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Internationalization of the Internet by design: The first decade

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Abstract
The successes and failures of Internet Internationalization reveal struggles between two systems: the network political (oriented around the machinic) and the geopolitical (oriented around the social). The frames through which this conflict are understood, and the technical decisions that enacted such frames, were put in place during the first decade of the network design process, 1969–79. Analysis of the technical document series that records the history of that process provides evidence of internationalization processes that include extension of the network outside of the United States, international participation in the design conversation, the influence of international organizations and associations, support for internationalization in the design criteria that serve as policy principles, and attention to issues raised by internationalization within the course of technical decision-making.

Keywords
architecture, ARPANet, globalization, governance, international communication, Internet, network, protocols, socio-technical infrastructure, standard-setting, technology design

> Network topology is a complicated political and economic question with obvious technical overtones. (Alex McKenzie, RFC 613: 1 [1974])

At the close of 2009, there were almost 2 billion Internet users in the world, with tens, often hundreds, of millions from every region of the world (Internet World Stats, 2010). A ‘fast track’ approval process supports internationalized domain names that use local language characters, including those with non-Latin characters such as those found in Arabic, Chinese, Tamil and Thai. There are more distinct country codes in the Internet

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domain name addressing system (256) than there are member states of the United Nations (192) or are recognized by the United States (194).

The extent to which the Internet is genuinely international, however, remains a matter of deep concern. Asymmetries in perceived responsiveness to user needs as they vary across cultures, technical and legal conditions, and political contexts are significant enough that they fuel ongoing conflict on Internet governance issues. These are severe enough that the degree of internationalization has been proposed as a criterion to be included in a policy impact assessment tool for evaluating the public interest in Internet standards (Morris and Davidson, 2003). The issue is a focal point for debate by those who argue that non-US needs, preferences and perspectives have not been adequately taken into account. These have been apparent since at least 1990, when those outside of the US made clear their resentment of the fact that the great preponderance of Internet addresses was owned by US-based entities (Denardis, 2009). Other contested Internet governance matters involving internationalization include accountability (Koppell, 2005), representation in decision-making (Crawford, 2004), Internet governance challenges to national sovereignty (Roman, 2007), and corporate dominance of governance discussions (McLaughlin and Pickard, 2005).

The research reported on here provides a foundation for understanding how such issues developed in a path-dependent way out of the framing (Braman, 2011b) that took place during the earliest years of Internet design. The successes and failures of internationalization took shape during the first decade of the design process, 1969–79. This article investigates internationalization during that decade through analysis of the technical document series that records the decision-making through which network protocols – technical standards – were developed, the Internet Requests for Comments (RFCs).[1] The RFCs, which are freely available online at *www.ietf.org,* began as a very informal conversation among graduate students a few months after the issuance of the first ARPA contract to network computers, but became more formal over time and were the medium through which ICANN and other very formal Internet governance institutions and processes developed. They are a particularly useful source of evidence for understanding internationalization of the Internet, since the RFCs meet the Habermasian criteria for an international discourse that can provide institutional legitimacy (Froomkin, 2003) and provide a history of the means by which informal ad hoc decision-making became formal international contract-based governance (Froomkin, 2000; Yu, 2004).

The research reported upon here is drawn from the larger project of a comprehensive inductive analysis of the legal and policy discussions embedded in the first 40 years of the RFCs.[2] The article begins by providing a brief introduction to the historical context of Internet internationalization, goes on to look at the means by which internationalization of the Internet occurred via the design process during its first decade, and concludes by thinking through the tension the Internet design process has generated between the network political (the politics of the machinic environment) and the geopolitical (the politics of the social environment).

Jurisdictional problems that underlie any attempt to apply national law to uses of the Internet were of course apparent with earlier networks and were very much the subject of discussion by the 1970s. Internet designers joined this conversation when, for example, they recommended both that there should be no more technical restrictions on transborder email (e.g. through encryption) than are placed on physical mail, and that national governments should simply change their laws so that they are all the same ('legal harmonization') in order to facilitate transborder data flow (RFC 828). By the close of the 1980s, there were RFCs referencing comparative computer law articles in law reviews (RFC 1135). Jurisdictional problems receiving technical attention by Internet designers included those affecting identity certification procedures (e.g. RFC 1114), addressing (e.g. RFC 1218), and network security (e.g. RFC 1244).

The context

The RFCs began to record decision-making for what we now refer to as the Internet shortly after the US government's Advanced Research Projects Agency (ARPA) issued the first contract to build a communications network to link together separate computers, a network initially known as ARPANet, in 1969. ARPANet was, however, only one among the 'network of networks' (RFC 1122) that soon became known as the Internet. There were many other efforts working towards networking computers around the world. The French CYCLADES network was of particular importance for Internet design (Hafner and Lyon, 1996), a dependence explicitly acknowledged in discussions such as RFC 635's treatment of flow control mechanisms. (There were times when other national networking efforts undercut the internationalization of the Internet. There were individuals in Australia who occasionally connected with ARPANet during the 1970s, for example, but interest was low because other approaches to networked computing were already providing such good service to Australian researchers that the inability to use the telnet protocol was not experienced as significant [Clarke, 2004].)

A number of technical innovations that are fundamentally important to the Internet came out of network development efforts other than those of the United States. The packet switching concept itself, so critical to Internet protocols, was developed in the United Kingdom in the early 1960s (Abbate, 1999). The commercial packet switching standard was developed in the mid-1970s by data networking groups in Canada, USA, the UK, and France (Cerf, 2004). The first Internet search engine, Archie, was developed at McGill University in Montreal in 1990. Famously, the concept of the World Wide Web was developed by Tim Berners-Lee at the European Organization for Nuclear Research (CERN) in Switzerland.

It was ARPANet protocols, however, that ultimately defined the Internet, and so study of its design process is of particular value. Thus, while there are many historical events that could arguably be treated as the 'starting point' of the Internet, beginning with the invention of the telegraph in the 1830s, it is not inappropriate to treat the funding of ARPANet as the launch point for technical decision-making specific to the Internet stage of the history of telecommunications, and the RFC document series, then, as a record of that history.

The goal of internationalizing the network created technical problems. The need for global synchronicity required the incorporation of a reliable clock into the network (e.g. RFC 675). A mix of technologies, including satellites and packet radio networks along with landlines, were used (RFC 694). The Internet Message Protocol (RFC 753) specification had to include identifying the country of origin of a message.

Not everyone involved in developing the network shared the government position on political matters, even though funding for the project was significantly motivated by the Cold War. There is no need to revisit here Turner's (2006) history of the political counterculture within which many early Internet designers lived, but it is worth noting that there is evidence of differences of opinion on political matters within the RFC document series. In a discussion of specifications of default sockets for specific activities, for example, Brian Harvey commented:

> This is a security issue, of course, and I'm afraid that I can't work up much excitement about helping the CIA keep track of what anti-war demonstrations I attended in 1968 and which Vietnamese hamlets to bomb for the greatest strategic effect even if they do pay my salary indirectly. (RFC 686: 1–2)

Even where ARPANet did successfully connect internationally during the 1970s, there were some difficulties that derived from the institutional structures within which network developers were working. Hauben (2004) reports that at least one British researcher was ordered not to work on anything that involved networking beyond Europe. In many countries, there were difficulties getting enough financial support to take advantage of a network link without the level of buy-in by government that had occurred in the United States. The need to bring the diverse corporate and technological cultures of landline, earth station and satellite providers into convergence in order to enable networked computing was also more difficult where there was no clear governmental mandate.

Methodological issues

In recent years, Internet internationalization has stimulated methodological innovations such as engaging in vertical as well as horizontal comparative work on factors influencing Internet penetration (Verhulst and Price, 2008). For research on the early years, though, the obscurity and lack of documentation presents methodological challenges. The mistaken belief that the Internet derived solely from ARPANet, and was developed only by the US government (see e.g. Flanagin *et al.,* 2000), however, may partially explain the relative paucity of research on involvement in Internet design by those outside of the US. Hauben (2004) describes such activities during the early years as 'hidden histories'; for her historical research on internationalization, Hauben relied largely on interviews with participants and documentary records such as meeting minutes of international associations like the International Federation of Information Processing Societies (IFIPS), which included input from Hungarians, Russians, and individuals from the German Democratic Republic.

The internationalization processes

The documentary record makes clear that the network concept was international from the moment of inception. Several processes interacted to make that concept a reality. These included international participation in the design conversation, contributions to the design process by international organizations and associations, discussion of international issues such as design problems, affordances for internationalization embedded in design criteria, and, of course, the actual extension of the network itself to countries other than the United States.

Participation in the design conversation

The RFCs provide evidence of three types of participation in the Internet design conversation. In addition to authorship, the documents include input into design conversations that took place in other venues. Conferences played a particularly important role in internationalization, particularly during the early years.

Authorship. By the close of 2009, authors associated with organizations headquartered in 44 countries had contributed to the Internet RFCs. Many more – 187 countries – had been mentioned in the document series. Although 82 of those appeared only in two documents, one listing telex codes and the other the first publication of 'Hobbes' Internet Timeline', which provided the years during which each country linked to the Internet, 105 countries were mentioned in additional documents referencing concerns to be addressed and describing input into the design process. During the 1969–79 period, however, only 5 documents out of the over 700 published[3] were authored by individuals associated with non-US institutions.

Non-authorship participation. There were, of course, many other conversations involving contributors to the Internet design process from around the world during this period, some oral only and some documented in various ways. (Indeed, there are items in the RFC series that were simultaneously published within other document series, such as the internal series of the consulting firm, Bolt, Baranek, and Newman [BBN], which held the initial ARPANet networking contract.) The inclusion of non-US host sites on RFC document distribution lists provides some evidence of international involvement in these additional conversations. Within a few years of the launch of the design process, the Network Information Center (NIC) had put in place an online document distribution system and the number of those receiving and reading documents had grown to the point that it was no longer cost-effective or particularly useful to keep a running list of those involved. For the first few years, though, many documents in the RFCs included lists of those to whom documents were being sent, at the time usually in hard copy and delivered through the postal service. The earliest distribution lists included names only from the United States, but, in May 1971, individuals from Canada and the Netherlands showed up (RFC 168). By January of 1972, the United Kingdom also appeared on these lists (RFC 300). Soon after, the UK, Canada and France were also included on lists of network servers (e.g. RFC 669) and in catalogs of numbers assigned to hosts (e.g. RFC 739).

Meeting minutes included within the RFC series also provide details on international participation in design conversations. At a May 1971 meeting, for example (RFC 101), a representative of the Canadian government announced that country's goal of what telecommunications policy analysts would refer to as universal access, and simultaneously identified the access problems raised by sparsely populated and geographically large rural areas. At another meeting in the same month, the British government reported that it had three 'main' machines, three terminals and post office plans for a digital network in the 'distant future'. University faculty from both the UK and Canada took part in that meeting, and plans to link ARPANet to Mexico, France, Israel, Australia, Japan, England and Canada – all hopefully in 1972 – were discussed (RFC 164). It may only be coincidental, for seesaw swings between trying to expand the number of people involved in the design process and efforts to restrict that group were endemic during the first decade (Braman, 2011b), but the May 1971 meetings also saw expressions of concern over the size of the group that led to an examination of working group functions and suggestions that a reorganization might be needed.

Conferences. Conferences were an important vector of Internet internationalization during the early years. There had been regular presentations of proposed, experimental or restricted use network protocols at international conferences at least since 1963 (RFC 243). In 1972, ARPANet was introduced to the public, including the target audience of those in library and information science, at the First International Conference on Computers and Communication. Attendees came from France, Italy, Sweden and the UK, as well as the US (Cerf, 2003), and papers were presented in French as well as in English (RFC 631). British researcher Donald Davies, a key figure in the history of packet switching and the person who coined the term, 'packet', described this event as 'quite the most important and influential conference I have ever attended … ' (quoted in Hauben, 2004: n.p.). The network was demonstrated at the conference by linking together computers in 40 different locations. One consequence of the event was the formation of the International Working Group, which formalized the participation of individuals from many countries in the RFC process.

Conferences promoted 'Internetworking' to possible users in the UK and provided a venue for demonstrating additional links, such as that between Canada and France during a 1976 event. RFC 712 was actually a preprint of a paper prepared for submission to the International Conference on Computer Communication, the ICCC-76 of 1976, held in Toronto.

International organizations and associations. In subsequent decades, authors from various international organizations contributed documents to the RFC series. During the first decade, such authorship was not evident, but RFCs repeatedly refer to the influence of technical standard specifications for networks such as ARPANet produced by an international association of professionals working in the areas of data processing and networking and by two international organizations comprised of representatives of geopolitically recognized governments. Both the association and the international organizations were genuinely international in nature, but actual participation in their decision-making was inevitably skewed in favor of representatives from those countries with sufficient resources to support ongoing representation not only during meetings, but also in the surrounding extended discussions that took place in relatively expensive European cities (Dutton *et al.,* 2007).

The International Federation for Information Processing. The International Federation for Information Processing (IFIP), originally the International Federation for Information

Processing Societies (IFIPS), is a non-governmental and non-profit umbrella organization for national societies of information processing professionals initially organized – as was the International Association for Media and Communication Research (IAMCR), in which many 21st-century communication scholars participate – under the auspices of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). IFIP's Working Group 6.1, a subset of a group with the mandate to develop communication systems standards, played a central role in establishing the packet switching that characterizes the Internet.[4] International agreements achieved within the IFIP and mentioned within several Internet RFCs include the preference for a form of TCP with a simple header (144 bits instead of 256 bits), the goal that the maximum packet delay through all concatenated networks should not exceed 30 seconds, and the expectation that message elements need not arrive at their destination in a preordained order before being recompiled to constitute meaning accessible to humans (e.g. RFC 675; RFC 714). These standards, in turn, were reactions to experience with the French, British and US networks in play during the 1970s.

Input from IFIP helped Internet designers think through techniques for incorporating internationalization into networking technologies, software and practices. It was the IFIP that wanted to keep some bits in packet headers specifically for the support of international services through the provision of information about the routing, accounting and class of service that would be needed at gateways between national networks. The IFIP was also sensitive to the importance of leaving choices about some header bits for discretionary uses by those involved in local networks around the world, whether message senders or receivers (RFC 696).

The International Consultative Committee on Telephony and Telegraphy. The IFIP pushed its ideas forward not only through its influence on the professionals involved in designing and building networks, but also through the submission of recommendations to the International Consultative Committee on Telephony and Telegraphy (CCITT), a standard-setting group operating under the auspices of the International Telecommunications Union (ITU).[5] The CCITT was working on the problem of trying to build an international consensus around a set of technical standards for a digital network that would transmit any kind of information (voice, data, images, etc.) anywhere in the world using a standard interface; for the user, the concept was modeled on electricity, with the ability to plug into the network from anywhere using a simple, common and inexpensive plug to tap into the information flow. For the CCITT, the center of interest during the 1970s was not ARPANet, but the Integrated Services Digital Network (ISDN) (Cerni, 1982). In 1980, a consensus upon a set of standards for the ISDN was achieved, vendors began to provide technologies that met those standards, and the first ISDN networks were being built in places with either a strong government commitment (notably South Korea) or in particularly dense areas of telecommunications activity, such as, in the US, Wall Street and within clusters of state capital buildings.

Rutkowski (1983) usefully described the ISDN as a concept that simultaneously provided a design goal, a set of technical standards and an operational system. This trifold conceptualization continues to be useful to understand Internet history as well as contemporary efforts to go beyond the Internet with developments such as a computational grid that would provide scientists with a utility offering access to shared computing power, data and instruments from anywhere in the world without concern about the underlying architecture or the weaknesses of the contemporary Internet (uneven and often inadequate bandwidth, failures of service, and vulnerability to intrusion and malware) (David, 2004). In the 21st century, ISDN networks themselves have become merged into the Internet, remaining particularly important in developing societies where they provide access at 64 and 128 Kbps (Abdullah, 2005).

The International Standards Organization. When the CCITT was challenged by the transition to digital networks (Cowhey, 1990), it turned to another international organization, the International Standards Organization (ISO), for assistance in the development of Internet-related protocols. The ISO was also the source of recommendations taken up by Internet designers for embedding date and time into the network (RFC 753). By the mid-1990s, the ISO and CCITT were working directly with the Internet design community to try to improve the coordination between the two standard-setting processes (Chang, 1994).

Issues raised by the internationalization of the network

The military and research ambitions of those who decided to fund the building of the Internet and were involved in its development both drove towards internationalization. In addition, however, there was very real sensitivity to ways in which access to the network was pertinent to its social implications (RFC 371) and political valence (RFC 613). At least some designers believed that involvement in the worldwide packet-switching community (RFC 704) and cooperation with others building national computer networks around the world (RFC 635) were required if there was to be a genuinely international network.

In two areas, discussion in the Internet RFCs during the first decade of the design process explicitly dealt with the international dimensions of the social policy issues raised in the course of technical problem solving – cross-cultural differences and the language problem. However, it also became clear during that period that collaborations on building the network could run afoul of international treaties and agreements.

Cross-cultural differences. Cross-cultural differences entered the Internet design conversation in a variety of ways. The importance of national identity for addressing choices within what became the international domain name system (see e.g. Schlesinger, 2004; Yu, 2004) were evident in the selection of names for addressing purposes as early as 1971 (RFC 273). International differences in the treatment of dates led designers to choose the string-day rather than slash-day format for dating messages, and time zones were indicated using the Greenwich, UK, system (RFC 724; RFC 738). Because it was understood that users from around the world were likely to ask different types of questions from shared databases – demonstrated in the 1970s through uses of the weather database – this highlighted the need to design networked databases in such a way that they could be used interactively to achieve different views on the data (RFC 610).

Language. The single international topic that received the most attention in Internet RFCs during the first decade of the design process was language differences. The variety of character sets used by different languages was a focal issue for the computer scientists and electrical engineers who dominated the RFC discourse during this period as they made their initial decisions regarding using ASCII as a standard (e.g. RFC 139; RFC 338), though some complained that leaders in network development ignored early warnings about the difficulties this issue would raise (RFC 647). There was explicit attention to the need to reach cross-cultural agreement on how particular characters would be used (RFC 20). Limits to natural language searching in an environment in which users will have many different native and preferred languages were recognized (RFC 164; RFC 553). Options such as allowing the registration of additional characters (even Chinese ideograms) (RFC 373), escaping to other character sets (RFC 328), using ASCII to create graphic images to communicate in alternative ways (RFC 338), and requiring receiving hosts to let senders know which representation types would be accepted (RFC 354) were explored as means of addressing these language problems.

The real-world impact of the need to begin networked computing with a standardized character set based on that which dominated science and technology research internationally played out as predicted. Abdullah (2005) reports on language as a barrier to take-up of the Internet in Egypt, and the same story is found around the world. It is also the case that not all Internet designers believed that the language limit was inevitable but temporary; the highly influential Vint Cerf (2004) argued that the use of non-Latin character sets would localize rather than internationalize the network because people who accessed only materials using such character sets would get exposed to a narrower range of information. Still, the treatment of the social policy issue of language by Internet designers is an example of an issue in which critics in the social sciences are insufficiently appreciative of the pragmatic problems involved. As happened with graphics, the need was recognized from the start, but many technical problems had to be resolved before the policy goal could be achieved.

Conflicts with international treaties. Two additional social policy problems were encountered during the network internationalization processes of the 1970s, though they are not explicitly discussed within the RFC document series – those raised by dual use technologies, and by tariffs. Dual use technologies are those that can be used either for purposes of war or for purposes of peace; the most commonly used of these are computer chips themselves (OTA, 1988). Following World War II, most North Atlantic Treaty Organization (NATO) countries and Japan entered into an international treaty that created the Coordinating Committee on Export Controls (COCOM), regulating and restricting exports of items that could be used for purposes of war, including those that were dual use (Hunt, 1982; Yasuhara, 1991). (Decisions about just what qualified as dual use technologies were revisited from time to time, but for much of the period during which COCOM was a significant factor in international relations, dual use 'technologies' also included information and ideas [Cheh, 1982].) As is the case with all international treaties, each country involved then had to pass domestic legislation putting the treaty into force; in the United States, this was covered by the Export Arms Regulation Act (EAR) and the International Trade in Arms Regulations (ITAR), legislation that turned out to create difficulties for networking (Mills, 2003). Dual use issues arose with the very first network connection outside of the US, for the Norwegian facility with which that connection was made was civilian. Similarly, the first international connections introduced network designers to tariff issues raised by international information flows[6] that they had not taken into account (Hauben, 2004).

Design criteria/policy principles. Basic ideas about the nature of the network and the goals for which it was being built provide frames for how those involved in Internet design thought and think about policy issues. The goals of expanding access to research results (RFC 316), to computer-based instruction systems (RFC 313), and to education in computer science (RFC 369), for example, all had international implications that were ultimately acted upon.

Several of the criteria used to guide design of the Internet were also implicitly of importance from the perspective of support for internationalization. For the policy analyst, these design criteria can be considered policy principles underlying the Internet design process. Those design criteria-cum-policy principles particularly pertinent to internationalization include a form of technological democracy, what we can now describe as telepresent distant and distributed computing, access and redundancy.

Technological democracy. Although those involved in designing the Internet were working on the technological horizon, pushing computer networking limits, the needs of those with much less sophisticated technologies were also consistently taken into account. The goal was to design protocols that could be implemented on the least powerful hosts (computers) (RFC 292). As a policy principle, this design criterion can be described as a democracy of technologies, meaning the creation of a network that can used by those with any type of equipment, from the most humble and limited to the most sophisticated and capacity-rich. Many intervening variables influence the differential rate of network diffusion from country to country, but it is operationalization of the principle of technological democracy at the level of design that has made it possible for the Internet to internationalize to the extent that it has.

This principle grew out of early assumptions that the number of computers on the network would continuously expand, and that users would continue to vary in the level of sophistication of their equipment and computing capacity. It was thus believed necessary to design for a highly heterogeneous hardware (e.g. RFC 55), software (e.g. RFC 80) and content (e.g. RFC 82) environment. Designers were encouraged to think both in terms of situations more complex and more general than those raising the problems with which they were immediately involved (RFC 94) and to design for worst case scenarios (RFC 60). The best way of doing so, it was suggested, was to 'stay aloof from the eccentricities of present day machine organization' (RFC 150: 2) while simultaneously creating protocols that could be easily implemented under the size and complexity restrictions then in place for the smallest of the hosts involved in the network (RFC 167). One manifestation of this approach in practice was the computer industry design philosophy of beginning with the most primitive elements of a program and then building ever-more powerful tools upon that base (RFC 192).

Achieving the goal of technological democracy was made difficult by the heterogeneity of the elements of the network themselves (RFC 285), the fact that not every node was on the network at all times during the early years (RFC 54), and differences between physical and logical structures (e.g. RFC 58). Specific types of hardware were more difficult than others to accommodate (e.g. RFC 282) and sometimes it was felt necessary to 'trick' the network in order to make something work (RFC 60). Network designers were aware that there were national differences in the extent of technology transfer and what we would now describe as network-readiness (RFC 647).

Telepresent distant and distributed computing. In a technological equivalent of the concept of the 'glocal' – manifestations of globalized phenomena and processes in the local – another design criterion-cum-policy principle for the Internet that supported internationalization was to achieve a computing environment in which it would be possible to experience both processing at a distance and distributed processing as if they were taking place at the physical site of the user – what social scientists have come to refer to as the 'telepresent' (Steuer, 1992). Telepresence was considered a desideratum for activities as diverse as data sharing (RFC 144), achieving cooperation among software processes at several sites (RFC 302), and operating a single database distributed across multiple hosts (RFC 299). In one early formulation, success in making the user's console appear to be directly connected to a machine in another location was described as having achieved network transparency (RFC 339). It was also understood that transmission speed was essential if real-time conferencing were to become possible (RFC 508), a practice soon referred to as teleconferencing (RFC 647).

Access. Inequities in access to the Internet underlie concerns about what has been popularly referred to in recent years as the 'digital divide' and has been referred to by sociologists historically as the 'knowledge gap' (Tichenor *et al.,* 1970; Viswanath and Finnegan, 1996). As is the case with any telecommunications system, though, access is not a singular concept. Those responsible for technically designing the Internet during the period, 1969–1979, were well aware of the multiple dimensions of the access problem. Access to the network (RFC 164), to files available through the network (RFC 172), and to computational facilities available over the network (RFC 136) were all treated as distinct issues, each to receive separate attention. Designers understood that computing at a distance brought with it institutional barriers to access that could include not having the opportunity to rely on technical and administrative staff at a foreign site and the possibility that local users would be prioritized over those using facilities remotely (RFC 364). Even having access to the RFC documents themselves was considered important (RFC 82), for it was possible to build a network using just these documents as instructions.

Redundancy. The concept of redundancy became a communication policy principle in the 1960s when satellites became an alternative to under-sea cables for international communication. The US government insisted that providers acquiring satellites must continue to build and service under-sea cables because satellites and cables had very different types of vulnerabilities. This same notion of redundancy as a means of ensuring the continued ability to communicate, despite attacks, weaknesses, errors or failures, was an important policy principle for the Internet as well. The types of redundancy incorporated into the network were many, including alternative options for error detection (RFC 68), coding (RFC 150), information about network activities (RFC 468) and transmission of messages (RFC 528), as well as redundancy in network components (RFC 684).

Extension of the network outside of the US. ARPANet was funded by and intended to serve the US government, but was defined as an international network (RFC 610). Not only the concept, but also the reality of what we now call the Internet, was international from the beginning. The British packet-switched network that soon became a part of the new network actually entered its experimentation stage before the ARPANet effort was launched (Abbate, 1990). In 1970, less than a year after the launch of the ARPANet design process, discussions opened between US and British research groups about how to connect their networks and a representative of the ARPANet group left for Norway to look at what would be required to create a direct link between the US and that country as a doorway to Europe (NORSAR, n.d.; RFC 67). Network testing during 1971 included Canadian sites (RFC 230). During 1972, the French version of ARPANet, known as CYCLADES, was launched.

The network became functionally international in 1973, with a first connection to Norway via satellite links, and then, within minutes, to the United Kingdom. The initial links were with research institutions, beginning with a non-governmental unit doing seismic sensing and quickly expanding in scope. A weather database – enormous for the era – with data from 5,000 surface and 1,200 upper atmosphere data collection sites and users distributed all over world (RFC 251) served as a leading design challenge from 1973 on (RFC 420).

Functional internationalization required the use of multiple technologies; a test plan for permanently linking the packet radio network, ARPANet, and Atlantic satellite networks was under way by 1975 (RFC 696). In 1976, Queen Elizabeth II of the UK used email herself to announce that a government facility had become available on ARPANet (Cerf, 1993) and internationalization of the network was described as a reality (RFC 707). Experiments in 1977, undertaken to try to simulate a battlefield scenario, used a combination of ARPANet, mobile radio networks and the satellite network to send packets on a 94,000 mile round trip – much further than would have been possible with an 800-mile roundtrip via ARPANet (Cerf, 2004). In 1978, an international packet-switched network serving multiple purposes opened between the US and the UK. In 1979, additional satellite ground stations to serve as TCP links were added to the network in Italy and Germany. Although the US did become the global hub for Internet communications, first linkages to the network by other countries were not necessarily with the United States. The UK connected first with Norway. Brazil connected first with France (Tanner, 1999).

Internationalization of the network also introduced possible dangers. Throughout the 1970s, European governments kept an eye on what US efforts would mean for their own scientific research, economic growth and national security. Two highly influential reports to governments were produced in 1979 – the Tengelin Report to the Government of Sweden (Tengelin, 1981) and the Nora-Minc Report to the Government of France (Nora and Minc, 1980). Both warned that governments and societies would be vulnerable if they had to rely upon the computers and networks of other countries, and both fueled national and regional efforts to develop networked computing systems that did not depend upon the United States. From the US perspective, sharing network resources with those in other countries was also perceived as a source of vulnerability. In addition to fears of malicious users and attacks on the network that were to be expected in the national security context, there were technical concerns, too. The University of London site had only one network connection, for example, which was problematic in a network architecture that aimed at a minimum of four connections from each node in order to operate as planned (RFC 613).

Geopolitical vs network political power

Experiences during the first decade of the Internet design process, and continuing on, made it clear that collaborating in the building of an international computer network was more difficult than anticipated. Some argued that it was necessary to rethink inter-societal, -national and -cultural collaborative practices altogether for computer networking purposes (RFC 1173). An alternative interpretation of the difficulties experienced, though, is that a conflict between geopolitical structures and relationships and network political structures and relationships was inevitable and inherent in the effort. If so, this would be an historical continuity, for telegraph and telephone networks' history similarly shows that networking in those forms provide challenges to, as well as supports for, geopolitical power (Headrick, 1990). The significance of technologies for jurisdictional purposes when it comes to telecommunications regulation had regulatory consequences; the United States' Federal Communication Commission (FCC), for example, had long treated Mexico and Canada as 'domestic' for a variety of regulatory purposes because there was no need to change technologies at the border, while Hawaii and Alaska were treated as 'international' because landlines had to be swapped out for under-sea cables or satellite in order to make the connection. With the Internet, the tension between network political and geopolitical power has both broadened and deepened, intensifying both the use and privileging of computerized systems over human decision-making and needs within domestic law (Braman, 2002) and the legal globalization processes (Braman, 2009, 2011a) that are transforming law–state–society relations.

Evidence of this tension within the Internet RFCs document series first becomes evident with the dual commitment to human and 'daemon' (software programs and computational processes) users. As discussed in more detail elsewhere (Braman, 2011b), daemons are considered to be at a 'higher level' than humans (RFC 172). Humans are often treated with disdain, accommodated only grudgingly, and designers often show sheer astonishment at the things that matter to humans as opposed to computers or networks. Humans were in many ways problematic for the design process because, as Denardis notes, 'The Internet standards community ... believed it could, and should, devise technical definitions and assess protocol alternatives on the basis of technology with no consideration of subjective factors like culture or politics' (2009: 38).

As time went on, discursive evidence emerged of the effort by those deeply involved in the network political to subsume the geopolitical in their network design activities. Although the term, 'nation', was not used, that concept, as it has historically been used to group people together for governance purposes (Greenfeld, 1992), was ultimately implicit in treatment of the Internet as both a communications network characterized by particular technical features and as a community of people bound into a common group through the Internet (RFC 1287).

In such an environment, geopolitically recognized governments must reassert themselves using the techniques of network politics in order to retain either identity or jurisdiction online. In the 21st century, there is no type of law – contract, constitutional, statutory or regulatory – that functions without software. As a consequence, for implementation purposes, 'we have to carve out national territories on the Internet by means of software' (Dommering, 2006: 10). That effort must come not from Internet designers, but from national governments, for, as Jon Postel put it, those involved in Internet governance are 'not in the business of deciding what is and is not a country' (RFC 1591: 6).

The very terminology used within the RFC discourse enhances the sense of the network political. Something is 'foreign', for example, when it involves a user (RFC 15), site (RFC 33) or process (RFC 46) that is not part of a specific host. Matters are considered cross-cultural when they involve differences in computer operating environments and equipment (see e.g. RFC 468). A system is 'polyglot' if it includes computers or databases that are organized in such different ways that a user can't operate in a common manner across them (RFC 316). The word, 'global', is used to refer either to something that operates across the entire network, such as a clock (RFC 675) or a failure (RFC 589), or that applies to all network processes (e.g. RFC 31; RFC 553). A 1974 map of the network replicates the FCC's technological approach to bounding the United States by using wavy lines to indicate network connections overseas and solid lines for all connections on the North American continent (RFC 616).

Conclusions

There is no single story that summarizes the early history of internationalization of the Internet during the first decade of the process through which the network was designed and built. That the network would be international was an assumption from the start, but internationalization of the design process was less of a concern. There was awareness of the need to collaborate internationally on behalf of all, but pre-existing legal arrangements and institutional differences often impeded such efforts. The electrical engineers and computer scientists whose work dominated the process voiced sensitivity to cross-cultural differences and to the social and political dimensions of networking, but were not always able to operationalize those perceptions and beliefs in the course of their technical work.

In some cases, as with the effort to facilitate the use of alternative character sets and languages on the network, the gap between goals and realities was not a matter of awareness, but of the number of technical problems that had to be solved first. In this area, it in fact took decades before it was possible to meet needs identified in the early 1970s. In many cases, the most influential decision-making from the perspective of internationalization of the Internet derived indirectly from the policy principles embedded in Internet design criteria rather than from head-on attention to issues raised by networking outside of the United States. Pursuit of a technological democracy, telepresent distant and distributed computing, access and redundancy all created affordances for global diffusion of the Internet, even though other factors created inequities in international use, and continue to do so today.

The most significant consequence of internationalization and of what we now call the Internet during its first decade was the tension between network political and geopolitical structures and relationships. Struggles between the two contributed significantly to the transformations in law–state–society relations that began to appear in the last decades of the 20th century and characterize the 21st. Further analysis of the social policy impact of Internet design decisions should deepen our understanding of ways in which the difference between making decisions for machines and for people – for daemons and for human users of the Internet – has path-dependent effects on the nature of society.

Notes

1. This is actually a decade plus three months. The document series analyzed here began in October 1969.
2. For an overview of the project as a whole, see Braman (2010). This material is based upon work supported by the National Science Foundation under Grant No. 0823265. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author. Thanks to networking experts David Stack and David Crass of the University of Wisconsin-Milwaukee's University Information Technology Services for their assistance in translating the technical language of the RFCs into terms understandable by the layperson, and to research assistants Alyse Below and Bethany Blount for their contributions.
3. The final document number in 1979 was 758, but not every document was 'issued' to the public.
4. In the traditional wired telegraphy and telephony environment, messages were moved around the network through line switching, in which a line connects two switches and messages or conversations in their entirety are moved from one line to another using either the manual switching equipment of a telephone or telegraph switchboard, or are electronically switched. In the packet-switching environment, messages are broken up into many packets, each with its own header and each with its own path to the receiver, with the whole being reassembled into a coherent message only upon receipt.
5. Numerous documents reference the CCITT and the impact on the Internet design process of the ITU (e.g. RFC 694). RFC 714 provides the most extensive discussion of the relationship between the two decision-making groups.
6. It was these same types of tariff issues that ultimately led to the formation of the World Trade Organization and the General Agreement on Trade in Services.

References

Abbate J (1999) *Inventing the Internet*. Cambridge, MA: MIT Press.

Abdullah RA (2005) Taking the E-train: The development of the Internet in Egypt. *Global Media and Communication* 1(2): 149–165.

Braman S (2002) Posthuman law: Information policy and the machinic world. *First Monday*. Available at: http://www.firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1011/932

Braman S (2009) Globalizing media law and policy. In: Thussu D (ed.) *Internationalizing Media Studies*. London: Routledge, pp.93–115.

Braman S (2010) The interpenetration of technical and legal decision-making for the Internet. *Information, Communication, and Society* 13(3): 309–324.

Braman S (2011a) Anti-terrorism laws and the harmonization of media and communication policy. In: Mansell R and Raboy M (eds) *Handbook of Global Media and Communication Policy*. Oxford: Blackwell/Wiley, pp.486–504.

Braman S (2011b) The framing years: Policy fundamentals in the Internet design process, 1969–1979. *The Information Society*, 27(5): 295–310.

Cerf VG (1993) How the Internet came to be, as told to Bernard Aboba. Available at: http://netvalley.com/archives/mirrors/cerf-how-inet.html (accessed 23 May, 2010).

Cerf VG (2004) On the evolution of Internet technologies. *Proceedings of the IEEE* 92(9): 1360–1370.

Cerni DM (1982) *The CCITT: Organization, US Participation, and Studies toward the ISDN*. Boulder, CO: US Department of Commerce, National Telecommunications and Information Administration.

Chang A (ed.) (1994) *ISO/CCITT and Internet Management Coexistence (IIMC): ISO/CCITT to Internet Management Proxy (IIMCPROXY)*. February. Internet draft.

Cheh MM (1982) Government control of private ideas: Striking a balance between scientific freedom and national security. *Jurimetrics Journal* 23(1): 1–32.

Clarke R (2004) Origins and nature of the Internet in Australia. Available at: http://www.rogerclarke.com/II/OzI04.html#IntC (accessed 22 May 2010).

Cowhey PF (1990) The international telecommunications regime: The political roots of regimes for high technology. *International Organization* 44(2): 169–199.

Crawford SP (2004) The ICANN experiment. *Cardozo Journal of International and Comparative Law* 12: 409–448.

David PA (2004) Toward a cyber-infrastructure for enhanced scientific collaboration: Providing the ‘soft’ (institutional) foundations may be the hardest part. Paper presented to the workshop, Networks of Knowledge: Research and Policy for the Knowledge-Based Economy, European Commission/NSF/OECD, Brussels, June.

Denardis L (2009) *Protocol Politics: The Globalization of Internet Governance*. Cambridge, MA: MIT Press.

Dommering E (2006) Regulating technology: Code is not law. In: Dommering EJ and Asscher LF (eds) *Coding Regulation: Essays on the Normative Role of Information Technologies*. The Hague: T.M.C. Asser Press, pp.1–17.

Dutton WH, Palfrey J and Peltu M (2007) *Deciphering the Code of Internet Governance: Understanding the Hard Issues at Stake*. Oxford: OII/E-Horizons Forum Discussion Paper No 8, January.

Flanagin AJ, Maynard Farinola WJ and Metzger MJ (2000) The technical code of the Internet/world wide web. *Critical Studies in Media Communication* 17(4): 409–428.

Froomkin AM (2000) Wrong turn in cyberspace: Using ICANN to route around the APA and the constitution. *Duke Law Journal* 50: 17–186.

Froomkin AM (2003) Habermas@discourse.net: Toward a critical theory of cyberspace. *Harvard Law Review* 116(3): 749–873.

Greenfeld L (1992) *Nationalism: Five Roads to Modernity*. Cambridge, MA: Harvard University Press.

Hafner K and Lyon M (1996) *Where Wizards Stay up Late: The Origins of the Internet*. New York: Simon and Schuster.

Hauben R (2004) The Internet: On its international origins and collaborative vision. *Amateur Computerist* 12(2). Available at: http://www.ais.org/~jrh/acn/ACn12-2.a03.txt (accessed 22 May 2010).

Headrick DR (1990) *The Invisible Weapon: Telecommunications and International Relations, 1851–1945*. New York: Oxford University Press.

Hunt C (1982) Multilateral cooperation in export controls: The role of COCOM. *Toledo University Law Review* 14: 1285.

Internet World Stats (2010) Available at: http://www.Internetworldstats.com/stats.htm (accessed 22 May 2010).

Koppell JGS (2005) Pathololologies of accountability: ICANN and the challenge of ‘multiple accountabilities disorder’. *Public Administration Review* 65(1): 94–108.
McLaughlin L and Pickard V (2005) What is bottom-up about global Internet governance? *Global Media and Communication* 1(3): 357–373.
Mills DL (2003) A brief history of NTP time: Memoirs of an Internet timekeeper. *Computer Communications Review* 33(2): 9–21.
Morris J and Davidson A (2003) Policy impact assessments: Considering the public interest in Internet standards development. Paper presented to the Telecommunications Policy Research Conference, Arlington, VA, August.
NORSAR (n.d.) NORSAR and the Internet. Available at http://www.norsar.no/pc-5-30-NORSAR-and-the-Internet.aspx (accessed 22 May 2010).
Nora S and Minc A (1980) *The Computerization of Society*. Cambridge, MA: MIT Press.
Office of Technology Assessment (OTA), US Congress (1988) *Science, Technology, and the First Amendment*, OTA-CIT-369. Washington, DC: US Government Printing Office.
Roman R (2007) What if ICANN can’t? Can the United Nations really save the Internet? *Syracuse Science and Technology Law Reporter* 15: 27-61.
Rutkowski AM (1983) The integrated services digital network: Issues and options for the future, *Jurimetrics Journal* 24(1): 19–42.
Schlesinger E (2004) Theories of cyber-sociology: Communicating culture through codes, *Cardozo Journal of International and Comparative Law* 12: 547-559.
Steuer J (1992) Defining virtual reality: Dimensions determining telepresence. *Journal of Communication* 42(4): 73–93.
Tanner E (1999) Links to the world: The Internet in Chile, 1983–97. *Gazette* 61: 39-57.
Tengelin V (1981) The vulnerability of the computerized society. In: Gassmann HP (ed.) *Information, Computer and Communications Policies for the 80s*. Amsterdam: North-Holland Publishing, pp.205–213.
Tichenor PJ, Donohue GA and Olien CN (1970) Mass media flow and differential growth in knowledge. *Public Opinion Quarterly* 34(2): 159–170.
Turner F (2006) *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism*. Chicago: University of Chicago Press.
Verhulst SG and Price ME (2008) Comparative media law research and its impact on policy. *International Journal of Communication* 2: 406–420.
Viswanath K and Finnegan JR (1996) The knowledge gap hypothesis: Twenty-five years later. In: Burleson BR and Kunkel AW (eds) *Communication Yearbook*. Thousand Oaks, CA: Sage, pp.187–227.
Yasuhara Y (1991) The myth of free trade: The origins of COCOM 1945–1950. *Japanese Journal of American Studies* 4: 127–148.
Yu PK (2004) The origins of ccTLD policymaking. *Cardozo Journal of International and Comparative Law* 12: 387-408.

RFCs cited

RFC 15. *Network Subsystem for Time Sharing Hosts*. CS Carr. September 1969.
RFC 20. *ASCII Format for Network Interchange*. VG Cerf. October 1969.
RFC 31. *Binary Message Forms in Computer*. D Bobrow, WR Sutherland. February 1968.
RFC 33. *New Host-Host Protocol*. SD Crocker. February 1970.
RFC 46. *ARPA Network Protocol Notes*. E Meyer. April 1970.
RFC 54. *Official Protocol Proffering*. SD Crocker, J Postel, J Newkirk, M Kraley. June 1970.
RFC 55. *Prototypical Implementation of the NCP*. J Newkirk, M Kraley, J Postel, SD Crocker. June 1970.

RFC 58. *Logical Message Synchronization*. TP Skinner. June 1970.
RFC 60. *Simplified NCP Protocol*. RB Kalin. July 1970.
RFC 65. *Comments on Host/Host Protocol Document #1*. DC Walden. August 1970.
RFC 67. *Proposed Change to Host/IMP Spec to Eliminate Marking*. WR Crowther. January 1970.
RFC 68. *Comments on Memory Allocation Control Commands: CEASE, ALL, GVB, RET, and RFNM*. M Elie. August 1970.
RFC 80. *Protocols and Data Formats*. E Harslem, JF Heafner. December 1970.
RFC 82. *Network Meeting Notes*. E Meyer. December 1970.
RFC 94. *Some Thoughts on Network Graphics*. E Harslem, JF Heafner. February 1971.
RFC 101. *Notes on the Network Working Group Meeting, Urbana, Illinois, February 17, 1971*. RW Watson. February 1971.
RFC 136. *Host Accounting and Administrative Procedures*. RE Kahn. April 1971.
RFC 139. *Discussion of Telnet Protocol*. TC O'Sullivan. May 1971.
RFC 144. *Data Sharing on Computer Networks*. A Shoshani. April 1971.
RFC 150. *Use of IPC Facilities: A Working Paper*. RB Kalin. May 1971.
RFC 164. *Minutes of Network Working Group meeting, 5/16 through 5/19/71*. JF Heafner. May 1971.
RFC 167. *Socket Conventions Reconsidered*. AK Bhushan, RM Metcalfe, JM Winett. May 1971.
RFC 168. *ARPA Network Mailing Lists*. JB North. May 1971.
RFC 172. *The File Transfer Protocol*. A Bhushan, B Braden, W Crowther, E Harslem, J Heafner, A McKenzie, J Melvin, B Sundberg, D Watson, J White. June 1971.
RFC 192. *Some Factors Which a Network Graphics Protocol Must Consider*. RW Watson. July 1971.
RFC 230. *Toward Reliable Operation of Minicomputer-based Terminals on a TIP*. T Pyke. September 1971.
RFC 243. *Network and Data Sharing Bibliography*. AP Mullery. October 1971.
RFC 251. *Weather Data*. D Stern. October 1971.
RFC 273. *More on Standard Host Names*. RW Watson. October 1971.
RFC 282. *Graphics Meeting Report*. MA Padlipsky. December 1971.
RFC 285. *Network Graphics*. D Huff. December 1971.
RFC 292. *Graphics Protocol: Level 0 Only*. JC Michener, IW Cotton, KC Kelley, DE Liddle, E Meyer. January 1972.
RFC 299. *Information Management System*. D Hopkin. February 1972.
RFC 300. *ARPA Network Mailing Lists*. JB North. January 1972.
RFC 302. *Exercising the ARPANET*. RF Bryan. February 1972.
RFC 313. *Computer Based Instruction*. TC O'Sullivan. March 1972.
RFC 316. *ARPA Network Data Management Group*. DB McKay, AP Mullery. February 1972.
RFC 328. *Suggested Telnet Protocol Changes*. J Postel. April 1972.
RFC 338. *EBDIC/ASCII Mapping for Network RJE*. RT Braden. May 1972.
RFC 339. *MLTNET: A 'Multi Telnet' Subsystem for Tenex*. R Thomas. May 1972.
RFC 354. *File Transfer Protocol*. AK Bhushan. July 1972.
RFC 364. *Serving Remote Users on the ARPANET*. MD Abrams. July 1972.
RFC 369. *Evaluation of ARPANET Services January–March, 1972*. JR Pickens. July 1972.
RFC 371. *Demonstration at International Computer Communications Conference*. RE Kahn. July 1972.
RFC 373. *Arbitrary Character Sets*. J McCarthy. July 1972.
RFC 420. *CCA ICCC Weather Demo*. H Murray. January 1973.
RFC 468. *FTP Data Compression*. RT Braden. March 1973.
RFC 508. *Real-time Data Transmission on the ARPANET*. L Pfeifer, J McAfee. May 1973.
RFC 528. *Software Checksumming in the IMP and Network Reliability*. JM McQuillan. June 1973.

RFC 553. *Draft Design for a Text/Graphics Protocol*. CH Irby, K Victor. July 1973.
RFC 589. *CCN NETRJS Server Messages to Remote User*. RT Braden. November 1973.
RFC 610. *Further Datalanguage Design Concepts*. R Winter, J Hill, W Greiff. December 1973.
RFC 613. *Network Connectivity: A Response to RFC 603*. AM McKenzie. January 1974.
RFC 616. *Latest Network Maps*. D Walden. February 1973.
RFC 631. *International Meeting on Minicomputers and Data Communication: Call for Papers*. A Danthine. April 1974.
RFC 635. *Assessment of ARPANET Protocols*. V Cerf. April 1974.
RFC 647. *Proposed Protocol for Connecting Host Computers to ARPA-Like Networks via Front End Processors*. MA Padlipsky. November 1974.
RFC 669. *November, 1974, Survey of New Protocol-Telnet Servers*. DW Dodds. January 1974.
RFC 675. *Specification of Internet Transmission Control Program*. V Cerf, Y Dalal, C Sunshine. December 1974.
RFC 684. *Commentary on Procedure Calling as a Network Protocol*. R Schantz. April 1975.
RFC 686. *Leaving Well Enough Alone*. B Harvey. May 1975.
RFC 694. *Protocol Information*. J Postel. June 1975.
RFC 696. *Comments on the IMP/Host and Host/IMP Protocol Changes*. VG Cerf. July 1975.
RFC 704. *IMP/Host and Host/IMP Protocol Change*. PJ Santos. September 1975.
RFC 707. *High-Level Framework for Network-Based Resource Sharing*. JE White. December 1975.
RFC 712. *Distributed Capability Computing System (DCCS)*. JE Donnelley. February 1976.
RFC 714. *Host-Host Protocol for an ARPANET-Type Network*. AM McKenzie. April 1976.
RFC 724. *Proposed Official Standard for the Format of ARPA Network Messages*. D Crocker, KT Pogran, J Vittal, DA Henderson. May 1977.
RFC 738. *Time Server*. K Harrenstien. October 1977.
RFC 739. *Assigned Numbers*. J Postel. November 1977.
RFC 753. *Internet Message Protocol*. J Postel. March 1979.
RFC 828. *Data Communications: IFIP's International 'Network' of Experts*. K Owen. August 1982.
RFC 1114. *Privacy Enhancement for Electronic Mail: Part II – Certificate-Based Key Management*. ST Kent, J Linn. August 1989.
RFC 1122. *Requirements for Internet Hosts – Communication Layers*. R Braden, ed. October 1989.
RFC 1135. *Helminthiasis of the Internet*. JK Reynolds. December 1989.
RFC 1173. *Responsibilities of Host and Network Managers: A Summary of the 'Oral Tradition' of the Internet*. J Van Bokkelen. August 1990.
RFC 1218. *Naming Scheme for c=US. North American Directory Forum*. April 1991.
RFC 1244. *Site Security Handbook*. JP Holbrook, JK Reynolds. July 1991.
RFC 1287. *Towards the Future Internet Architecture*. D Clark, L Chapin, V Cerf, R Braden, R Hobby. December 1991.
RFC 1591. *Domain Name System Structure and Delegation*. J Postel. March 1994.

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