules of sane social discourse.

In June 1996 Hugh Irvine sent a “Call for Formation” to the inet-issues mailing-list, stating that, in response to the widely-expressed need for an Australian Internet organisation, he’d commenced legal formalities to set up an Internet Society of Australia as a company limited by guarantee and operating as a not for profit organisation. The directors, objects, scope and format of the society were matters for the Australian Internet community to establish.

Much debate occurred over the next five or six months, culminating in an Inaugural General Meeting on 27th November 1996. The Society had around 350 founding members and enormous support from the Australian Internet community overall. Its Objects clearly positioned it as an organisation dedicated to the end-users of the networks and the public-good obligations of Internet governance bodies.

Around the same time, as a response to the enormous workload of **com.au** administration, Robert Elz gave a non-exclusive 5-year licence to Melbourne-IT, a commercial offshoot of Melbourne University (which had freely subsidised the cost of Elz's labours on behalf of the Internet community for many years) to do the actual administration of **com.au**. Melbourne-IT started charging for domain name registrations in November 1996, at \$125-\$150 a year.

At Connect, demand for **net.au** names exploded as they were seen as free alternatives to **com.au** names. After **net.au** administration almost collapsed under the demand, Connect brought in charging at the same level as Melbourne-IT to prevent the land-grab on **net.au** names.

10. Enter ADNA

Melbourne-IT had initially planned to remove the registration of pre-existing **com.au** names whose owners had not paid them fees by mid-March 1997. A class action was brought by ISP iiNet on behalf of **com.au** owners to prevent this. ISOC-AU suggested changes to the timetable which assisted in the resolution of the case, and the period of grace for existing owners was extended until November 1997.

Around the same time, moves to establish a domain name administration body had begun, driven by the Internet Industry Association of Australia (then called INTIAA, now part of IIA). Because of the court case the delegates for most domains were unable to be involved. Despite concern expressed by individuals, ISOC-AU, the AVCC and CSIRO about the haste of formation, lack of consultation and shortcomings of the Articles, the company ADNA (Australian Domain Name Administration) was incorporated in May 1997.

ADNA's view was that the scope of its governance included **.au** and all of the SLDs, but a widely-expressed reservation was that neither **.au** nor the smaller SLDs were the problem: in most eyes other than ADNA's the main problem was that **com.au** was not open to competition.

The AVCC and CSIRO refused to recognise any authority of the new body over the domains they used and the delegates for **net.au** (Irvine) and for **edu.au** and **gov.au** (Huston) also refused to be involved. The delegate for **org.au** and **.au** itself (Elz) remained outside of the discussion. Only **asn.au** (Malone) and **com.au** (Melbourne-IT) joined the organisation, as registrars. ADNA had only eight members—six industry associations and two registrars. (One association has now resigned.)

ISOC-AU also did not join, but directors attended Board meetings as observers and volunteered to help amend the organisation's Articles to address community concerns. Changes were proposed to make a public-benefit role explicit, to clearly separate policy from operations, and to include all of the current delegates on the board to try to ensure a smooth transition to a new scheme of governance.

Over this time disagreements arose between the ADNA directors themselves regarding details of the minutes; legal action between directors was threatened and

some of the directors either resigned or simply stopped attending meetings.

By early 1998 ADNA was no closer to gaining the support of the Internet community than when it had begun. It had withdrawn from discussion with ISOC-AU. It had passed several highly controversial motions at meetings with only a few directors in attendance, but had no authority to put them into action anyway.

The only positive was that Malone had released a first version of shared registry software, a technical necessity for multiple DNS administration. But the opening up of the lucrative **com.au** domain to competition, which had been confidently expected to happen by November 1997, was still only a remote possibility (and has not occurred by September 1998).

11. The Memorandum of Understanding

The agreement between NSF and NSI concludes officially at the end of September 1998. Planning for what will come next has consumed the efforts of many of the most productive and far-sighted people in the world-wide Internet community over the last few years.

In May 1996 Jon Postel opened discussion on the possibility of new multiple top-level domain name registries (those that deal with generic domains like **.com**, not the country-code ones). After much discussion, the International Ad Hoc Committee was set up in September 1996 to organise public input into a report to suggest new procedures for international DNS management.

On February 28 1997 the IAHC released the gTLD-MoU, the generic Top Level Domain Memorandum of Understanding, which requested public support for a set of proposed international DNS bodies: a Policy Oversight Committee (POC), a Policy Advisory Body (PAB) and a Council of Registrars (CORE). Over 220 international organisations to date have signed their agreement to the gTLD-MoU, including ISOC-AU and five other Australian Internet organisations.

The gTLD-MoU proposed seven new gTLDs and a not-for-profit, public-good top-level registry working in association with an openly competitive system of registrars (CORE members) rather than the anti-competitive combination of the two functions, as at NSI.

The CORE members started building a centralised shared registry software system. Most invested reasonably large sums of money setting up businesses to handle registry traffic when the system was due to start operations in March 1998.

At this stage NSI's income from DNS was around four million US dollars per month. The company began a campaign of high-level lobbying of US legislators in late 1997—most of whom had never heard of the DNS—with the startling suggestion that the IAHC was a Swiss conspiracy to take over the Internet, and that Jon Postel was “double-dealing” the US government.

12. Green Paper, White Paper...

The US government responded. It appointed Ira Magaziner to produce a draft Green Paper called “A Proposal to Improve Technical Management of Names and Addresses” which appeared on January 30 1998. The cooperative gTLD-MoU effort ground to a halt.

The Green Paper borrowed a number of ideas, without attribution, from the gTLD-MoU, but a major area of disagreement was the proposal that the top-level registries be open to competition, which basically indicated a lack of understanding of their function or of their vulnerability to abuse. International discussion was invited, and it certainly took place. Comments flooded in from individuals, small businesses, international Internet groups, legal organisations, telecommunications bodies and sovereign governments.

The flaws in the Green Paper were fairly obvious to most of the Internet community. In Australia, even the quarreling factions around ADNA were able to get together in March 1998 and, under the auspices of NOIE (the National Office for the Information Economy, charged with providing policy advice on IT to the government), were able to agree on a common set of criticisms of the plan, which appeared in the Australian government's official response to the US government.

On June 5 1998 the US government replied with the White Paper "Management of Internet Names and Addresses". This appeared to take into account many of the concerns of the international community. Further meetings for consultation, called the "International Forum on the White Paper", have been held in the US in early July, Europe (Geneva) in late July, and the Asia-Pacific region (Singapore) in mid-August.

The consensus seems to be that a new IANA should be set up as a "not-for-profit, cost-recovery, nonpartisan corporation for charitable and public purposes, dedicated to preserving the operational stability of the central coordinating functions of the global Internet for the public good". It would coordinate assignment of Internet technical parameters, manage the coordination of Internet address space, manage the coordination of the Internet domain name system and oversee operation of the authoritative Internet root server system.

Discussion to bring about broad-based support on the structure, international representation and responsibilities of the new organisation is currently active. The hope is to have something ready to take on the function of NSI by the end of September 1998.

13. What a Long, Strange Trip it's Been

...from cooperative engineering utility to the frenzied focus of world-wide governments; from boring administrivia to commercial power-grab.

In Australia we still don't have a functional organisation to handle our **.au** top-level domain and its hierarchy. The system holds together because of the inherent engineering strengths of the DNS and because of the trustees, the delegates who have put in years of effort maintaining one of the essential elements of Australian Internet connectivity.

We have seen that several times in the brief history of the Internet in Australia efforts to set up organisations for Internet governance have failed, usually because of various combinations of fear, self-interest, ignorance, mistrust and inertia.

We have one last chance to bring it about. Meetings and discussions are continuing, some with the guidance of NOIE as a source of expertise on industry self-regulation. We must achieve consensus on:

- a broad-based definition of stakeholders

- clearly-defined objectives and principles
- inclusive, transparent and accountable processes
- dispute resolution procedures
- compliance mechanisms
- funding and resources
- a possible legislative framework

As an emerging Internet community we have (often) worked well together under a regime of self-governance—rough consensus and working code. But now, as a new industry, we have to show we are mature enough to cooperatively bring about self-regulation in domain name governance. No-one else is going to do it for us.

How do we make the transition from a community to an industry? Industry so often means simply the supply-side of the transaction: the demand-side is assumed to be no more than a passive consumer. But the Internet shatters those assumptions: it grew out of the grass-roots cooperation of its users, and its functional infrastructure, such as the DNS, clearly reflects that heritage.

Supply and demand are not opposite sides of the fence on the Internet: service providers are also customers; users can provide content as compelling as that of any large business; independent volunteers write much of the code that makes it all work. The complex interdependencies of the world-wide mesh of networks means that no-one is the supplier, no-one is the consumer, no-one runs it and everyone runs it.

A few selfless volunteers helped keep it going because they appreciated its value—in the broadest possible sense—long before anyone else did. Now the world sees that value and is rushing to to turn it into cash. While the Internet is famously resilient to damage it still has fundamental vulnerabilities, such as its dependence on the integrity of the DNS at every level. Only time will tell if the precision engineering of Internet connectivity will survive the gold-rush.