COMPETING DNS ROOTS:
CREATIVE DESTRUCTION OR JUST PLAIN DESTRUCTION?

1. INTRODUCTION AND OVERVIEW

Three years after the creation of the Internet Corporation for Assigned Names and Numbers (ICANN), management of the Domain Name System (DNS) continues to generate controversy. One of the most intense and significant policy controversies associated with ICANN is the problem of competing DNS roots. The term “competing DNS roots” refers to attempts to undermine ICANN’s monopoly over the administration of the Domain Name System by establishing alternative root servers that allow users to register or resolve new top-level domain names not authorized by ICANN.

There are several alternative root server systems, but the most significant is operated by New.net, a US company with venture capital backing that has created more than 30 new top-level domain names.\(^1\) The International Telecommunication Union’s General Secretariat, a critic of ICANN, has taken an interest in alternative roots, adding a political dimension to the economic challenge of New.net.\(^2\) Industry efforts to implement the new ENUM protocol (RFC 2916, 2000), which would use DNS to map telephone numbers to Internet addresses, also sparked a new debate over competing DNS roots.\(^3\) Furthermore, cultural and linguistic differences are entering the picture, as engineers and businesses are now trying to create

\(^{1}\) Such as \texttt{.law}, \texttt{.mp3}, \texttt{.xxx}, and \texttt{.kids}. See New.net, 2001 and http://www.new.net.

\(^{2}\) A 28 September 2001 statement by ICANN’s Protocol Supporting Organization was forced to admit the technical feasibility of multiple DNS roots due to pressure from the International Telecommunication Union. See http://www.pso.icann.org/PSO_Statements/PSO-Statements-28September2001.txt.

\(^{3}\) RFC 2916 specifies e164.arpa as the root of the ENUM implementation. However, several commercial implementers of ENUM, such as Netnumber and Verisign Inc., have proposed using other domains as the root, and/or have favored a system of multiple roots. The US government was unable to take sides in this debate. A recent Internet draft by representatives of Verisign proposes to eliminate specification of e164.arpa as the “official” root of the ENUM implementation. See “ENUM Root Domain”, February 20, 2002 Internet draft, http://www.ietf.org/internet-drafts/draft-dutcher-enum-root-domain-01.txt.
domain names that can use more characters than the restricted ASCII set required by the existing DNS protocol.\(^4\) There is intense interest in these efforts in parts of the world that do not use the Roman alphabet, such as China, Korea, and the Middle East. The creation of “internationalized” domain names actually amounts to a standards migration that could lead to competing roots in the domain name system.\(^5\) Indeed, among the new top-level domains created by New.net are names that utilize non-ASCII characters that reflect German, French, Spanish, Portuguese and Italian words.

Within Internet circles, the problem of competing roots has all the characteristics of a religious war. Internet “Catholics”, a collection of veteran technologists acknowledging Vint Cerf as their Pope and the late Jon Postel as the Messiah,\(^6\) demand allegiance to The One True Universal Root administered by ICANN (IAB, 2000; Lynn, 2001). Internet Protestants, with elected ICANN Board member Karl Auerbach assuming the role of Luther, insist on the freedom to create alternate roots – but just as Luther’s challenge led to the proliferation of hundreds of sects and denominations, so (some fear) will the proliferation of DNS roots fragment the Internet.

My goal in this paper is to identify and discuss the economic and policy issues raised by competing DNS roots. I begin with the observation that multiple roots are a species of standards competition, in which network

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\(^4\) The Internet Engineering Task Force formed in November 1999 a working group on “Internationalized Domain Names” its documents are available at http://www.i-d-n.net/. See also the International Telecommunication Union Briefing Paper on Multilingual Domain Names, December 2001, http://www.itu.int/mdns/briefingpaper/itu/index.html.

\(^5\) The ITU Briefing Paper (note 4, above) observes that many multilingual DNS implementations rely on alternate roots and notes, “there appears to be general agreement on the need for a DNS name space visible to a maximum of Internet users: a severely fragmented name space is of little value to anyone. As evidence, the managers of “unsanctioned” top level domains in alternative root systems have argued both (a) for inclusion in the “authoritative root” and (b), against ICANN introducing TLDs identical with their TLDs used in alternative inclusive roots. They also contend that it is possible to have an administratively coordinated root function that avoids collision between different top-level domains based on multiple root systems. This suggests that the debate remains more about who is the root or coordinating naming authority rather than about the merits of a single coordinated name space.”

\(^6\) Vinton Cerf is one of the two inventors of the Internet protocol, an early recipient of DARPA funds, a DARPA program officer, and one of the founders of the Internet Society, a group that initiated the process that led to the creation of ICANN. Jon Postel was the administrator of the Internet Assigned Numbers Authority back in the days when the Internet was a research project funded by the U.S. DARPA and the National Science Foundation. Cerf and Postel played a major role in defining the processes and procedures of the Internet Engineering Task Force and commanded tremendous loyalty among IETF participants.
externalities play an important role. I then perform a structural analysis of the different forms that competition among DNS roots can take, and analyze their compatibility effects and policy implications.

In the established domain name market, the value that can be added by competing DNS roots seems to be small relative to the compatibility and fragmentation risks. So why do competing DNS roots exist? My thesis is that they are a predictable response to ICANN’s severe, artificial restrictions in the supply of top-level domain names and over-regulation of domain name registries. Technically, thousands of new top-level names could be added to the DNS root. There are many willing suppliers of new top-level domains, and (at least) hundreds of thousands customers willing to buy services from them. The ICANN regime, however, has deliberately maintained extreme scarcity in the supply of top-level domain names. It has authorized a tiny number of new top-level domains (7) and subjected their operators to excruciatingly slow and expensive contractual negotiations. The growth of alternate DNS roots is an attempt to bypass that bottleneck.

More fundamentally, competing roots are about competing sources of authority over the Internet. The DNS root has proven to be a bottleneck that allows a central authority to impose regulations on certain aspects of the Internet. The policy conclusion I draw is that competition among DNS roots should be permitted and is a healthy outlet for abuses of power by the dominant root. Such competition does not threaten the universality of the Internet interconnection, because both suppliers and end users have powerful economic incentives to remain compatible and connected with each other. Indeed, due to the strong network externalities involved, the deck is stacked so heavily in favor of an established root that if an alternate root achieves critical mass and threatens the dominance of the incumbent, it can only be because the existing root administrator is doing something seriously wrong. Given the importance of network externalities in this market, a sustainable alternate root could only arise from a clear lack of consensus support for ICANN policies among a critical mass of suppliers and consumers.

A more difficult and complex issue to be faced is how much interconnection should be implemented between a dominant root and alternate systems. If ICANN continues to stifle the market for new top-level domains, this issue will have to be faced some time in the future. In this

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7 For the ordinary business or nonprofit organization holding a few domain names, the cost of the domain name (20–50 per year) is quite small compared to the other costs associated with an Internet presence (server infrastructure, design and content management, ISP service, etc.).
paper, I sketch out some of the issues involved in interconnecting roots, but do not make any detailed proposals.

2. The Economic and Technical Structure of the Domain Name Registration Industry

To understand the economics of DNS root competition, one must understand certain facts about the DNS as a technical protocol. The description that follows is highly simplified and attempts to be as non-technical as possible.

The DNS is a distributed database protocol that Internet users invoke every time they use a Web address, an email address, or a textual name of a computer in a networked application. Domain names are semantically meaningful identifiers that appear to be the “addresses” used in Internet communication. In fact, the Internet uses 32-bit binary Internet protocol (IP) addresses for actual routing and transmission. For domain names to work as “addresses”, they must be constantly looked up to find out the binary address associated with each name. The process of mapping a domain name to an IP address is called “resolving” a domain name; the computers that perform this function are called “name servers.”

Resolution of a domain name consists of a sequence of queries from the end user’s computer to a series of name servers that store the records about a particular name. Queries start at the root and are relayed down through the hierarchical structure of the DNS until they find the local name server that stores the data about that particular name.

The DNS name space is organized as a hierarchy. At the top of the naming hierarchy is a single, unnamed root, administered by a central authority. (Figure 1) The DNS root refers to two distinct things:

a) A list of top-level domain name assignments, with pointers to name servers that can answer queries about how to resolve names under each top-level domain. The list is known as the root zone file;

b) A set of 13 name servers that make the information in the root zone file available to any user of the Internet who initiates a DNS query. The 13 root name servers are distributed geographically in order to make the root zone file available more rapidly to spatially distributed users, and provide redundancy in case some root servers lose connectivity or crash. For technical reasons, there can only be 13.

The central authority that runs the root only needs to assign and keep track of top-level domain names. The companies that operate a top-level domain (TLD) only need to assign and keep track of second-level domains
under their TLD. An organization with a second-level domain can assign any unique names they like at the third-level, and be sure that they are globally unique. And so on down the hierarchy.

Usually, end users pay top-level domain name registrars and registries an annual fee to register a second-level domain name. In addition to that, end users must either pay a service provider to operate a local name server (i.e., maintain a database capable of telling other computers on the Internet what binary address is associated with the name), or provide this service for themselves. Domain name registration services generate US$ 2–3 billion in revenues annually. When the Internet was a subsidized research and education network, the root administrator was supported by US government contracts. Now, commercial registration suppliers pay

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8 In the “generic” .com, .net, .org, .info, and .biz TLDs, ICANN imposes a vertical separation between the “registry” that maintains the database or registrations, and the “registrars” who service the customer account. In this scheme, the registry price is regulated and the registrar prices are unregulated. End users do not interact directly with the registry, they register names only through registrars. The registry function might be viewed as a wholesale part of the business and the registrar as the retail end. The policy objective of this separation is similar to the separation of local and long distance voice telecommunication service; the registry is considered an inherently exclusive, “monopoly” service and the customer service retail part is perceived as competitive, permitting customers to port their accounts from one registrar to another.
ICANN fees for accreditation, and both registrars and registries pay ICANN “taxes” based on the number of domains they have registered.

Technically, the most important thing about the DNS root is that it provides a single, and therefore globally consistent, starting point for the translation of domain names into binary addresses. As long as all the world’s name servers reference the same data about the contents of the root zone, the results of mapping any given domain name to an IP address is likely to be consistent regardless of who initiates the query.

Aside from its critical technical function, administration of the DNS root has political and economic importance. Whoever controls the root zone file is able to decide which top-level domains will exist and who gets to operate them. If top-level domain assignments are economically valuable, then the decision about who gets one and who doesn’t gives the assignment authority a great deal of leverage over the industry. Exclusive control of top-level domain name assignments can thus provide the power needed to regulate registry policies, second-level domain name assignments and other aspects of Internet use related to domain names.

The problem of regulatory leverage was avidly discussed during the creation of ICANN. The discussion resulted in widespread agreement that the root administrator should be primarily a technical coordinator not a regulator; that the coordinating authority should be a private sector, non-profit organization rather than an international, intergovernmental treaty organization; and that the nonprofit should be both representative of and accountable to the diverse interests that would be affected by domain name policies.9

3. COMPETING ROOTS AND NETWORK EXTERNALITIES

Below, I will argue that competing roots are a form of standards competition with strong network externalities. I begin by defining and exploring network externality phenomena, and then show how competing DNS roots are characterized by network externalities.

Network Externalities (Demand-side Scope Economies) and Competition

When network externalities exist, user choices are affected by the value of compatibility with other users, not just by the functions of the product

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9 Whether ICANN actually realized those goals remains an open question. The international debate over the root’s governance arrangements and the formation of ICANN are described in detail in Mueller (2002). The relevant US Government documents are NTIA (1997, 1998a,b).
or service in isolation. In this demand-side phenomenon, the value of a good to its users tends to increase as other users adopt the same system or service. This feature of goods is often called a positive consumption externality or the network externality, but a more precise definition characterizes them as demand-side economies of scope that arise from the creation of complementary relationships among the components of a system (Economides, 1996).

Network externalities are sometimes erroneously described as demand-side economies of scale (Shapiro and Varian, 1998). That description equates an increase in the number of participants in a network with an increase in scale. The equation of “more users” with “increasing scale” is both empirically false and logically inconsistent with basic theorems of economics. It is false empirically because users of a network are not homogeneous units. Every user and location are distinct entities, and adding them to a network adds new services to the bundle of services offered by a network, not more of the same service. Thus, adding participants to a network increases its scope, not its scale.10 Further, if adding users to a network increased its scale, the presence of network externalities would contradict the fundamental assumption of a downward sloping demand curve, because the value of a unit of the good would increase with the number of units sold.

When demand-side economies of scope are present, competition takes on distinctive characteristics. First, any network must achieve what is commonly called “critical mass” to be sustainable. Critical mass refers to a threshold level of users sufficient to realize enough scope economies to retain existing subscribers and attract new ones (Economides and Himmelberg, 1995). Put more simply and concretely, there is little incentive to pay money to join a telephone network with no other subscribers on it. The process of achieving critical mass is path-dependent, as the game-theoretic analysis of Rohlfs (1974) and the probabilistic modeling of Arthur (1989) have proved. When network externalities are present a model of network growth will exhibit multiple equilibria, depending on who joins and in what sequence.

The same models demonstrate that competition among incompatible networks is “tippy.” If one of the competing networks gains a decisive advantage in scope (i.e., number of users and/or locations covered) the...

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10 Economides (1996) makes this point more abstractly: “Consider for example a typical two-way network, such as the local telephone network . . . In this n-component network, there are n(n – 1) potential goods. An additional (n + 1th) customer provides direct externalities to all other customers in the network by adding 2n potential new goods through the provision of a complementary link (say ES) to the existing links.”
market will tip and users will converge on the larger system in order to reap the benefits of the network externality. Of course, network externalities can be realized in two ways: either all users converge on a single system (e.g., the Microsoft operating system), or gateway technologies can be developed that interconnect the separate systems or make them compatible (e.g., competing but interconnected telecommunication networks). When the separate systems are economic competitors, however, the political and institutional processes required to bring about compatibility are costly and complex, as telephone regulators have learned over the past two decades.

The theoretical literature also refers to the presence of “inertia” after users have converged on a single network (Farrell and Saloner, 1987). Inertia is created by the risks and transaction costs associated with switching to another network. Just as a user’s decision to join the network was dependent upon the decision of other users to also join, so a user’s decision to abandon a network for a competitive alternative will be affected by the level of network benefits he might have to sacrifice by moving to a new network. As an example, widespread hostility to Microsoft and frequent dissatisfaction with the quality of its products have not undermined its dominance of the PC-compatible operating system market, because most users are unwilling to sacrifice compatibility benefits by adopting another system.

There are many historical examples of competition based on compatibility. Studies of competing railroad gauges (Friedlander, 1995), alternate electric power grid standards (Bunn and David, 1988), separate telegraph systems (Brock, 1981), non-interconnected telephone networks (Mueller 1997), and alternate broadcast standards (Farrell and Shapiro, 1992) all have shown that the need for compatibility among multiple users led to convergence on a single standard or network, or in interconnection arrangements among formerly separate systems. In some cases, political and economic factors limited the scope of convergence (e.g., common broadcast standards were limited to world regions rather than becoming global in scope). Universal compatibility is not always necessary or desirable. Finland, for example, adopted a railroad gauge incompatible with neighboring Russia’s for national security reasons.

DNS Root Competition and Network Externalities

As noted in Section 2, the root zone file is the list of recognized top-level domain (TLD) names (such as .com, .uk, .jp, .fr, .org) with pointers to the IP addresses of the name servers capable of resolving names registered under that TLD. Competition at the root level means competition for the right to define the contents of the root zone file. When everyone uses the
same DNS root, this information is standardized and uniform. When there are competing roots, there are different sources of this information.

Anyone with control over the configuration of a DNS client or name server has the ability to choose which computer they query for resolution of domain names. When there are competing roots, the competitors try to persuade Internet service providers, domain name server operators, and end users to direct root-level DNS queries to them, so that their definition of the content of the root zone is recognized and accepted by the rest of the Internet.

There are strong network effects in the choice of a DNS root. The purpose of registering a domain name is to obtain an identifier that can act as an Internet address or locator. Internet user A who registers a domain name wants that address to be compatible with the DNS implementations of all existing and future communication partners (which we will refer to as N). “Compatibility” in this case means that any N who encounters A's domain name will, after sending the appropriate queries to the name servers to which N are connected, be returned the correct answer about the IP address associated with the A's domain name. Incompatibility means that an incorrect answer, or no answer, is returned.

Competing roots can result in varying levels of incompatibility. (See Section 4 below for a more structured description.) In general, incompatibility can arise in two ways. First, if A's and N's name assignments are derived from distinct and uncoordinated roots, A's domain name may not be globally unique. If it is not unique, there is a chance that the name servers that handle user N's query will confuse it with some user other than A who has adopted the same name, and return the wrong information. Second, even if the name is unique, the name servers that handle user N's query may not know where to find the information needed to resolve A's name if it does not begin its query process at the same root as A.

Obviously, the value of a domain name to A increases as the scope of its compatibility widens. An identifier that cannot be resolved by other users is as useless as a telephone set without any connectivity. If only a fragment of A's universe of communicating parties can resolve the name, A will have to carefully manage and restrict his use of the identifier and utilize another, globally recognized identifier for use with communication partners who employ an incompatible root. Because so much of the communication on the Internet takes place among parties who do not know each other and have no prior relationships that would allow for coordination, the compati-

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11 In actual practice, default values are set in the implementation software, which for 90% of the world’s computers is a software known as BIND (Berkeley Internet Name Domain).
bility barriers created by fragmentation of the name space are high. There is very little reason to ever want to utilize a domain name that is not globally compatible. The demand-side economies of scope realized by means of universal compatibility are thus very great indeed.

If all Internet Service Providers and users rely on the same public name space – the same delegation hierarchy – it is likely that all name assignments will be unique, and also that any name server in the system will know how to find the corresponding name server with the information needed to correctly resolve user A's domain name. Hence, a single root increases the chance that all domain names will be compatible. Network service providers who want to offer universal connectivity to their customers or clients have a strong incentive to converge on a single DNS root.

Competing roots face the classic chicken and egg problem associated with goods that require a critical mass of users. End users will be reluctant to purchase domain name registrations from a competing root unless they can be ensured that all of their communication partners can resolve the name. While the risk of incompatibility will greatly limit user adoption, the small scope of the competing root will reinforce the reluctance of users to utilize the competing root.

Network externalities are really the only barrier to all-out competition over the right to administer the DNS root. A root server system is just a name server at the top of the DNS hierarchy. There are hundreds of thousands of name servers being operated by various organizations on the Internet. In principle, any one of them could declare itself a public name space, assign top-level domain names to registries, and either resolve the names or point to other name servers that resolve them at lower levels of the hierarchy. The catch, however, is that names in an alternate space are not worth much unless a critical mass of name servers on the Internet recognize the alternate root and use it to resolve names.

There is a powerful inertia at work that maintains the dominance of the incumbent root. The software implementation of DNS used by over 90 percent of the world’s name servers is an open-source product known as BIND. BIND was created in the 1980s and is currently in its 9th version. All 9 versions contain default values that tell name servers where to look for the DNS root. Over 500,000 independently administered name servers exist on the Internet and are using some version of BIND. With such an enormous installed base and such a wide dispersion of responsibility for changing those initial values, coordinating a switch to a new root would be difficult, somewhat akin to coordinating a software upgrade in a major
multinational enterprise, only without any hierarchical authority over the adoption and administration decisions of the users.

Coordinated action by major Internet industry players might be able to overcome the inertia and critical mass problems. If the producers of Internet browsers, for example, pre-configured them with software pointing to a new root with an alternate root zone file that included or was compatible with the incumbent root zone, millions of users could be switched to an alternate root. It is also possible that a national government with a large population that communicated predominantly with itself could establish an alternate root zone file and require, either through persuasion or regulation, national ISPs to point at it. Indeed, the Peoples Republic of China is offering new top-level domains based on Chinese characters on an experimental basis. The whole transition to multilingual names is creating an opportunity for establishing alternate roots. But even in these cases, all market actors have powerful incentives to retain backwards compatibility with the existing root. No firm or nation, no matter how substantial, would risk cutting themselves off from a significant part of the Internet by creating a DNS implementation or alternate naming scheme that was incompatible with the ICANN-US Department of Commerce root.

4. COMPATIBILITY STRUCTURES OF COMPETING ROOTS

The debate over competing roots can be further clarified by modeling the different structures competition might take and their impact on end user compatibility. Assume two DNS roots: the ICANN-US Department of Commerce-managed root (Root-I) and a competing root (Root-C). Competition between them can take one of three forms (Auerbach, 2000):

- **Type 1:** The zone files of Root-I and Root-C have identical contents due to mutual recognition and coordination.
- **Type 2:** Root-C adds new top-level domains to its own zone file, but duplicates the contents of Root-I’s root zone and makes no TLD assignments that conflict with the incumbent’s assignments. We might consider this a case of unilateral coordination by one of the root operators but not the other.
- **Type 3:** Root-C and Root-I contain at least one, and possibly many more, conflicting assignments of top-level domains. In other words, each root administrator has assigned the same top-level character string to different organizations. The name servers operated by those organizations contain different zone file contents for the top-level domain in question; i.e., they resolve to different IP addresses.
Each of these structures can be described using a simple matrix, in which the columns represent the origin of a DNS resolution query and the rows represent the origin of a domain name assignment (see Tables I–III). The cells in the matrix represent the compatibility relationships.

**Type 1 Competition**

In Type 1 competition, the identical content of the root zone file is achieved through mutual coordination. That is, Root-I agrees to recognize and provide name service to top-level domains created by Root-C, and vice versa. Both roots agree to avoid making top-level assignments that conflict with TLDs in the other root. As can be seen in Table I, this results in compatibility across all cells.

The economic effect is identical to an interconnection agreement in telecommunications. The method of coordination can be either social-institutional in nature (e.g., meetings and procedures for assigning names and resolving conflicting claims) or technical (i.e., some kind of protocol that keeps assignments within the roots consistent, or adds information to inconsistent assignments to make them unique).

**TABLE I**

Type 1 competition – compatibility relations.

| Origin of domain name assignment | Origin of domain name query |
|--------------------------------|-----------------------------|
| Users of Root-I                 | Users of Root-C              |
| Root-I                         | Compatible                  |
| Root-C                         | Compatible                  |

**Type 2 Competition**

In Type 2 competition, the competing root adds new TLD names that do not exist in the incumbent root. This is the form of competition that we are now experiencing. New.net, the Open Root Server Confederation, and other alternate roots all duplicate the ICANN root zone but add new TLDs to it. They do not make assignments that conflict with ICANN top-level names; e.g., they do not assign .com to a registry other than Verisign. This method of competition preserves universal compatibility in all the existing domains, and for all users of Root-C, but creates incompatibility for users of Root-I. Users of Root-I will not be able to resolve names that are unique to Root-C. For example, if Root-C adds a top-level domain “.new” to its root, its own customers will be able to fully utilize domain names ending in
.new, as well as all the Root-I top-level domains. But users of Root-I will not be able to resolve domain names ending in .new. The compatibility relationships look like this:

| Origin of domain name assignment | Origin of domain name query |
|----------------------------------|-----------------------------|
|                                  | Users of Root-I | Users of Root-C |
| Root-I                           | Compatible      | Compatible      |
| Root-C                           | Incompatible    | Compatible      |

The amount of incompatibility this produces for users depends on the relative popularity of the two roots. In the current situation, Root-I is overwhelmingly dominant, controlling over 99 percent of all users. Further, most of the holders of alternate root domain names also have Root-I domain names that they use when communicating with the rest of the Internet. Thus, the probability that a Root-I user will encounter an incompatible domain name is triply diminished: first by the smaller number of Root-C users, second by the fact that every Internet user doesn’t communicate with every other Internet users, third by the registration of multiple names across the two roots by most Root-C users.

**Type 3 Competition**

In Type 3 competition (Table III), the root zones are uncoordinated. No user of either root can be sure that they have a unique domain name. Users have a high risk of experiencing incompatibility when they interact with each other (unless of course they all converge on the same root).

There are very powerful economic incentives limiting the possibility of such a scenario. Over the medium and long terms, it is difficult to understand why customers would buy, or how suppliers could sustain a business selling, domain names that did not work a significant amount of time, names that were perpetually at risk of being incompatible with a significant portion of the Internet. Both ISPs and their customers have very strong incentives to maximize compatibility, and could be expected to converge on a common root or to coordinate the alternate roots at least to some degree.

Continuing with the unrealistic assumption of no coordination whatsoever, the compatibility situation may be even worse than is portrayed in the table. DNS relies heavily on caching (storing) data obtained from
TABLE III
Type 3 competition – compatibility relations.

| Origin of domain name assignment | Origin of domain name query Users of Root-I | Users of Root-C |
|---------------------------------|------------------------------------------|------------------|
| Root-I                          | Compatible                               | Incompatible     |
| Root-C                          | Incompatible                             | Compatible       |

queries, and if contradictory data is cached it might replace correct data or even be transferred to other name servers. Some analysts have argued that competing roots have the potential to “seriously disrupt the Internet” because of the dissemination of inconsistent data throughout the DNS (Lynn, 2001; Crispin, 2001). That argument, however, applies only to Type 3 competition; i.e., when there is no coordination among the separate roots’ name assignments and numerous conflicting TLD assignments exist. Type 2 competition does not create cache pollution problems, because it retains the consistency of all assignments under TLDs in Root-I, and simply adds new, non-conflicting TLDs to the Root-I zone file.

5. POLICY ISSUES

The three types of root competition enumerated above are useful categories for analyzing the policy issues regarding competing DNS roots. Each of the different types of competition raises distinct policy issues.

Policy Problems in Type 1 Competition

Certain members of the Internet technical community are fond of pointing out that a Type 1 arrangement is mathematically equivalent to single root. Mathematically, it is. But from a social point of view they are worlds apart. A domain name industry that relies on a root zone achieved through coordination and interconnection of different firms will have radically different economic, political, institutional, and perhaps even operational characteristics, as we have learned in the telecommunications industry.

The world’s telephone numbering plans achieved compatibility by means of the Type 1 model. Each national administration developed its own numbering plan, which was originally incompatible with the numbering systems of other national administrations. Various forms of regional and then international coordination were added on top of
the national numbering hierarchies to achieve international numbering compatibility (Rutkowski, 2001).

While Type 1 competition might be optimal from the standpoint of the market participants’ ability to realize the benefits of network effects, it would severely undermine ICANN’s ability to impose regulation upon the domain name system. An interconnection agreement with alternate roots would give prospective domain name suppliers a way to operate new top-level domains without going through ICANN’s centralized contracting process. Firms that did not like the complex and highly regulatory template contract offered by ICANN might be able to get a better deal from another root service provider. This might also provide end users with a choice of policies – if they did not like ICANN’s domain name dispute resolution policy, for example, they would be free to register a domain name in the alternate root system without sacrificing compatibility. In short, to be able to impose policy obligations on DNS providers and users ICANN must maintain the exclusivity of its root. Whether ICANN’s capacity to enforce policy is something worth preserving or not depends on one’s opinion of ICANN and its policies. It may well be that both ICANN and the public would be well served by some competition. The point here is that ICANN itself has no incentive whatsoever to interconnect with an alternate root. Such a contract would undermine its regulatory power and impose a competitive constraint on the taxes it imposes on registries and registrars to finance its operations.

There is another important policy issue raised by Type 1 competition. Even if ICANN agreed to recognize the existence of an alternate root, it would still have to establish some criteria for agreeing to interconnect them. It is easy to establish an alternate root with new TLDs if one needn’t worry about having real customers. It would be inefficient for ICANN to incur costs of negotiation and coordination with another root that had no real industry presence. Indiscriminate recognition of any alternate root that came along would simply encourage new alternate roots to stake indiscriminate claims on top-level domain strings. Some kind of criteria for distinguishing between “real” and “unreal” or “serious” and “silly” alternate roots would have to be established.

A policy white paper put forward by New.net proposes a general solution to this problem. (New.net, 2001, pp. 4–5) It analogizes the addition of new top-level domains to the DNS root to the decision by local cable television operators to add programming channels to their menu of offerings. A new TLD would seek to gain support among ISPs and users in a similar way. As an alternative to ICANN’s highly political and slow TLD-licensing process, New.net proposes that ICANN encourage private
companies to develop top-level domains in the market and set some minimal technical standards and a “minimum number of domain names being used by disparate users.” When those thresholds are met the TLD is added to the public root. One problem with this approach is that it would not easily allow for the creation of TLDs oriented toward private companies that wanted to internalize their DNS service (e.g., a .aol or a .ford), or TLDs that served relatively small communities of users (e.g., there are less than 100 registrants in .int).

Policy Problems in Type 2 Competition

The interesting policy issue created by Type 2 competition comes when the dominant root wants to add new TLDs. At that point it must decide whether or not to assign top-level domains that collide with (i.e., duplicate) those already assigned by the alternate root. For example, if ICANN ever decides to add new top-level domains, it will find that the .hola string is already in use by many customers of New.net. If ICANN avoids assigning .hola to any registry licensed through its own process for that reason, it is tacitly recognizing New.net, a kind of halfway house toward a Type 1 situation. Of course, avoidance of conflicting assignments is not the same as mutual recognition and coordination – the alternate root’s TLDs still would not be listed in the ICANN root zone files. But conflict-avoidance would constrain ICANN’s choices of TLD strings, and make it easier for the competing root to survive.

On the other hand, if ICANN assigns TLDs already in public use by another root, it is initiating Type 3 competition. The effect is to create bilateral incompatibilities in the market for domain names. Because of the powerful network externalities, end user reaction to those incompatibilities would in most cases tip the market toward one of the competing roots (in this case, probably the dominant one). For example, if ICANN chose to assign .hola to someone other than New.net, it might transform all holders of New.net’s .hola names into “orphans” and render worthless their prior investments in the names.12 Such an exercise of market power by the dominant root (ICANN) raises a serious competition policy issue. If it was not illegal for New.net to enter the market in the first place, should it be legal for ICANN to use its dominance of the DNS root-server system to put non-conflicting name services out of business – particularly if ICANN was the entity who initiated the incompatibility? A deliberate attempt by Microsoft to configure its dominant operating system in a way that made

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12 By the same token, if New.net were well-established enough and had lots of functional registrations under .hola, it is possible that the ICANN delegee could fail to attract customers because of the conflict.
it impossible or horribly difficult to use a competitor’s application software would certainly be considered legally actionable. From a network economics standpoint, there is no great distinction between the two cases. ICANN’s quasi-governmental nature is not much of a shield, because the record of the government documents that created ICANN explicitly recognized that the new organization would be and should be subject to antitrust constraints.13

ICANN’s TLD selection process sent out mixed signals about its willingness to recognize alternate roots. At the Board meeting in November 2000 when it chose the new domains from among 43 applicants, Board member Vinton Cerf opposed awarding .web to one applicant, explicitly acknowledging the prior claim and use of the .web TLD in an alternate root. Cerf’s motion was opposed by Board member Hans Kraijenbrink, who explicitly acknowledged the conflict and asserted that ICANN ought not to recognize any claims to TLDs that emerged from outside of its own process. In a tense and close vote, Cerf and the ICANN Board “liberals” prevailed over the conservatives. The Afilias corporation was awarded .info instead of .web, and the alternate root applicant was encouraged to wait for the second round.14 On the other hand, one of the other successful bidders applied to operate the .biz top-level domain name. That name was also in use, albeit more recently, by an alternate root system (Gallegos, 2001). Unlike the .web case, the prior claim was not recognized by ICANN, and .biz was awarded to the NeuStar/Melbourne IT joint venture. In the .web decision, ICANN avoided conflict with an alternate root; in the .biz decision, it did not.

One suggestion for resolving such conflicts is that a right of first use be recognized, similar to the establishment of rights over trademarks. Here again, workable criteria and thresholds must be established. Just as one cannot claim exclusive trademark rights over words and designs that are confusingly similar to marks used by others, and just as one must actually use the mark in commerce and achieve some level of distinction to be afforded protection, so could analogous distinctions be applied to TLD claims.

13 “Applicable antitrust law will provide accountability to and protection for the international Internet community. Legal challenges and lawsuits can be expected within the normal course of business for any enterprise and the new corporation should anticipate this reality” (NTIA, 1998b).

14 These conversations are recorded and available for public viewing on the Harvard Berkman Center’s web site (http://cyber.law.harvard.edu/scripts/rammaker.asp?s=cyber&dir=icann&file=icann-111600&start=6-16-00).
Ban Alternate Roots?

One option that does not seem feasible is to make alternative roots illegal. Any attempt to require all users to point to an “authoritative” root raises a number of serious policy problems. First, it violates a foundational principle of the Internet, which is that the Internet is a collection of private networks that choose to interconnect with each other (or not) on a voluntary basis. Second, such “authority”, to be effective, would have to be global and legally enforceable, which means that it would have to come from an international agreement among governments. This would involve a rather intrusive assertion of power over what values and pointers are contained in software applications. Furthermore, it would not be easy or unambiguous to define what “pointing to the authoritative root” means in legal terms. Such a definition might inadvertently outlaw technologies that enhance the DNS, such as content distribution networks, keyword systems, or private name spaces. Worse, any attempt to designate and make mandatory an authoritative root would risk freezing Internet naming technology in its tracks, by prohibiting efforts to bypass DNS altogether with a radical new naming or addressing technology.

6. WHAT SUSTAINS ALTERNATE ROOTS?

The Internet technical community tends to view competing or alternative roots as a form of heresy. Those who advocate it are dismissed as anarchic troublemakers who want to undermine order for its own sake, or as confused people who don’t understand DNS technology (RFC 2826, 2000).

There is a simpler and more accurate explanation for the existence of alternate roots. Competing roots reflect a serious disequilibrium between the demand for new top-level domain names and the willingness of the root administrator to supply them.

Domain name registrations generate approximately US$ 2.5 billion in revenues each year. From 1995 (the year the US National Science Foundation first authorized charging annual fees for domain name registrations) to 2001, about three-fourths of that market was controlled by one company, Network Solutions, Inc. (NSI). Throughout that period, there was widespread demand for both competition with NSI and new domain names that would better reflect consumer preferences and interests. The first competing roots arose in the chaotic period between the Fall 1995 and the end of 1996, when no one was sure who had policy authority over
the DNS root, the Internet community was paralyzed, and the demand for competition and new names (and antipathy to NSI) was particularly strong.

Alternative DNS roots are a function of this intense demand for new TLDs coupled with the US Government’s and ICANN’s unwillingness to deliver them. That conclusion is supported by the following facts:

• **Alternate root competition has invariably taken the form of Type 2 competition.** Competitors have attempted to add new TLDs to the set supported by ICANN. None of them have made assignments that conflict with prior ICANN TLDs. It is apparent, therefore, that the primary motive of these efforts is to find a way to add TLDs to the available set, not to take over ICANN’s functions or to promote incompatibility in the naming system.

• **Alternate root operators consistently have sought compatibility with the ICANN/US Government root.** New.net repeatedly makes explicit its desire to have ICANN recognize its new TLDs and enter them into the incumbent DNS root. Prior to the creation of ICANN, alternate root operator Name.Space repeatedly petitioned the US Government to enter its TLDs into the official DNS root. Likewise, key backers of the early alternate root movement were strong supporters of the US Government’s March 1998 Green Paper (NTIA, 1998a), which advocated rapid addition of 5 new TLDs into the root.

• **Alternate root operators all sought assignments from ICANN.** The major advocates and implementers of alternate roots – New.net, Image Online Design’s .web registry, and Name.Space – all applied for TLDs via the ICANN process – that is, all paid $50,000 into ICANN’s application process and invested at least twice that much in proposal development (and all were rebuffed). Clearly, all of them would strongly prefer to be visible in the ICANN root rather than attempting to establish an alternate root. Their formation of alternate roots can be seen as a response to being shut out of the official market.

• **There is evidence of suppressed supply of TLDs.** Despite the clamour for new TLDs dating back to 1995, ICANN did not solicit bids for new TLDs until August of 2000, nearly two years after its creation. It required bidders for new TLDs to provide a large non-refundable fee to finance its evaluation and implementation.15 Nevertheless, forty-four applicants proposing over 250 new top-level domain names were willing to pay ICANN sizable sums to apply, a number that,…

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15 An earlier (1996) proposal by Jon Postel would have charged only $10,000 to successful registry applicants, yet led to the protests about “taxation” that sparked the first alternate root movement. ICANN was proposing to make organizations pay five to twenty times as much just to be considered.
by its own admission, exceeded ICANN’s expectations.\textsuperscript{16} Applicants included major commercial registrars such as Register.com, research organizations such as Sarnoff Laboratories, and the World Health Organization. In November 2000, ICANN finally authorized only seven new top-level domains. Only three of the new ones (.biz, .info, and .name) were targeted at larger commercial markets. The rest were restricted domains targeted at specific communities, such as museums, cooperatives, and the airline industry. The successful bidders, moreover, were almost all closely tied to ICANN or the Internet Society.\textsuperscript{17} Thus, not only was the number of new TLDs small, but the awards went to a very limited group of market participants, to the exclusion of many viable new entrants.

- \textit{There is persuasive evidence of suppressed consumer demand.} Tens of thousands of end users have been willing to register names in New.net’s alternate root, despite the limited compatibility of its identifiers. Over a million registrations of experimental multilingual domain names are estimated to be in place.\textsuperscript{18} Over a million new registrations are claimed to have been received in .biz and .info, the two relatively open TLDs authorized by ICANN.\textsuperscript{19} It is true that the market for .com, .net, and .org domain names has stagnated with the Internet recession of 2000–2001, and that many speculative registrations are not being renewed. However, the secular growth trend in Internet adoption and use around the world continues, and as it does domain name registrations in country codes continues to grow. Also, the secondary market in expiring, desirable .com names has heated up considerably, leading to the creation of auctions for the names. It is only logical that a wider variety of top-level domain names would be more likely to conform to consumer preferences.

\textsuperscript{16} Author interview with Andrew McLauglin, Chief Policy Officer, ICANN, May 2001.
\textsuperscript{17} Network Solutions, which already controlled .com, .org and .net, and Register.com, the second-largest registrar after Network Solutions, formed a consortium called Afilias with several other registrars to successfully bid for .info. Register.com also received the TLD .pro, CORE, a group of registrars that played a major political role in supporting and creating ICANN, received the contract for operating the .museum TLD and was also a member of the Afilias group.
\textsuperscript{18} Report of the Internationalized Domain Names Internal Working Group of the ICANN Board of Directors. August 28, 2001. http://www.icann.org/committees/idn/final-report-28aug01.htm.
\textsuperscript{19} Afilias Corp. news release, Feb 18 2002. http://www.nic.info/news/press_releases/pr_articles/2002-02-18-01, claiming 750,000 domain name registrations under .info. Neulevel news release, claiming 500,000 domain name registrations under .biz, Dec. 13, 2001 Press release http://www.neulevel.biz/press/index.html.
As noted earlier, the problem of competing DNS roots is not just about economic competition but also about competing sources of authority over the Internet. The basic issue they raise is: Should the direction of the domain name market be driven by technology and the market, or by quasi-governmental collective action such as ICANN?

Why does ICANN insist on maintaining artificial scarcity? The reason is rooted in the political constraints imposed on ICANN. As a corporatist “industry self-regulatory” body, ICANN represents a coalition of the Internet technical community, the intellectual property interests, incumbent registries, and a few major telecommunication and e-commerce firms. Few of these groups have anything to gain from expanding the supply of domain names; many have a direct economic or political interest in preventing it. More fundamentally, tight regulation of access to the root provides the leverage for the imposition of regulatory policy on the domain name industry. If ICANN were truly a “technical coordinator”, as claimed by Ira Magaziner and the US Department of Commerce when it was created, it would passively accept and coordinate applications for new TLDs rather than actively restricting access to the root and regulating the services and characteristics of registries. Such a “thin ICANN” would be unable to impose on the DNS industry the kinds of trademark and market structure regulations that certain interests want. Nor would it provide the established technical hierarchy – the Jesuits of the Internet-Catholic faction – the degree of power over the Internet’s technical evolution that they desire.

Thus the administration of the domain name system suffers from an inherent tension between the demands of the market place, where there are willing buyers and sellers of new top-level domains eager to enter the market, and the demands of various interest groups for regulation and restriction of the market. The conflict between these two forms of organization explains the invocation of Schumpeter in the title. Schumpeter refers to a “process of industrial mutation” that “incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in” (1975, p. 83). Market forces may destroy one form of ordered compatibility in order to create a new form of organization with a broader scope and more responsiveness to demand and supply potentialities. There is no question that a successful alternate root would be “destructive” of the apparatus of domain name industry regulation created by ICANN. Such destruction could also be creative, in that it
would permit the market for names and indeed the Internet itself to evolve in new directions.

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