STEWARDSHIP

AND THE MANAGEMENT OF
INTERNET PROTOCOL ADDRESSES

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WHAT IS STEWARDSHIP IN CYBERSPACE?

The concept of stewardship has a long history and an uncertain future when it comes to critical virtual resources such as IP addresses and domain names. The early Internet developers were fond of the notion of stewardship and its sister concept, trusteeship. Jon Postel frequently invoked both notions in his discussions of managing domain names.[1] To this day, the Internet Society gives an annual Postel service award to "commemorate [Postel's] extraordinary stewardship exercised over the course of a thirty year career in networking." All of the major Internet address registries (RIRs) explicitly characterize their management of the address space as "stewardship."

To those who have tracked the evolution of Internet governance — especially its migration from the relatively informal, technically oriented self-governance of computer scientists and engineers to the more legalistic, commercialized, and politicized forms it takes today — it is easy to see why the notion of stewardship is appealing. The steward is thought of as a responsible and wise leader who is entrusted with the care of a shared resource. It is a community-oriented concept that resonates with the tightly knit Internet engineers and technicians who founded the IETF, the Internet Society, and the regional address registries. Confronted with divergent paths and conflicting claims, the steward steers toward the common good and the long-range benefit.

But the concept is also noteworthy for what it avoids or leaves unsaid. The concept of stewardship has almost nothing to say, for example, about the political dimension of resource management. While it articulates a guiding ideal of responsibility, it does not tell us anything about the processes by which a steward should be selected, replaced, or held accountable. It avoids the messier issue of what happens if multiple individuals or a set of competing factions all contend for stewardship responsibilities. In some incarnations, stewards resemble paternalistic rulers or enlightened monarchs — which explains a great deal of the credibility the stewardship concept has in the Internet technical community. The appeals to stewardship by key Internet technical community leaders came at a time when the Internet's growth challenged the authority they had inherited from their role in building the Internet. We reached the point where it was not unreasonable to ask of Jon Postel: why are you in this powerful position, how did you get there, how do you set policies, and to whom are you accountable? Likewise, the US government and its defenders sometimes claim it is in a stewardship position with respect to supervision of the Internet or of ICANN.[2] But other governments and organizations sometimes ask, not unreasonably, *why are you in that position and what happens if you abuse that authority?*

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1   In RFC 1591 Postel describes the party to whom a country code top-level domain was delegated as "the trustee of the top-level domain for both the nation, in the case of a country code, and the global Internet community."

2   Robert Kahn, who along with Vinton Cerf is one of the original developers of the Internet protocol, said before a Congressional committee in 1998, "The Internet would not exist if it were not for the US Government. It helped to create the Internet, and has been an excellent steward for it since its creation over 25 years ago. It funded the necessary research, made sure the community had the responsibility for its operation, and insulated it to a very great extent from bureaucratic obstacles and commercial matters so that it could evolve dynamically." (Robert E. Kahn, President and CEO, Corporation for National Research Initiatives, Testimony before the Subcommittee on Basic Research of the Committee on Science on the subject of Internet Domain Names, March 31, 1998. http://www.cnri.reston.va.us/testimony.html)

The stewardship concept also elides contentious economic issues. For example, it leaves aside the issue of individual and corporate ownership rights. To claim to be a *steward* of Internet resources is much softer and more palatable than claiming to be the *owner* of them, but in practical terms the powers exercised by a steward and an owner are often indistinguishable. Although stewardship is supposed to be focused on maximizing collective benefits, by invoking it and related concepts of trusteeship and authority we can sometimes paper over issues about individual rights, obscure discussion of the way benefits are distributed among a population, or overlook cozy deals and self-dealing among the groups and individuals in control of resources.

Thus the notion of stewardship, by itself, does not resolve the institutional problems we face in Internet governance. At best, it describes a desirable end state: a person or entity that subordinates its own interest to service and succeeds in responsibly managing resources in a way that optimizes their value, while earning the trust and compliance of the community involved. But it leaves open the issue of how to get to that happy end state, or what institutional forms and processes are most likely to keep us there.

THE IP ADDRESS SPACE AND STEWARDSHIP

Questions of stewardship issues are now posed most saliently with respect to the IP address space. In economic terms, IP addresses, along with the routing tables that utilize address prefixes to enable the accurate movement of packets, can be described as a resource space. Fixed in supply by the technical standards defining the Internet protocol, IP addresses have economic value and need to be managed and conserved. Blocks of addresses can be traded in a market

and have been valued in the millions of dollars in bankruptcy proceedings. The way the address space is divided up among network operators also has important side effects on the efficiency of routing.

IP addressing is nominally a part of the ICANN regime, but most of the real governance of those resources was delegated to regional Internet address registries (RIRs). There are now five RIRs, one for North America (The American Registry for Internet Numbers or ARIN), one for Europe (RIPE-NCC), one for the Asia-Pacific region (Asia Pacific Network Information Center or APNIC), one for Latin America (LACNIC), and one for Africa (AfriNIC). All are private-sector nonprofits.

As I noted earlier, in materials describing their mission and function the RIRs describe themselves as stewards of the address space. Indeed, whether out of naïveté or arrogance, the RIRs claim that "each RIR consists of the Internet community in its region."[3] So while Louis XIV is only reputed to have claimed that *l'état c'est moi,* the RIRs have put their claim in black and white that *L'Internet community, c'est moi*. Nominally, the RIRs are part of the ICANN regime. They receive their initial delegation of large IP address blocks from the Internet Assigned Numbers Authority (IANA), which ICANN runs under the terms of a contract with the US Department of Commerce. But ICANN's relationship to the RIRs is remarkably loose, and sometimes even competitive.

In fact, IP addressing can be seen as unfinished business from the transformation of Internet governance that took place in 1997-98. The three major RIRs — the ones for Europe, Asia, and America — actually predate ICANN as an organization. Possession being nine-tenths of

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3   "About" page, Number Resource Organization, http://www.nro.net/about-the-nro.
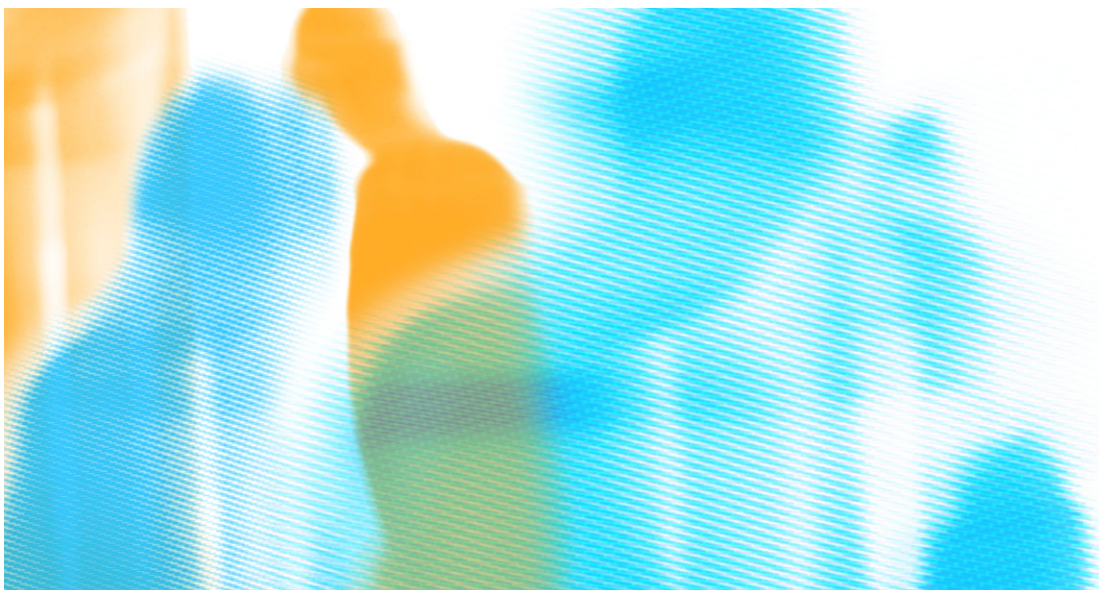
the law, the RIRs actually had ongoing control of address resources before ICANN existed, which meant that ICANN was not in a position to assert any hierarchical regulatory authority over them. The relationship between ICANN and the RIRs was a negotiated one, just as the relationship between ICANN and the country code top-level domain managers turned out to be. The IP address registries were also cautious about ICANN because it wasn't clear whether it was going to succeed or fail. As ICANN reached the nadir of its existence under former CEO Stuart Lynn in 2002, there seemed to be a real possibility that it would fail.

Thus the RIRs held the ICANN regime at arms' length. The address registries formed a separate organization, the Number Resource Organization (NRO) in 2003. They delivered an open letter to ICANN advising it of the NRO's formation and included a copy of a proposed memorandum of understanding between the NRO and ICANN. The MoU between the NRO and ICANN was signed and implemented in 2004. It made the NRO — an independent, unincorporated combination of the RIRs — into the basis of ICANN's Address Supporting Organization

(ASO).[4] One could call NRO/ASO the stewards of the IP address space, but one could just as reasonably call it the Organization of the Petroleum Exporting Countries (OPEC) of the IP address space: a group of private suppliers with exclusive control of an important resource. The NRO's status as the ASO in ICANN's corporate governance structure allows the RIRs' chief executives to appoint people directly to the ICANN board, and also allows it to place people on ICANN's nominating committee, which appoints people to both the board and to the governing councils of the domain name-related supporting organizations (the GNSO and ccNSO). But the nominating committee, uniquely among all the SOs, does not appoint anyone to the ASO Council.

This governance structure insulates IP address management from the globalized politics of ICANN. The ASO, unlike the domain name policy-making organs within ICANN, really does very little except ratify and report on any initiatives undertaken by the RIRs. In some respects

4   ICANN, "ICANN Address Supporting Organization (ASO) MoU", October 29 2004,
     http://www.icann.org/en/aso/aso-mou-29oct04.htm.

this structure is a good thing, given ICANN's accountability deficit and the need to avoid the kind of political disputes over centralized power that the domain name system attracts. But it also has some problems. Two challenges to the NRO/ASO/RIR regime may lead to fundamental changes in IP address resource stewardship in the future. They are: 1) IPv4 address scarcity and 2) the migration to a new Internet standard with a larger address space, IPv6.

CHALLENGE ONE: IPV4 ADDRESS SCARCITY

The free pool of IPv4 addresses held at the IANA is now depleted. While some of the RIRs still have some available supplies, a special, highly restrictive set of policies applies to the delegation of the remaining address blocks. The Asia-Pacific region seems to have run out most rapidly. Most people consider the ultimate solution to this problem to be the migration to a new Internet standard known as IPv6, which has a much larger address space. But that migration will take time, possibly a decade or so. Moreover, anyone who adopts IPv6 in the short term is required to run both IPv4 and IPv6 (known as the dual stack migration strategy). Thus, the demand for IPv4 addresses continues to expand even for companies and organizations that invest in the migration.

This demand has forced us to foster a trading market for the IPv4 address blocks. An address transfer market gives organizations holding unused or underutilized IPv4 addresses a stronger incentive to release those addresses. A market price system also provides an accurate reflection of the actual scarcity and exchange value of IP address blocks, encouraging conservation and better management. Over three dozen transactions in IP address blocks are

documented in the ARIN region.

From an institutional standpoint, market forces can be revolutionary in nature. Allow people to trade resources and all kinds of unexpected things start to happen, and this case is no exception. One issue with the emerging market for addresses is that while each RIR has its own distinctive transfer policy, many trades are bound to be inter-regional in nature. More specifically, we can expect North America, which got more than its share of address blocks in the early stages of Internet development, to be a net seller of IPv4 address space — and we can expect the Asia Pacific region, which is growing fastest and got less than its share early on, to be a net buyer. Yet the policies regarding needs assessment, transfer terms, and so on are different across regions. Even the IP address Whois databases of the two RIRs are not fully integrated. Why should this be the case? What purpose does it serve? Why shouldn't there be a globally integrated market for IP address blocks?

More fundamentally, the possibility of serving as brokers in this emerging market has attracted a new set of commercial actors into the address allocation space. These business actors think that many of the postallocation IP address-related services provided by the RIRs could actually form the basis of a commercial service. They would like to compete with the RIRs in the provision of these services. They see no reason why the RIRs' exclusive control of IP address allocation should also give them exclusive control of ancillary services such as address transfer brokerage, reverse delegation, and Whois-related services. They are proposing a major structural reform of the IP addressing system's governance, namely a structural separation between address registries (the RIRs) and address registrars (the postallocation services). This would be similar to the separation ICANN created

between domain name registries and registrars, which paved the way for robust competition in retail domain name services.

Whether these proposed reforms are meritorious or not is outside the scope of this paper. The point is that the RIR/NRO regime is structurally incapable of making them. The entities in charge of the current regime of address governance — the RIRs themselves — have no interest in undermining their authority, revenues, and status by implementing such reforms. It would be exactly like asking the old AT&T regime to be in charge of introducing competition into telecommunications. And in resisting such reforms, they invariably wrap themselves in the mantle of stewardship, just as AT&T did when its monopoly over telecommunications was challenged in the 1970s.

CHALLENGE TWO: IPV6 AND THE OBSOLESCENCE OF REGIONAL ADDRESS ALLOCATION

Let us assume for a moment that we succeed in making the transition to IPv6. That creates another challenge to address stewardship. The new, vastly expanded address space creates allocation conditions that undermine the whole rationale for the regionalized address registry system.

To understand why this is true, one must first ask why RIRs became regionalized in the first place. There were two reasons: one political, the other economic. This situation is clear from the very first standards document proposing regionalization of address allocation. In RFC 1174 (August 1990) Vint Cerf argued that "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… will become an increasingly scarce commodity whose allocation must be handled with thoughtful care." To elaborate on the political dimension, in these early days of the Internet protocol's dissemination some Europeans resisted adopting TCP/IP because it was made in America and many government policy-makers there were still hoping for the emergence of a European data communications standard that could challenge the pre-eminence of IBM. Moreover, the domain name and IP address resources of the newly emerging Internet were tied to the US. The creation of a European address registry in 1991 overcame both objections by putting computer networkers in that part of the world in direct control of the addressing resources they needed to expand.

But the economic scarcity factor was even more important. In the early 1990s, Internet growth was *already* creating technical scalability problems. Address blocks had been handed out too liberally in the early days, increasing pressures for conservation. And as the number of networks grew, the size of the Internet's routing tables also threatened to grow at a pace that outstripped the information-processing capabilities of routers. These two related types of scarcity meant that every organization's application for address blocks had to be carefully scrutinized and justified on a "needs" basis, and that the dissemination of address blocks had to be governed by policies that encouraged Internet operators to aggregate their route announcements. Most of the policy-making that the RIRs do is actually caused by these two types of scarcity: address conservation and route table size conservation. If one is carefully examining each individual application among thousands for address blocks and carefully formulating policies

regarding efficient route aggregation, regional allocation authorities make sense.

Fast forward to a world in which IPv6 has succeeded. With the Internet well established as the dominant data communications protocol and a globalized institutional framework in place (ICANN) there is no longer any political reason to delegate address allocation to regions. Insofar as address allocation is linked to politics, it comes from demands to delegate address registries to *nation-states*, not to RIRs! As for economic scarcity, the supply of addresses is largely overcome by the huge address space of the new v6 technical standard. The factors that qualify a network for an IPv6 address block are relatively simple to define and administer. The IETF has defined a global standard for initial allocations based on how many organizational units an entity has, and there are also global standards that determine how much of that initial allocation an organization must use before applying for any new blocks.

The IPv6 address blocks are so much larger than their IPv4 equivalents that the need for carefully crafted local policies to mitigate route disaggregation is also diminished. Only a few routes for each network should need to be announced. While there still may be a need for some kinds of route aggregation policies, it is difficult to understand why they should differ from region to region. Policies that support or encourage basic levels of route aggregation in the Americas would also encourage it in China, India, or Brazil. Consequently, in an IPv6 world the need for localized and highly specific policies regarding address allocation is mitigated, if not eliminated.

But here we face the exact same problem as before: all reforms in IP address governance structure must come from the RIRs themselves. The ASO of ICANN is nothing more than the

NRO, and the NRO is nothing more than a combination of the staff and CEOs of the RIRs. And why would the RIRs initiate or institute reforms that would put themselves out of business? The RIRs have many merits as organizations, but they are also quite entrenched, with tens of millions of dollars in annual revenues, a growing number of jobs, and an important place for their managers in the overall Internet governance regime. If this structure is to be dramatically changed, the impetus will not and cannot come from the RIRs themselves.

CONCLUSION

So we see the possibility of, and maybe even the need for, sweeping reforms in the governance of IP address resources. At the same time as IPv4 depletes, a globalized market emerges, policies regarding address block transfers need to be harmonized, and address Whois data needs to become integrated. We can also see that if the gigantic IPv6 address space gains traction there is no longer any rationale for regional policy-making regarding addresses. But our capacity to enact reforms adapting to the new situation is paralyzed by the pre-existing situation, which puts all authority in the hands of regional registries with a vested interest in maintaining the current structure.

One danger is that the existing regime's inability to make needed reforms will create pressure on the US government to intervene. Through its control of the IANA contract, the US could try to dictate globally applicable changes in the nature of the address regime. At best, an intelligent redesign of the ICANN/IANA regime could pave the way for a stable, well-ordered market for addresses and postallocation services; the co-existence of accountable, bottom-up governance with competitive market forces would

protect the public interest and individual rights. But reliance on US hegemony to push through the needed changes has its dangers as well. By integrating IP address governance more firmly into the ICANN/IANA regime, we are making it extremely centralized, creating a potential single point of control, and hence a political magnet and single point of institutional failure. The US Congress and Commerce Department tends to be more swayed by special-interest lobbying in Washington and by its national interest than by stewardship and the public interest as SOPA/PIPA illustrated. Such a centralized point of governance could become a target for powers seeking to exert more control and regulation of the Internet communications, especially once it embraces both domain names and IP addressing in the same contractual regime. Attempts by ICANN's governmental advisory committee

to intervene in and manipulate ICANN's new top-level domain program offer a taste of what could be in store. Moreover, rising, counter-hegemonic states such as the BRICS or IBSA could use such a reform as yet another opportunity to challenge US preeminence and try to pull Internet governance into the intergovernmental system. In negotiating these problems, we will need more than vague, pleasant-sounding concepts like stewardship. We will need innovative concepts of institutional design and people with courage and a long-range political vision.

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