

# EXHIBIT 1014

Network Working Group  
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## DOMAIN NAMES - CONCEPTS AND FACILITIES

### 1. STATUS OF THIS MEMO

This RFC is an introduction to the Domain Name System (DNS), and omits many details which can be found in a companion RFC, "Domain Names - Implementation and Specification" [RFC-1035]. That RFC assumes that the reader is familiar with the concepts discussed in this memo.

A subset of DNS functions and data types constitute an official protocol. The official protocol includes standard queries and their responses and most of the Internet class data formats (e.g., host addresses).

However, the domain system is intentionally extensible. Researchers are continuously proposing, implementing and experimenting with new data types, query types, classes, functions, etc. Thus while the components of the official protocol are expected to stay essentially unchanged and operate as a production service, experimental behavior should always be expected in extensions beyond the official protocol. Experimental or obsolete features are clearly marked in these RFCs, and such information should be used with caution.

The reader is especially cautioned not to depend on the values which appear in examples to be current or complete, since their purpose is primarily pedagogical. Distribution of this memo is unlimited.

### 2. INTRODUCTION

This RFC introduces domain style names, their use for Internet mail and host address support, and the protocols and servers used to implement domain name facilities.

#### 2.1. The history of domain names

The impetus for the development of the domain system was growth in the Internet:

- Host name to address mappings were maintained by the Network Information Center (NIC) in a single file (HOSTS.TXT) which was FTPed by all hosts [RFC-952, RFC-953]. The total network

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bandwidth consumed in distributing a new version by this scheme is proportional to the square of the number of hosts in the network, and even when multiple levels of FTP are used, the outgoing FTP load on the NIC host is considerable. Explosive growth in the number of hosts didn't bode well for the future.

- The network population was also changing in character. The timeshared hosts that made up the original ARPANET were being replaced with local networks of workstations. Local organizations were administering their own names and addresses, but had to wait for the NIC to change HOSTS.TXT to make changes visible to the Internet at large. Organizations also wanted some local structure on the name space.
- The applications on the Internet were getting more sophisticated and creating a need for general purpose name service.

The result was several ideas about name spaces and their management [IEN-116, RFC-799, RFC-819, RFC-830]. The proposals varied, but a common thread was the idea of a hierarchical name space, with the hierarchy roughly corresponding to organizational structure, and names using "." as the character to mark the boundary between hierarchy levels. A design using a distributed database and generalized resources was described in [RFC-882, RFC-883]. Based on experience with several implementations, the system evolved into the scheme described in this memo.

The terms "domain" or "domain name" are used in many contexts beyond the DNS described here. Very often, the term domain name is used to refer to a name with structure indicated by dots, but no relation to the DNS. This is particularly true in mail addressing [Quarterman 86].

## 2.2. DNS design goals

The design goals of the DNS influence its structure. They are:

- The primary goal is a consistent name space which will be used for referring to resources. In order to avoid the problems caused by ad hoc encodings, names should not be required to contain network identifiers, addresses, routes, or similar information as part of the name.
- The sheer size of the database and frequency of updates suggest that it must be maintained in a distributed manner, with local caching to improve performance. Approaches that

attempt to collect a consistent copy of the entire database will become more and more expensive and difficult, and hence should be avoided. The same principle holds for the structure of the name space, and in particular mechanisms for creating and deleting names; these should also be distributed.

- Where there tradeoffs between the cost of acquiring data, the speed of updates, and the accuracy of caches, the source of the data should control the tradeoff.
- The costs of implementing such a facility dictate that it be generally useful, and not restricted to a single application. We should be able to use names to retrieve host addresses, mailbox data, and other as yet undetermined information. All data associated with a name is tagged with a type, and queries can be limited to a single type.
- Because we want the name space to be useful in dissimilar networks and applications, we provide the ability to use the same name space with different protocol families or management. For example, host address formats differ between protocols, though all protocols have the notion of address. The DNS tags all data with a class as well as the type, so that we can allow parallel use of different formats for data of type address.
- We want name server transactions to be independent of the communications system that carries them. Some systems may wish to use datagrams for queries and responses, and only establish virtual circuits for transactions that need the reliability (e.g., database updates, long transactions); other systems will use virtual circuits exclusively.
- The system should be useful across a wide spectrum of host capabilities. Both personal computers and large timeshared hosts should be able to use the system, though perhaps in different ways.

### 2.3. Assumptions about usage

The organization of the domain system derives from some assumptions about the needs and usage patterns of its user community and is designed to avoid many of the the complicated problems found in general purpose database systems.

The assumptions are:

- The size of the total database will initially be proportional

to the number of hosts using the system, but will eventually grow to be proportional to the number of users on those hosts as mailboxes and other information are added to the domain system.

- Most of the data in the system will change very slowly (e.g., mailbox bindings, host addresses), but that the system should be able to deal with subsets that change more rapidly (on the order of seconds or minutes).
- The administrative boundaries used to distribute responsibility for the database will usually correspond to organizations that have one or more hosts. Each organization that has responsibility for a particular set of domains will provide redundant name servers, either on the organization's own hosts or other hosts that the organization arranges to use.
- Clients of the domain system should be able to identify trusted name servers they prefer to use before accepting referrals to name servers outside of this "trusted" set.
- Access to information is more critical than instantaneous updates or guarantees of consistency. Hence the update process allows updates to percolate out through the users of the domain system rather than guaranteeing that all copies are simultaneously updated. When updates are unavailable due to network or host failure, the usual course is to believe old information while continuing efforts to update it. The general model is that copies are distributed with timeouts for refreshing. The distributor sets the timeout value and the recipient of the distribution is responsible for performing the refresh. In special situations, very short intervals can be specified, or the owner can prohibit copies.
- In any system that has a distributed database, a particular name server may be presented with a query that can only be answered by some other server. The two general approaches to dealing with this problem are "recursive", in which the first server pursues the query for the client at another server, and "iterative", in which the server refers the client to another server and lets the client pursue the query. Both approaches have advantages and disadvantages, but the iterative approach is preferred for the datagram style of access. The domain system requires implementation of the iterative approach, but allows the recursive approach as an option.

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