Name Server Operations Guide for BIND

Release 4.9.5

Releases from 4.9

Paul Vixie[1]

<paul@vix.com>

Internet Software Consortium

La Honda, CA

Releases through 4.8.3

Kevin J. Dunlap[2]

Michael J. Karels

Computer Systems Research Group

Computer Science Division

Department of Electrical Engineering and Computer Sciences

University of California

Berkeley, CA 94720

1. Introduction

The Berkeley Internet Name Domain (BIND) implements an Internet name server for BSD-derived operating systems. The BIND consists of a server (or ''daemon'') called *named* and a *resolver* library. A name server is a network service that enables clients to name resources or objects and share this information with other objects in the network. This in effect is a distributed data base system for objects in a computer network. The BIND server runs in the background, servicing queries on a well known network port. The standard port for UDP and TCP is specified in */etc/services*. The *resolver* is a set of routines residing in a system library that provides the interface that programs can use to access the domain name services.

BIND is fully integrated into BSD (4.3 and later releases) network programs for use in storing and retrieving host names and address. The system administrator can configure the system to use BIND

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as a replacement to the older host table lookup of information in the network hosts file */etc/hosts*. The default configuration for BSD uses BIND.

2. The Name Service

The basic function of the name server is to provide information about network objects by answering queries. The specifications for this name server are defined in RFC1034, RFC1035 and RFC974. These documents can be found in */usr/src/etc/named/doc* in 4.3BSD or *ftp*ed from **ftp.rs.internic.net**. It is also recommended that you read the related manual pages, *named* (8), *resolver* (3), and *resolver* (5).

The advantage of using a name server over the host table lookup for host name resolution is to avoid the need for a single centralized clearinghouse for all names. The authority for this information can be delegated to the different organizations on the network responsible for it.

The host table lookup routines require that the master file for the entire network be maintained at a central location by a few people. This works fine for small networks where there are only a few machines and the different organizations responsible for them cooperate. But this does not work well for large networks where machines cross organizational boundaries.

With the name server, the network can be broken into a hierarchy of domains. The name space is organized as a tree according to organizational or administrative boundaries. Each node, called a *domain*, is given a label, and the name of the domain is the concatenation of all the labels of the domains from the root to the current domain, listed from right to left separated by dots. A label need only be unique within its domain. The whole space is partitioned into several areas called *zones*, each starting at a domain and extending down to the leaf domains or to domains where other zones start. Zones usually represent administrative boundaries. An example of a host address for a host at the University of California, Berkeley would look as follows:

monet **.** *Berkeley* **.** *EDU*

The top level domain for educational organizations is EDU; Berkeley is a subdomain of EDU and monet is the name of the host.

3. Security

This section examines some of the know security implications of various versions of BIND. Some of these have been used to attack the nameservers in the past.

3.1. Unnecessary Glue

Unnecessary glue can lead to incorrect records being loaded into the server. This can result in connections going to the wrong machines.

To prevent unnecessary glue being loaded, all the servers of zones being servered by a server and the servers of the parent zones need to be upgraded to BIND 4.9.3 or later.

3.2. Insertion of data into a zone that is being servered

BIND versions prior to BIND 4.9.2 are subject to the insertion of resource records into zone that they are serving.

3.3. Denial of Service: Hash Bug Exploit

September 1996 saw the COM TLD subject to a denial of service attack by injecting into the DNS a record with a final label of COM, eight spaces and COM. This effected BIND 4.9.4 servers. Similar attacks are possible on BIND 4.9.3 and BIND 4.9.3-P1.

It is recommend that you run a BIND 4.9.4-P1 or later server to avoid this exploit.

3.4. Denial of Service: TTL Inconsistency Attacks

If you are still using multiple TTL values within a RRset you can be subject to a denial of service attack. BIND 4.9.5 onwards uses multiple ttl values within a RRset to reject obviously bad RRset.

It is recommend that you upgrade to BIND 4.9.5 or later as these server prevent you loading multiple TTL values and doesn't merge answers received across the network.

4. Types of Zones

A ‘‘zone’’ is a point of delegation in the DNS tree. It contains all names from a certain point ‘‘downward’’ except those which are delegated to other zones. A ‘‘delegation point’’ has one or more *NS* records in the ‘‘parent zone’’, which should be matched by equivalent *NS* records at the root of the ‘‘delegated zone’’ (i.e., the ‘‘@’’ name in the zone file).

Understanding the difference between a ‘‘zone’’ and a ‘‘domain’’ is crucial to the proper operation of a name server. As an example, consider the DEC.COM *domain*, which includes names such as POBOX1.PA.DEC.COM and QUABBIN.CRL.DEC.COM even though the DEC.COM *zone* includes only *delegations* for the PA.DEC.COM and CRL.DEC.COM zones. A zone can map exactly to a single domain, but could also include only part of a domain (the rest of which could be delegated to other name servers). Technically speaking, every name in the DNS tree is a ‘‘domain’’, even if it is ‘‘terminal’’, that is, has no ‘‘subdomains’’. Technically speaking, every subdomain is a domain and every domain except the root is also a subdomain. The terminology is not intuitive and you would do well to read RFC's 1033, 1034, and 1035 to gain a complete understanding of this difficult and subtle topic.

Though BIND is a *Domain* Name Server, it deals primarily in terms of *zones*. The *primary* and *secondary* declarations in the *named.boot* file specify *zones*, not *domains*. When you ask someone if they are willing to be a secondary server for your ‘‘domain’’, you are actually asking for secondary service for some collection of *zones*.

Each zone will have one ‘‘primary’’ server, which loads the zone contents from some local file which is edited by humans or perhaps generated mechanically from some other local file which is edited by humans. Then there will be some number of ‘‘secondary’’ servers, which load the zone contents using the IP/DNS protocol (that is, the secondary servers will contact the primary and fetch the zone using IP/TCP). This set of servers (the primary and all of the secondaries) should be listed in the *NS* records in the parent zone, which will constitute a ‘‘delegation’’. This set of servers must also be listed in the zone file itself, usually under the ‘‘@’’ name which is a magic cookie that means the ‘‘top level’’ or ‘‘root’’ of current zone. You can list servers in the zone's top-level ‘‘@’’ *NS* records that are not in the parent's *NS* delegation, but you cannot list servers in the parent's delegation that are not present in the zone's ‘‘@’’. Any servers listed in the *NS* records must be configured as authoritative (either primary or secondary) for the zone. If a server listed in a *NS* record is not authoritative, it will respond with a ‘‘lame delegation’’ when queried.

5. Types of Servers

Servers do not really have ‘‘types’’. A server can be a primary for some zones and a secondary for others, or it can be only a primary, or only a secondary, or it can serve no zones and just answer queries via its ‘‘cache’’. Previous versions of this document referred to servers as ‘‘master’’ and ‘‘slave’’ but we now feel that those distinctions — and the assignment of a ‘‘type’’ to a name server — are not useful.

5.1. Caching Only Server

All servers are caching servers. This means that the server caches the information that it receives for use until the data expires. A *Caching Only Server* is a server that is not authoritative for any zone. This server services queries and asks other servers, who have the authority, for the information needed. All servers keep data in their cache until the data expires, based on a *TTL* (“Time To Live”) field which is maintained for all resource records.

5.2. Remote Server

A Remote Server is an option given to people who would like to use a name server from their workstation or on a machine that has a limited amount of memory and CPU cycles. With this option you can run all of the networking programs that use the name server without the name server running on the local machine. All of the queries are serviced by a name server that is running on another machine on the network. A host which has an */etc/resolv.conf* file listing only remote hosts, and which does not run a name server of its own, is sometimes called a Remote Server (because the actual server is remote?) but more often it is called simply a DNS Client. This kind of host is technically not a “server”, since it has no cache and does not answer queries.

5.3. Slave Server

A Slave Server is a server that always forwards queries it cannot satisfy from its cache, to a fixed list of *forwarding* servers instead of interacting with the name servers for the root and other domains. The queries to the *forwarding servers* are recursive queries. There may be one or more forwarding servers, and they are tried in turn until the list is exhausted. A Slave and forwarder configuration is typically used when you do not wish all the servers at a given site to interact with the rest of the Internet servers. A typical scenario would involve a number of workstations and a departmental timesharing machine with Internet access. The workstations might be administratively prohibited from having Internet access. To give the workstations the appearance of access to the Internet domain system, the workstations could be Slave servers to the timesharing machine which would forward the queries and interact with other name servers to resolve the query before returning the answer. An added benefit of using the forwarding feature is that the central machine develops a much more complete cache of information that all the workstations can take advantage of. The use of Slave mode and forwarding is discussed further under the description of the *named* bootfile commands.

There is no prohibition against declaring a server to be a *slave* even though it has *primary* and/or *secondary* zones as well; the effect will still be that anything in the local server’s cache or zones will be answered, and anything else will be forwarded using the *forwarders* list.

6. Files

The name server uses several files to load its data base. This section covers the files and their formats needed for *named*.

6.1. Boot File

This is the file that is first read when *named* starts up. This tells the server what type of server it is, which zones it has authority over and where to get its initial data. The default location for this file is */etc/named.boot*. However this can be changed by setting the *BOOTFILE* variable when you compile *named* or by specifying the location on the command line when *named* is started up.

6.1.1. Domain

A default domain may be specified for the name server using a line such as

domain Berkeley.Edu

Older name servers use this information when they receive a query for a name without a “**.**” that is not known. Newer designs assume that the resolver library will append its own idea of a “default domain” to any unqualified names. Though the name server can still be compiled with support for the *domain* directive in the boot file, the default is to leave it out and we strenuously recommend against its use. If you use this feature, clients outside your local domain which send you requests about unqualified names will have the implicit qualification of your domain rather than theirs. The proper place for this function is on the client, in their **/etc/resolv.conf** (or equivalent) file. Use of the *domain* directive in your boot file is strongly discouraged.

6.1.2. Directory

The *directory* directive specifies the directory in which the name server should run, allowing the other file names in the boot file to use relative path names. There can be only one *directory* directive and it should be given before any other directives that specify file names.

```
directory          /var/named
```

If you have more than a couple of named files to be maintained, you may wish to place the named files in a directory such as /var/named and adjust the directory command properly. The main purposes of this command are to make sure named is in the proper directory when trying to include files by relative path names with $INCLUDE and to allow named to run in a location that is reasonable to dump core if it feels the urge.

6.1.3. Primary Service

The line in the boot file that designates the server as a primary master server for a zone looks as follows:

```
primary            Berkeley.Edu ucbhosts
```

The first field specifies that the server is a primary one for the zone stated in the second field. The third field is the name of the file from which the data is read.

The above assumes that the zone you are specifying is a class *IN* zone. If you wish to designate a different class you can append */class* to the first field, where *class* is either the integer value or the standard mnemonic for the class. For example the line for a primary server for a hesiod class zone looks as follows:

```
primary/HS      Berkeley.Edu    hesiod.data
```

Note that this support for specifying other than class *IN* zones is a compile-time option which your vendor may not have enabled when they built your operating system.

6.1.4. Secondary Service

The line for a secondary server is similar to the primary except that it lists addresses of other servers (usually primary servers) from which the zone data will be obtained.

```
secondary          Berkeley.Edu 128.32.0.10  128.32.0.4 ucbhosts.bak
```

The first field specifies that the server is a secondary server for the zone stated in the second field. The two network addresses specify the name servers which have data for the zone. Note that at least one of these will be a *primary*, and, unless you are using some protocol other than IP/DNS for your zone transfer mechanism, the others will all be other *secondary* servers. Having your secondary server pull data from other secondary servers is usually unwise, since you can add delay to the propagation of zone updates if your network's connectivity varies in pathological but common ways. The intended use for multiple addresses on a *secondary* declaration is when the *primary* server has multiple network interfaces and therefore multiple host addresses. The secondary server gets its data across the network from one of the listed servers. The server addresses are tried in the order listed. If a filename is present after the list of primary servers, data for the zone will be dumped into that file as a backup. When the server is first started, the data is loaded from the backup file if possible, and a primary server is then consulted to check that the zone is still up-to-date. Note that listing your server as a *secondary* server does not necessarily make it one — the parent zone must *delegate* authority to your server as well as the primary and the other secondaries, or you will be transferring a zone over for no reason; no other server will have a reason to query you for that zone unless the parent zone lists you as a server for the zone.

As with primary you may specify a secondary server for a class other than *IN* by appending */class* to the *secondary* keyword, e.g., *secondary/HS*.

6.1.5. Stub Service

The line for a stub server is similar to a secondary. (This feature is experimental as of 4.9.3.)

stub Berkeley.Edu 128.32.0.10 128.32.0.4 ucbhosts.bak

The first field specifies that the server is a stub server for the zone stated in the second field.

Stub zones are intended to ensure that a primary for a zone always has the correct *NS* records for children of that zone. If the primary is not a secondary for a child zone it should be configured with stub zones for all its children. Stub zones provide a mechanism to allow *NS* records for a zone to be specified in only one place.

```
primary CSIRO.AU          csiro.dat
stub    dms.CSIRO.AU      130.155.16.1  dms.stub
stub    dap.CSIRO.AU      130.155.98.1  dap.stub
```

6.1.6. Cache Initialization

All servers, including ‘‘caching only’’ servers, should have a line as follows in the boot file to prime the name servers cache:

cache . root.cache

Do not put anything into your *cache* files other than root server information.

All cache files listed will be read in at named boot time and any values still valid will be reinstated in the cache. The root name server information in the cache files will be used until a root query is actually answered by one of the name servers in the cache file, after which that answer will be used instead of the cache file until the answer times out.

As with *primary* and *secondary*, you may specify a secondary server for a class other than *IN* by appending */class* to the *cache* keyword, e.g., *class/HS*.

6.1.7. Forwarders

Any server can make use of *forwarders*. A *forwarder* is another server capable of processing recursive queries that is willing to try resolving queries on behalf of other systems. The *forwarders* command specifies forwarders by internet address as follows:

forwarders 128.32.0.10 128.32.0.4

There are two main reasons for wanting to do so. First, some systems may not have full network access and may be prevented from sending any IP packets into the rest of the Internet and therefore must rely on a forwarder which does have access to the full net. The second reason is that the forwarder sees a union of all queries as they pass through its server and therefore it builds up a very rich cache of data compared to the cache in a typical workstation name server. In effect, the *forwarder* becomes a meta-cache that all hosts can benefit from, thereby reducing the total number of queries from that site to the rest of the net.

The effect of ‘‘forwarders’’ is to prepend some fixed addresses to the list of name servers to be tried for every query. Normally that list is made up only of higher-authority servers discovered via *NS* record lookups for the relevant domain. If the forwarders do not answer, then unless the *slave* directive was given, the appropriate servers for the domains will be queried directly.

6.1.8. Slave Servers

Slave mode is used if the use of forwarders is the only possible way to resolve queries due to lack of full net access or if you wish to prevent the name server from using other than the listed forwarders. Slave mode is activated by placing the simple command

options forward-only

in the bootfile. If this option is used, then you must specify forwarders. When in slave mode, the server will forward each query to each of the forwarders until an answer is found or the list of forwarders is exhausted. The server will not try to contact any remote name server other than those named in the *forwarders* list.

So while *forwarders* prepends addresses to the ‘‘server list’’ for each query, *options forward-only* causes the ‘‘server list’’ to contain *only* those addresses listed in the *forwarders* declarations. Careless use of the *options forward-only* directive can cause really horrible forwarding loops, since you could end up forwarding queries only to some set of hosts which are also slaves, and one or several of them could be forwarding queries back to you.

Use of the *options forward-only* directive should be considered very carefully. Note that this same behaviour can be achieved using the deprecated directive, *slave*.

6.1.9. Nonrecursive Servers

BIND’s separation of authoritative (zone) and nonauthoritiative (cache) data has always been somewhat weak, and pollution of the former via the latter has been known to occur. One way to prevent this, as well as to save memory on servers carrying a lot of authoritative data (e.g., root servers) is to make such servers ‘‘nonrecursive.’’ This can be achieved via the directive

options no-recursion

in the bootfile. A server with this option enabled will not attempt to fetch data to help answer queries — if you ask it for data it does not have, it will send you a referral to a more authoritative server or, if it is itself authoritative for the zone of the query, it will send you an negative answer.

A nonrecursive server can be named in an NS RR but it cannot be listed in the *resolv.conf* file.

6.1.10. Query Logging

If the file system containing your *syslog* file has quite a bit of space, you can consider using the

options query-log

directive in your bootfile. This will cause your name server to log every query it receives, which when combined with a Perl or AWK script to postprocess the logs, can be a useful management tool.

6.1.11. Inverse Query Pseudosupport

BIND by default does not support inverse queries, and this has been known to cause problems for certain microcomputer operating systems and for older versions of BIND’s *nslookup* tool. You may decide that rather than answering with ‘‘operation not implemented,’’ *named* should detect the most common inverse queries and answer them with bogus information. It is better to upgrade your clients to stop depending on inverse queries, but if that is not possible, you should use the

options fake-iquery

directive in your bootfile. *NOTE:* the responses are in fact bogus, in that they contain ISO8859 square brackets ([and]), so your clients will not be able to do anything useful with these responses. It has been observed that no client ever did anything useful with real inverse query responses, either.

6.1.12. Setting Name Server Limits

Some name server operations can be quite resource intensive, and in order to tune your system properly it is sometimes necessary to change BIND’s internal quotas. This is accomplished via

limit <name> <value>

directives in the bootfile. Limits, and their default values, are as follows:

limit transfers-in 10

This is the number of simultaneous *named-xfer* processes BIND is willing to start. Higher numbers yield faster convergence to primary servers if your secondary server has hundreds or thousands of zones to maintain, but setting this number too high can cause thrashing due to starvation of resources such as network bandwidth or swap space. *NOTE:* this limit can also be expressed via the deprecated directive *max-fetch NN*.

limit transfers-per-ns 2

This is the number of simultaneous *named-xfer* processes BIND is willing to initiate *to any given name server*. In most cases, you should not need to change it. If your secondary server is pulling hundreds or thousands of zones from a single primary server, increasing *transfers-per-ns* may speed convergence. It should be kept as small as possible, to avoid causing thrashing and resource starvation on the primary server.

limit datasize <system-dependent>

Most systems have a quota that limits the size of the so-called ‘‘data segment,’’ which is where BIND keeps all of its authority and cache data. BIND will behave suboptimally (perhaps even exiting) if it runs up against this quota. If your system supports a system call to change this quota for a given process, you can ask BIND to use that system call via the *limit datasize NN* directive. The value given here may be scaled by postfixing *k* for 1024X, *m* for (1024ˆ2)X, and *g* for (1024ˆ3)X. In 1995, the root servers all use *limit datasize 64m*.

6.1.13. Zone Transfer Restrictions

It may be the case that your organization does not wish to give complete lists of your hosts to anyone on the Internet who can reach your name servers. While it is still possible for people to ‘‘iterate’’ through your address range, looking for *PTR* records, and build a list of your hosts the ‘‘slow’’ way, it is still considered reasonable to restrict your export of zones via the zone transfer protocol. To limit the list of neighbors who can transfer zones from your server, use the *xfrnets* directive.

This directive has the same syntax as *forwarders* except that you can list network numbers in addition to host addresses. For example, you could add the directive *xfrnets 16.0.0.0*

if you wanted to permit only hosts on Class A network number 16 to transfer zones from your server. This is not nearly granular enough, and a future version of BIND will permit such access-control to be specified on a per-host basis rather than the current per-net basis. Note that while addresses without explicit masks are assumed by this directive to be networks, you can specify a mask which is as granular as you wish, perhaps including all bits of the address such that only a single host is given transfer permission. For example, consider

xfrnets 16.1.0.2&255.255.255.255

which would permit only host *16.1.0.2* to transfer zones from you. Note that no spaces are allowed surrounding the “*&*” character that introduces a netmask.

The *xfrnets* directive may also be given as *tcplist* for compatibility with interim releases of BIND 4.9.

6.1.14. Sorting Addresses

If there are multiple addresses available for a name server which BIND wants to contact, BIND will try the ones it believes are “closest” first. “Closeness” is defined in terms of similarity-of-address; that is, if one address is on the same *subnet* as some interface of the local host, then that address will be tried first. Failing that, an address which is on the same *network* will be tried first. Failing that, they will be tried in a more-or-less random order unless the *sortlist* directive was given in the *named.boot* file. *sortlist* has a syntax similar to *forwarders*, *xfrnets*, and *bogusns* — you give it a list of dotted-quad networks and it uses these to “prefer” some remote name server addresses over others. If no explicit mask is provided with each element of a *sortlist*, one will be inferred based on the high order address bits.

If you are on a Class C net which has a Class B net between you and the rest of the Internet, you could try to improve the name server’s luck in getting answers by listing the Class B network’s number in a *sortlist* directive. This should have the effect of trying “closer” servers before the more “distant” ones. Note that this behaviour is new as of BIND 4.9.

The other and older effect of the *sortlist* directive is to cause BIND to sort the *A* records in any response it generates, so as to put those which appear on the *sortlist* earlier than those which do not. This is not as helpful as you might think, since many clients will reorder the *A* records either at random or using LIFO; also, consider the fact that the server won’t be able to guess the client’s network topology, and so will not be able to accurately order for “closeness” to all possible clients. Doing the ordering in the resolver is clearly superior.

In actual practice, this directive is used only rarely since it hardwires information which changes rapidly; a network which is “close” today may be “distant” next month. Since BIND builds up a cache of the remote name servers’ response times, it will quickly converge on “reasonable” behaviour, which isn’t the same as “optimal” but it’s close enough. Future directions for BIND include choosing addresses based on local interface metrics (on hosts that have more than one) and perhaps on routing table information. We do not intend to solve the generalized “multihomed host” problem, but we should be able to do a little better than we’re doing now. Likewise, we hope to see a higher level resolver library that sorts responses using topology information that only exists on the client’s host.

6.1.15. Bogus Name Servers

It happens occasionally that some remote name server goes “bad”. You can tell your name server to refuse to listen to or ask questions of certain other name servers by listing them in a *bogusns* directive in your *named.boot* file. Its syntax is the same as *forwarders*, *xfrnets*, and *sortlist* — you just give it a list of dotted-quad Internet addresses. Note that zones delegated to such servers will not be reachable from clients of your servers; thus you should use this directive sparingly or not at all.

6.1.16. Segmented Boot Files

If you are secondary for a lot of zones, you may find it convenient to split your *named.boot* file into a static portion which hardly ever changes (directives such as *directory*, *sortlist*, *xfrnets* and *cache* could go here), and dynamic portions that change frequently (all of your *primary* directives might go in one file, and all of your *secondary* directives might go in another file — and either or both of these might be fetched automatically from some neighbor so that they can change your list of secondary zones without requiring your active intervention). You can accomplish this via the *include* directive, which takes just a single file name as its argument. No quotes are needed around the file name. The file name will be evaluated after the name server has changed its working directory to that specified in the *directory* directive, so you can use relative pathnames if your system supports them.

6.2. Resolver Configuration

The configuration file's name is */etc/resolv.conf*. This file designates the name servers on the network that should be sent queries. The resolver will try to contact a name server on the localhost if it cannot find its configuration file. You should install the configuration file on every host anyway, since this is the only recommended way to specify a system-level default domain, and you can still list the local host's address if it runs a name server. It is considered reasonable to create this file even if you run a local server, since its contents will be cached by each client of the resolver library when the client makes its first call to a resolver routine.

The *resolv.conf* file contains directives, one per line, of the following forms:

; comment
another comment
domain *local-domain*
search *search-list*
nameserver *server-address*
sortlist *sort-list*
options *option-list*

Exactly one of the *domain* or *search* directives should be given, exactly once. If the *search* directive is given, the first item in the given *search-list* will override any previously-specified *local-domain*. The *nameserver* directive may be given up to three times; additional *nameserver* directives will be ignored. Comments may be given by starting a line with a "`;`" or "`#`"; note that comments were not permitted in versions of the resolver earlier than the one included with BIND 4.9 — so if your vendor's resolver supports comments, you know they are really on the ball.

The *local-domain* will be appended to any query-name that does not contain a "`.`". *local-domain* can be overridden on a per-process basis by setting the LOCALDOMAIN environment variable. Note that *local-domain* processing can be disabled by setting an option in the resolver.

The *search-list* is a list of domains which are tried, in order, as qualifying domains for query-names which do not contain a "`.`". Note that *search-list* processing can be disabled by setting an option in the resolver. Also note that the environment variable "LOCALDOMAIN" can override this *search-list* on a per-process basis.

The *server-address*'s are aggregated and then used as the default destination of queries generated through the resolver. In other words, this is the way you tell the resolver which name servers it should use. It is possible for a given client application to override this list, and this is often done inside the name server (which is itself a *resolver* client) and in test programs such as *nslookup*.

Note that if you wish to list the local host in your resolver configuration file, you should probably use its primary Internet address rather than a local-host alias such as 127.0.0.1 or 0.0.0.0. This is due to a bug in the handling of connected SOCK_DGRAM sockets in some versions of the BSD networking code. If you must use an address-alias, you should prefer 0.0.0.0 (or simply "0") over 127.0.0.1, though be warned that depending on the vintage of your BSD-derived networking code, both of them are capable of failing in their own ways. If your host's IP implementation does not create a short-circuit route between the default interface and the loopback interface, then you might also want to add a static route (eg. in **/etc/rc.local**) to do so:

route add myhost.domain.name localhost 1

The *sort-list* is a list of IP address, netmask pairs. Addresses returned by gethostbyname are sorted to the order specified by this list. Any addresses that do not match the address netmask pair will be returned after those that do. The netmask is optional and the natural netmask will be used if not specified.

The *option-list* is a list of options which each override some internal resolver variable. Supported options at this time are:

debug
sets the RES_DEBUG bit in **_res.options**.

ndots:*n*
sets the lower threshold (measured in "number of dots") on names given to *res_query*() such that names with more than this number of dots will be tried as absolute names before any *local-domain* or *search-list* processing is done. The default for this internal variable is "1".

6.3. Cache Initialization File

6.3.1. root.cache

The name server needs to know the servers that are the authoritative name servers for the root domain of the network. To do this we have to prime the name server's cache with the addresses of these higher authorities. The location of this file is specified in the boot file. This file uses the Standard Resource Record Format (aka. Masterfile Format) covered further on in this paper.

6.4. Domain Data Files

There are two standard files for specifying the data for a domain. These are *hosts* and *host.rev*. These files use the Standard Resource Record Format covered later in this paper. Note that the file names are arbitrary; many network administrators prefer to name their zone files after the domains they contain, especially in the average case which is where a given server is primary and/or secondary for many different zones.

6.4.1. hosts

This file contains all the data about the machines in this zone. The location of this file is specified in the boot file.

6.4.2. hosts.rev

This file specifies the IN-ADDR . ARPA domain. This is a special domain for allowing address to name mapping. As internet host addresses do not fall within domain boundaries, this special domain was formed to allow inverse mapping. The IN-ADDR . ARPA domain has four labels preceding it. These labels correspond to the 4 octets of an Internet address. All four octets must be specified even if an octet contains zero. The Internet address 128.32.0.4 is located in the domain 4 . 0 . 32 . 128 . IN-ADDR . ARPA. This reversal of the address is awkward to read but allows for the natural grouping of hosts in a network.

6.4.3. named.local

This file specifies the *PTR* record for the local loopback interface, better known as *localhost*, whose network address is 127.0.0.1. The location of this file is specified in the boot file. It is vitally important to the proper operation of every name server that the 127.0.0.1 address have a *PTR* record pointing back to the name "**localhost.**". The name of this *PTR* record is always "**1.0.0.127.IN-ADDR.ARPA**". This is necessary if you want your users to be able to use hostname-authentication (*hosts.equiv* or *~/.rhosts*) on the name "**localhost**". As implied by this *PTR* record, there should be a "**localhost.***my.dom.ain*" *A* record (with address 127.0.0.1) in every domain that contains hosts. "**localhost.**" will lose its trailing dot when **1.0.0.127.in-addr.arpa** is queried for; then, the DEFNAMES and/or DNSRCH resolver options will cause "**localhost**" to be evaluated as a host name in the local domain, and that means the top domains (or ideally, every domain) in your resolver's search path had better have something by that name.

6.5. Standard Resource Record Format

The records in the name server data files are called resource records. The Standard Resource Record Format (RR) is specified in RFC1035. The following is a general description of these records:

{name} {ttl} addr-class Record Type Record Specific data

Resource records have a standard format shown above. The first field is always the name of the domain record and it must always start in column 1. For all RR's other than the first in a file, the name may be left blank; in that case it takes on the name of the previous RR. The second field is an optional time to live field. This specifies how long this data will be stored in the data base. By leaving this field blank the default time to live is specified in the *Start Of Authority* resource record (see below). The third field is the address class; currently, only one class is supported: *IN* for internet addresses and other internet information. Limited support is included for the *HS* class, which is for MIT/Athena "Hesiod" information. The fourth field states the type of the resource record. The fields after that are dependent on the type of the RR. Case is preserved in names and data fields when loaded into the name server. All comparisons and lookups in the name server data base are case insensitive.

The following characters have special meanings:

"**.**" A free standing dot in the name field refers to the root domain.

"@" A free standing @ in the name field denotes the current origin.

"\X" Where X is any character other than a digit (0-9), quotes that character so that its special meaning does not apply. For example, "\." can be used to place a dot character in a label.

"\DDD"
Where each D is a digit, is the octet corresponding to the decimal number described by DDD. The resulting octet is assumed to be text and is not checked for special meaning.

"( )" Parentheses are used to group data that crosses a line. In effect, line terminations are not recognized within parentheses. (At present, this notation only works for SOA RR's and is not optional.)

";" Semicolon starts a comment; the remainder of the line is ignored. Note that a completely blank line is also considered a comment, and ignored.

"*" An asterisk signifies wildcarding. Note that this is just another data character whose special meaning comes about only during internal name server search operations. Wildcarding is only meaningful for some RR types (notably *MX*), and then only in the name field — not in the data fields.

Anywhere a name appears — either in the name field or in some data field defined to contain names — the current origin will be appended if the name does not end in a "**.**". This is useful for appending the current domain name to the data, such as machine names, but may cause problems where you do not want this to happen. A good rule of thumb is that, if the name is not in the domain for which you are creating the data file, end the name with a "**.**".

6.5.1. $INCLUDE

An include line begins with $INCLUDE, starting in column 1, and is followed by a file name, and, optionally, by a new temporary $ORIGIN to be used while reading this file. This feature is particularly useful for separating different types of data into multiple files. An example would be:

$INCLUDE /usr/local/adm/named/data/mail-exchanges

The line would be interpreted as a request to load the file */usr/local/adm/named/data/mail-exchanges*. The $INCLUDE command does not cause data to be loaded into a different zone or tree. This is simply a way to allow data for a given primary zone to be organized in separate files. Not even the "temporary $ORIGIN" feature described above is sufficient to cause your data to branch out into some other zone — zone boundaries can only be introduced in the boot file.

A $INCLUDE file must have a name on its first RR. That is, the first character of the first non-comment line must not be a space. The current default name in the parent file *does not* carry into the $INCLUDE file.

6.5.2. $ORIGIN

The origin is a way of changing the origin in a data file. The line starts in column 1, and is followed by a domain origin. This seems like it could be useful for putting more then one zone into a data file, but that's not how it works. The name server fundamentally requires a given zone to map entirely to some specific file. You should therefore be very careful to use $ORIGIN only once at the top of a file, or, within a file, to change to a "lower" domain in the zone — never to some other zone altogether.

6.5.3. SOA - Start Of Authority

name	*{ttl}*	*addr-class*	*SOA*	*Origin*	*Person in charge*
@		IN	SOA	ucbvax**.**Berkeley**.**Edu**.**	kjd**.**ucbvax**.**Berkeley**.**Edu**.** (
			1995122103	; Serial	
			10800	; Refresh	
			1800	; Retry	
			3600000	; Expire	
			259200)	; Minimum	

The *Start of Authority, SOA,* record designates the start of a zone. The name is the name of the zone and is often given as "@" since this is always the current $ORIGIN and the SOA RR is usually the first record of the primary zone file. Origin is the name of the host on which this data file resides (in other words, the *primary master* server for this zone.) Person in charge is the e-mail address for the person responsible for the name server, with "@" changed to a "**.**". The serial number is the version number of this data file and must be a positive integer. This number must be incremented whenever a change is made to the data. Older servers permitted the use of a phantom ‘‘.’’ in this and other numbers in a zone file; the meaning of n.m was ‘‘n000m’’ rather than the more intuitive ‘‘n*1000+m’’ (such that 1.234 translated to 1000234 rather than to 1234). This feature has been deprecated due to its obscurity, unpredictability, and lack of necessity. Note that using a ‘‘YYYYMMDDNN’’ notation you can still make 100 changes per day until the year 4294. You should choose a notation that works for you. If you’re a clever *perl* programmer you could even use *RCS* version numbers to help generate your zone serial numbers. The refresh indicates how often, in seconds, the secondary name servers are to check with the primary name server to see if an update is needed. The retry indicates how long, in seconds, a secondary server should wait before retrying a failed zone transfer. Expire is the upper limit, in seconds, that a secondary name server is to use the data before it expires for lack of getting a refresh. Minimum is the default number of seconds to be used for the Time To Live field on resource records which do not specify one in the zone file. It is also an enforced minimum on Time To Live if it is specified on some resource record (RR) in the zone. There must be exactly one *SOA* record per zone.

6.5.4. NS - Name Server

{name}	*{ttl}*	*addr-class*	*NS*	*Name servers name*
		IN	NS	ucbarpa.Berkeley.Edu.

The *Name Server* record, *NS*, lists a name server responsible for a given domain, creating a *delegation point* and a *subzone*. The first name field specifies the zone that is serviced by the name server specified by the second name. Every zone needs at least two name servers.

6.5.5. A - Address

{name}	*{ttl}*	*addr-class*	*A*	*address*
ucbarpa		IN	A	128.32.0.4
		IN	A	10.0.0.78

The *Address* record, *A*, lists the address for a given machine. The name field is the machine name and the address is the network address. There should be one *A* record for each address of the machine.

6.5.6. HINFO - Host Information

{name}	*{ttl}*	*addr-class*	*HINFO*	*Hardware*	*OS*
		IN	HINFO	VAX-11/780	UNIX

Host Information resource record, *HINFO*, is for host specific data. This lists the hardware and operating system that are running at the listed host. If you want to include a space in the machine name you must quote the name (using “"” characters.) There could be one *HINFO* record for each host, though for security reasons most domains don’t have any *HINFO* records at all. No application depends on them.

6.5.7. WKS - Well Known Services

```
{name}  {ttl}  addr-class  WKS  address       protocol  list of services
               IN          WKS  128.32.0.10   UDP       who route timed domain
               IN          WKS  128.32.0.10   TCP       ( echo telnet
                                                        discard sunrpc sftp
                                                        uucp-path systat daytime
                                                        netstat qotd nntp
                                                        link chargen ftp
                                                        auth time whois mtp
                                                        pop rje finger smtp
                                                        supdup hostnames
                                                        domain
                                                        nameserver )
```

The *Well Known Services* record, *WKS*, describes the well known services supported by a particular protocol at a specified address. The list of services and port numbers come from the list of services specified in */etc/services.* There should be only one *WKS* record per protocol per address. Note that RFC1123 says of *WKS* records:

```
2.2  Using Domain Name Service
...
  An application SHOULD NOT rely on the ability to locate a WKS
  record containing an accurate listing of all services at a
  particular host address, since the WKS RR type is not often used
  by Internet sites.  To confirm that a service is present, simply
  attempt to use it.
...
  5.2.12  WKS Use in MX Processing: RFC-974, p. 5

    RFC-974 [SMTP:3] recommended that the domain system be queried
    for WKS ("Well-Known Service") records, to verify that each
    proposed mail target does support SMTP.  Later experience has
    shown that WKS is not widely supported, so the WKS step in MX
    processing SHOULD NOT be used.
```

...
6.1.3.6 Status of RR Types
...
The TXT and WKS RR types have not been widely used by
Internet sites; as a result, an application cannot rely
on the existence of a TXT or WKS RR in most
domains.

6.5.8. CNAME - Canonical Name

alias	*{ttl}*	*addr-class*	*CNAME*	*Canonical name*
ucbmonet		IN	CNAME	monet

The *Canonical Name* resource record, *CNAME*, specifies an alias or nickname for the official, or canonical, host name. This record must be the only one associated with the alias name. All other resource records must be associated with the canonical name, not with the nickname. Any resource records that include a domain name as their value (e.g., NS or MX) *must* list the canonical name, not the nickname. Similarly, a CNAME will be followed when searching for A RRs, but not for MX RRs or NS RRs or most other types of RRs. CNAMEs are allowed to point to other CNAMEs, but this is considered sloppy.

Nicknames are useful when a well known host changes its name. In that case, it is usually a good idea to have a *CNAME* record so that people still using the old name will get to the right place.

6.5.9. PTR - Domain Name Pointer

name	*{ttl}*	*addr-class*	*PTR*	*real name*
7.0		IN	PTR	monet.Berkeley.Edu.

A *Domain Name Pointer* record, *PTR*, allows special names to point to some other location in the domain. The above example of a *PTR* record is used in setting up reverse pointers for the special *IN-ADDR.ARPA* domain. This line is from the example *hosts.rev* file. *PTR* records are needed by the *gethostbyaddr* function. Note the trailing ‘‘.’’ which prevents BIND from appending the current $ORIGIN to that domain name.

6.5.10. MX - Mail Exchange

name	*{ttl}*	*addr-class*	*MX*	*preference value*	*mail exchange*
Munnari.OZ.AU.		IN	MX	0	Seismo.CSS.GOV.
*.IL.		IN	MX	0	RELAY.CS.NET.

Mail eXchange records, *MX*, are used to specify a list of hosts which are configured to receive mail sent to this domain name. Every name which receives mail should have an *MX* since if one is not found at the time mail is being delivered, an *MX* will be ‘‘imputed’’ with a cost of 0 and a destination of the host itself. If you want a host to receive its own mail, you should create an *MX* for your host’s name, pointing at your host’s name. It is better to have this be explicit than to let it be imputed by remote mailers. In the first example, above, Seismo.CSS.GOV. is a mail gateway that knows how to deliver mail to Munnari.OZ.AU.. These two machines may have a private connection or use a different transport medium. The preference value is the order that a mailer should follow when there is more than one way to deliver mail to a single machine. Note that lower numbers indicate higher precedence, and that mailers are supposed to randomize same-valued *MX* hosts so as to distribute the load evenly if the costs are equal. See RFC974 for more detailed information.

Wildcard names containing the character ‘‘*’’ may be used for mail routing with *MX* records. There are likely to be servers on the network that simply state that any mail to a domain is to be routed through a relay. Second example, above, all mail to hosts in the domain IL is routed through RELAY.CS.NET. This is done by creating a wildcard resource record, which states that *.IL has an *MX* of RELAY.CS.NET. Wildcard *MX* records are not very useful in practice, though, since once a mail message gets to the gateway for a given domain it still has to be routed *within* that domain and it is not currently possible to have an apparently-different set of *MX* records inside and outside of a domain. If you won't be needing any Mail Exchanges inside your domain, go ahead and use a wildcard. If you want to use both wildcard "top-level" and specific "interior" *MX* records, note that each specific record will have to "end with" a complete recitation of the same data that is carried in the top-level record. This is because the specific *MX* records will take precedence over the top-level wildcard records, and must be able to perform the top-level's if a given interior domain is to be able to receive mail from outside the gateway. Wildcard *MX* records are very subtle and you should be careful with them.

6.5.11. TXT - Text

name	*{ttl}*	*addr-class*	*TXT*	*string*
Munnari.OZ.AU.		IN	TXT	"foo"

A *TXT* record contains free-form textual data. The syntax of the text depends on the domain where it is found; many systems use *TXT* records to encode local data in a stylized format. MIT Hesiod is one such system.

6.5.12. RP - Responsible Person

owner	*{ttl}*	*addr-class*	*RP*	*mbox-domain-name*	*TXT-domain-name*
franklin		IN	RP	ben.franklin.berkeley.edu.	sysadmins.berkeley.edu.

The Responsible Person record, *RP*, identifies the name or group name of the responsible person for a host. Often it is desirable to be able to identify the responsible entity for a particular host. When that host is down or malfunctioning, you would want to contact those parties who might be able to repair the host.

The first field, *mbox-domain-name*, is a domain name that specifies the mailbox for the responsible person. Its format in a zone file uses the DNS convention for mailbox encoding, identical to that used for the *Person-in-charge* mailbox field in the SOA record. In the example above, the *mbox-domain-name* shows the encoding for "**<ben@franklin.berkeley.edu>**". The root domain name (just "**.**") may be specified to indicate that no mailbox is available.

The second field, *TXT-domain-name*, is a domain name for which *TXT* records exist. A subsequent query can be performed to retrieve the associated *TXT* resource records at *TXT-domain-name*. This provides a level of indirection so that the entity can be referred to from multiple places in the DNS. The root domain name (just "**.**") may be specified for *TXT-domain-name to indicate that no associated TXT RR exists. In the example above, "***sysadmins.berkeley.edu.***" is the name of a TXT record that might contain some text with names and phone numbers.*

The format of the *RP* record is class-insensitive. Multiple *RP* records at a single name may be present in the database, though they should have identical TTLs.

The *RP* record is still experimental; not all name servers implement or recognize it.

6.5.13. AFSDB - DCE or AFS Server

name	*{ttl}*	*addr-class*	*AFSDB*	*subtype*	*server host name*
toaster.com.		IN	AFSDB	1	jack.toaster.com.

toaster.com.	IN	AFSDB	1	jill.toaster.com.
toaster.com.	IN	AFSDB	2	tracker.toaster.com.

AFSDB records are used to specify the hosts that provide a style of distributed service advertised under this domain name. A subtype value (analogous to the ‘‘preference’’ value in the *MX* record) indicates which style of distributed service is provided with the given name. Subtype 1 indicates that the named host is an AFS (R) database server for the AFS cell of the given domain name. Subtype 2 indicates that the named host provides intra-cell name service for the DCE (R) cell named by the given domain name. In the example above, jack.toaster.com and jill.toaster.com are declared to be AFS database servers for the toaster.com AFS cell, so that AFS clients wishing service from toaster.com are directed to those two hosts for further information. The third record declares that tracker.toaster.com houses a directory server for the root of the DCE cell toaster.com, so that DCE clients that wish to refer to DCE services should consult with the host tracker.toaster.com for further information. The DCE sub-type of record is usually accompanied by a *TXT* record for other information specifying other details to be used in accessing the DCE cell. RFC1183 contains more detailed information on the use of this record type.

The *AFSDB* record is still experimental; not all name servers implement or recognize it.

6.5.14. PX - Pointer to X.400/RFC822 mapping information

name	*{ttl}*	*addr-class*	*PX*	*prefer*	*822-dom*	*X.400-dom*
*.ADMD-garr.X42D.it.		IN	PX	50	it.	ADMD-garr.C-it.
*.infn.it.		IN	PX	50	infn.it.	O.PRMD-infn.ADMD-garr.C-it.
*.it.		IN	PX	50	it.	O-gate.PRMD-garr.ADMD-garr.C-it.

The *PX* records (*Pointer to X.400/RFC822 mapping information*) are used to specify address mapping rules between X.400 O/R addresses and RFC822 style (domain-style) mail addresses. For a detailed description of the mapping process please refer to RFC1327.

Mapping rules are of 3 different types:

1) mapping from X.400 to RFC822 (defined as "table 1 rules" in RFC1327)

2) mapping from RFC822 to X.400 (defined as "table 2 rules" in RFC1327)

3) encoding RFC822 into X.400 (defined as "gate table" in RFC1327)

All three types of mapping rules are specified using *PX* Resource Records in DNS, although the *name* value is different: for case 1, the *name* value is an X.400 domain in DNS syntax, whereas for cases 2 and 3 the *name* value is an RFC822 domain. Refer to RFC-1664 for details on specifying an X.400 domain in DNS syntax and for the use of the *X42D* keyword in it. Tools are available to convert from RFC1327 tables format into DNS files syntax. *Preference* is analogous to the *MX* RR Preference parameter: it is currently advised to use a fixed value of 50 for it. *822-dom* gives the RFC822 part of the mapping rules, and *X.400-dom* gives the X.400 part of the mapping rule (in DNS syntax). It is currently advised always to use wildcarded *name* values, as the RFC1327 tables specifications permit wildcard specifications only. This is to keep compatibility with existing services using static RFC1327 tables instead of DNS *PX* information.

Specifications of mapping rules from X.400 to RFC822 syntax requires the creation of an appropriate X.400 domain tree into DNS, including thus specific *SOA* and *NS* records for the domain itself. Specification of mapping rules from RFC822 into X.400 can be embedded directly into the normal direct *name* tree. Again, refer to RFC1664 for details about organization of this structure.

Tools and library routines, based on the standard resolver ones, are available to retrieve from DNS the appropriate mapping rules in RFC1327 or DNS syntax.

Once again, refer to RFC1664 to use the *PX* resource record, and be careful in coordinating the mapping information you can specify in DNS with the same information specified into the RFC1327 static tables.

The *PX* record is still experimental; not all servers implement or recognize it.

6.6. Discussion about the TTL

The use of different Time To Live fields with in a RRset have been deprecated and this is enforced by the server when loading a primary zone. See the Security section for more discussion of differing TTLs.

The Time To Live assigned to the records and to the zone via the Minimum field in the SOA record is very important. High values will lead to lower BIND network traffic and faster response time. Lower values will tend to generate lots of requests but will allow faster propagation of changes.

Only changes and deletions from the zone are affected by the TTLs. Additions propagate according to the Refresh value in the SOA.

Experience has shown that sites use default TTLs for their zones varying from around 0.5 day to around 7 days. You may wish to consider boosting the default TTL shown in former versions of this guide from one day (86400 seconds) to three days (259200 seconds). This will drastically reduce the number of requests made to your name servers.

If you need fast propagation of changes and deletions, it might be wise to reduce the Minimum field a few days before the change, then do the modification itself and augment the TTL to its former value.

If you know that your zone is pretty stable (you mainly add new records without deleting or changing old ones) then you may even wish to consider a TTL higher than three days.

Note that in any case, it makes no sense to have records with a TTL below the SOA Refresh delay, as Delay is the time required for secondaries to get a copy of the newly modified zone.

6.7. About ‘‘secure zones’’

Secure zones implement named security on a zone by zone basis. It is designed to use a permission list of networks or hosts which may obtain particular information from the zone.

In order to use zone security, *named* must be compiled with SECURE_ZONES defined and you must have at least one secure_zone TXT RR. Unless a *secure_zone* record exists for a given zone, no restrictions will be applied to the data in that zone. The format of the secure_zone TXT RR is:

```
secure_zone      addr-class      TXT      string
```

The addr-class may be either *HS* or *IN*. The syntax for the TXT string is either ‘‘network address:netmask’’ or ‘‘host IP address:H’’.

‘‘network address:netmask’’ allows queries from an entire network. If the netmask is omitted, named will use the default netmask for the network address specified.

‘‘host IP address:H’’ allows queries from a host. The ‘‘H’’ after the ‘‘:’’ is required to differentiate the host address from a network address. Multiple secure_zone TXT RRs are allowed in the same zone file.

For example, you can set up a zone to only answer Hesiod requests from the masked class B network 130.215.0.0 and from host 128.23.10.56 by adding the following two TXT RR's:

secure_zone	HS	TXT	"130.215.0.0:255.255.0.0"
secure_zone	HS	TXT	"128.23.10.56:H"

This feature can be used to restrict access to a Hesiod password map or to separate internal and external internet address resolution on a firewall machine without needing to run a separate named for internal and external address resolution.

Note that you will need to include your loopback interface (127.0.0.1) in your secure_zone record, or your local clients won't be able to resolve names.

6.8. About Hesiod, and HS-class Resource Records

Hesiod, developed by MIT Project Athena, is an information service built upon BIND. Its intent is similar to that of Sun's NIS: to furnish information about users, groups, network-accessible file systems, printcaps, and mail service throughout an installation. Aside from its use of BIND rather than separate server code another important difference between Hesiod and NIS is that Hesiod is not intended to deal with passwords and authentication, but only with data that are not security sensitive. Hesiod servers can be implemented by adding resource records to BIND servers; or they can be implemented as separate servers separately administered.

To learn about and obtain Hesiod make an anonymous FTP connection to host ATHENA-DIST.MIT.EDU and retrieve the compressed tar file **/pub/ATHENA/hesiod.tar.Z**. You will not need the named and resolver library portions of the distribution because their functionality has already been integrated into BIND as of 4.9. To learn how Hesiod functions as part of the Athena computing environment obtain the paper **/pub/ATHENA/usenix/athena-changes.PS** from the above FTP server host. There is also a tar file of sample Hesiod resource files.

Whether one should use Hesiod class is open to question, since the same services can probably be provided with class IN, type TXT and type CNAME records. In either case, the code and documents for Hesiod will suggest how to set up and use the service.

Note that while BIND includes support for *HS*-class queries, the zone transfer logic for non-*IN*-class zones is still experimental.

6.9. Sample Files

The following section contains sample files for the name server. This covers example boot files for the different types of servers and example domain data base files.

6.9.1. Boot Files

6.9.1.1. Primary Server

```
;
; Boot file for Primary Name Server
;

; type        domain                  source file or host
;
directory     /usr/local/adm/named
primary       Berkeley.Edu            ucbhosts
primary       32.128.in-addr.arpa     ucbhosts.rev
primary       0.0.127.in-addr.arpa    named.local
cache         .                       root.cache
```

6.9.1.2. Secondary Server

```
;
; Boot file for Secondary Name Server
;

; type        domain                  source file or host
;
directory     /usr/local/adm/named
secondary     Berkeley.Edu            128.32.0.4 128.32.0.10 ucbhosts.bak
secondary     32.128.in-addr.arpa     128.32.0.4 128.32.0.10 ucbhosts.rev.bak
primary       0.0.127.in-addr.arpa    named.local
cache         .                       root.cache
```

6.9.1.3. Caching Only Server

```
;
; Boot file for Caching Only Name Server
;

; type        domain                  source file or host
;
directory     /usr/local/adm/named
cache         .                       root.cache
primary       0.0.127.in-addr.arpa    named.local
```

6.9.2. Remote Server / DNS Client

6.9.2.1. /etc/resolv.conf

```
domain Berkeley.Edu
nameserver 128.32.0.4
nameserver 128.32.0.10
sortlist 130.155.160.0/255.255.240.0 130.155.0.0
```

6.9.3. root.cache

```
;
;       This file holds the information on root name servers needed to
;       initialize cache of Internet domain name servers
;       (e.g. reference this file in the "cache  .  <file>"
;       configuration file of BIND domain name servers).
;
;       This file is made available by InterNIC registration services
;       under anonymous FTP as
;           file                /domain/named.root
;           on server           FTP.RS.INTERNIC.NET
;       -OR- under Gopher at    RS.INTERNIC.NET
;           under menu          InterNIC Registration Services (NSI)
;              submenu          InterNIC Registration Archives
;           file                named.root
;
;       last update:    Oct 5, 1994
;       related version of root zone:   1994100500
;
.                       604800  IN  NS  NS.INTERNIC.NET.
NS.INTERNIC.NET.        604800  IN  A   198.41.0.4
.                       604800  IN  NS  NS1.ISI.EDU.
NS1.ISI.EDU.            604800  IN  A   128.9.0.107
.                       604800  IN  NS  C.PSI.NET.
C.PSI.NET.              604800  IN  A   192.33.4.12
.                       604800  IN  NS  TERP.UMD.EDU.
TERP.UMD.EDU.           604800  IN  A   128.8.10.90
.                       604800  IN  NS  NS.NASA.GOV.
NS.NASA.GOV.            604800  IN  A   128.102.16.10
                        604800  IN  A   192.52.195.10
.                       604800  IN  NS  NS.ISC.ORG.
NS.ISC.ORG.             604800  IN  A   192.5.5.241
.                       604800  IN  NS  NS.NIC.DDN.MIL.
NS.NIC.DDN.MIL.         604800  IN  A   192.112.36.4
.                       604800  IN  NS  AOS.ARL.ARMY.MIL.
AOS.ARL.ARMY.MIL.       604800  IN  A   128.63.4.82
                        604800  IN  A   192.5.25.82
.                       604800  IN  NS  NIC.NORDU.NET.
NIC.NORDU.NET.          604800  IN  A   192.36.148.17
; End of File
```

6.9.4. named.local

```
@	IN	SOA	ucbvax.Berkeley.Edu.	kjd.ucbvax.Berkeley.Edu. (
			1994072100		; Serial
			10800			; Refresh
			1800			; Retry
			3600000			; Expire
			259200 )		; Minimum
	IN	NS	ucbvax.Berkeley.Edu.	; pedantic
1	IN	PTR	localhost.
```

6.9.5. host.rev

```
;
;	@(#)ucb-hosts.rev	1.1	(Berkeley)	86/02/05
;
@	IN	SOA	ucbvax.Berkeley.Edu.	kjd.monet.Berkeley.Edu. (
			1986020501		; Serial
			10800			; Refresh
			1800			; Retry
			3600000			; Expire
			259200 )		; Minimum
	IN	NS	ucbarpa.Berkeley.Edu.
	IN	NS	ucbvax.Berkeley.Edu.
0.0	IN	PTR	Berkeley-net.Berkeley.EDU.
	IN	A	255.255.255.0
0.130	IN	PTR	csdiv-net.Berkeley.EDU.
4.0	IN	PTR	ucbarpa.Berkeley.Edu.
6.0	IN	PTR	ernie.Berkeley.Edu.
7.0	IN	PTR	monet.Berkeley.Edu.
10.0	IN	PTR	ucbvax.Berkeley.Edu.
6.130	IN	PTR	monet.Berkeley.Edu.
```

6.9.6. Hosts

```
;
;   @(#)ucb-hosts   1.2   (berkeley)   88/02/05
;
@            IN   SOA     ucbvax.Berkeley.Edu.          kjd.monet.Berkeley.Edu. (
                          1988020501                    ; Serial
                          10800                         ; Refresh
                          1800                          ; Retry
                          3600000                       ; Expire
                          259200 )                      ; Minimum
             IN   NS      ucbarpa.Berkeley.Edu.
             IN   NS      ucbvax.Berkeley.Edu.
localhost    IN   A       127.1
                          ; note that 127.1 is the same as 127.0.0.1; see inet(3n)
ucbarpa      IN   A       128.32.4
             IN   A       10.0.0.78
             IN   HINFO   VAX-11/780 UNIX
arpa         IN   CNAME   ucbarpa
ernie        IN   A       128.32.6
             IN   HINFO   VAX-11/780 UNIX
ucbernie     IN   CNAME   ernie
monet        IN   A       128.32.7
             IN   A       128.32.130.6
             IN   HINFO   VAX-11/750 UNIX
ucbmonet     IN   CNAME   monet
ucbvax       IN   A       10.2.0.78
                          ; 128.32.10 means 128.32.0.10; see inet(3n)
             IN   A       128.32.10
                          ; HINFO and WKS are widely unused,
                          ; but we'll show them as examples.
             IN   HINFO   VAX-11/750 UNIX
             IN   WKS     128.32.0.10 TCP ( echo telnet
                          discard sunrpc sftp
                          uucp-path systat daytime
                          netstat qotd nntp
                          link chargen ftp
                          auth time whhois mtp
                          pop rje finger smtp
                          supdup hostnames
                          domain
                          nameserver )
vax          IN   CNAME   ucbvax
toybox       IN   A       128.32.131.119
             IN   HINFO   Pro350 RT11
toybox       IN   MX      0  monet.Berkeley.Edu.
csrg         IN   MX      0 Ralph.CS
             IN   MX      0 Zhou.CS
             IN   MX      0 Painter.CS
             IN   MX      0 Riggle.CS
             IN   MX      0 Terry.CS
             IN   MX      0 Kevin.CS
```

7. Setting up Your Own Domain

When setting up a domain that is going to be on a public network the site administrator should contact the organization in charge of the network and request the appropriate domain registration form. An organization that belongs to multiple networks (such as the *Internet* and *BITNET*) should register with only one network.

7.1. Internet

Sites on the Internet who need information on setting up a domain should contact the registrar for their network, which is one of the following:

MILnet	HOSTMASTER@NIC.DDN.MIL
other	HOSTMASTER@INTERNIC.NET

You may also want to be placed on the BIND mailing list, which is a mail group for people on the Internet who run BIND. The group discusses future design decisions, operational problems, and other related topic. The address to request being placed on this mailing list is:

bind-request @ uunet.uu.net

7.2. Subdomains of Existing Domains

If you want a subdomain of some existing domain, you should find the contact point for the parent domain rather than asking one of the above top-level registrars. There should be a convention that **registrar**@*domain* or **hostmaster**@*domain* for any given domain will always be an alias for that domain's registrar (somewhat analogous to **postmaster**), but there is no such convention. Try it as a last resort, but first you should examine the *SOA* record for the domain and send mail to the ''responsible person'' shown therein. You can also try *whois*.

8. Domain Management

This section contains information for starting, controlling and debugging *named*.

8.1. /etc/rc.local

The hostname should be set to the full domain style name in */etc/rc.local* using *hostname (1)*. The following entry should be added to */etc/rc.local* to start up *named* at system boot time:

```
if [ -f /usr/sbin/named ]; then
   /usr/sbin/named [options] & echo -n ' named'  >/dev/console
fi
```

This usually directly follows the lines that start *syslogd*. **Do Not** attempt to run *named* from *inetd*. This will continuously restart the name server and defeat the purpose of the cache.

8.2. /var/run/named.pid

When *named* is successfully started up it writes its process id into the file */var/run/named.pid*. This is useful to programs that want to send signals to *named*. The name of this file may be changed by defining *PIDFILE* to the new name when compiling *named*.

8.3. /etc/hosts

The *gethostbyname()* library call can detect if *named* is running. If it is determined that *named* is not running it will look in */etc/hosts* to resolve an address. This option was added to allow *ifconfig (8C)* to configure the machines local interfaces and to enable a system manager to access the network while the system is in single user mode. It is advisable to put the local machines interface addresses and a couple of machine names and address in */etc/hosts* so the system manager can rcp files from another machine when the system is in single user mode. The format of */etc/hosts* has not changed. See *hosts (5)* for more information. Since the process of reading */etc/hosts* is slow, it is not advisable to use this option when the system is in multi user mode.

8.4. Signals

There are several signals that can be sent to the *named* process to have it do tasks without restarting the process.

8.4.1. Reload

SIGHUP - Causes *named* to read *named.boot* and reload the database. This is useful when you have made a change to a "primary" data file and you want *named*'s internal database to reflect the change. If you build BIND with the FORCED_RELOAD option, then SIGHUP also has the effect of scheduling all "secondary" zones for serial-number checks, which could lead to zone transfers ahead of the usual schedule. Normally serial-number compares are done only at the intervals specified in the zone's SOA record.

8.4.2. Debugging

When *named* is running incorrectly, look first in */var/log/messages* and check for any messages logged by *syslog*. Next send it a signal to see what is happening. Unless you run it with the "-d" option, *named* has very little to say on its standard output or standard error. Everything *named* has to say, it says to *syslog*.

SIGINT - Dumps the current data base and cache to */var/tmp/named_dump.db* This should give you an indication to whether the data base was loaded correctly. The name of the dump file may be changed by defining *DUMPFILE* to the new name when compiling *named*.

Note: the following two signals only work when *named* is built with *DEBUG* defined.

SIGUSR1 - Turns on debugging. Each following SIGUSR1 increments the debug level. The output goes to */var/tmp/named.run* The name of this debug file may be changed by defining *DEBUGFILE* to the new name before compiling *named*.

SIGUSR2 - Turns off debugging completely.

For more detailed debugging, define DEBUG when compiling the resolver routines into */lib/libc.a*.

SIGWINCH - Toggles tracing of all incoming queries if *named* has been compiled with *QRYLOG* defined. The trace is sent to syslog, and is huge, but it is very useful for tracking down problems.

To run with tracing of all queries specify the *-q* flag on the command line. If you routinely log queries you will probably want to analyze the results using the dnsstats stats script in the contrib directory.

SIGIOT - Dumps statistics data into */var/tmp/named.stats* if the server is built with *STATS* defined. Statistics are appended to the file.

9. Building a System with a Name Server

BIND is composed of two parts. One is the user interface called the *resolver* which consists of a group of routines that reside in the C library */lib/libc.a*. Second is the actual server called *named*. This is a daemon that runs in the background and services queries on a given network port. The standard port for UDP and TCP is specified in */etc/services*.

9.1. Resolver Routines in libc

When building your 4.3BSD system you may either build the C library to use the name server resolver routines or use the host table lookup routines to do host name and address resolution. The default resolver for 4.3BSD uses the name server. Newer BSD systems include both name server and host table functionality with preference given to the name server if there is one or if there is a */etc/resolv.conf* file.

Building the C library to use the name server changes the way *gethostbyname*(3N), *gethostbyaddr*(3N), and *sethostent*(3N) do their functions. The name server renders *gethostent*(3N) obsolete, since it has no concept of a next line in the database. These library calls are built with the resolver routines needed to query the name server.

The *resolver* contains functions that build query packets and exchange them with name servers.

Before building the 4.3BSD C library, set the variable *HOSTLOOKUP* equal to *named* in */usr/src/lib/libc/Makefile*. You then make and install the C library and compiler and then compile the rest of the 4.3BSD system. For more information see section 6.6 of ‘‘Installing and Operating 4.3BSD on the VAX‡’’.

If your operating system isn’t VAX‡ 4.3BSD, it is probably the case that your vendor has included *resolver* support in the supplied C Library. You should consult your vendor’s documentation to find out what has to be done to enable *resolver* support. Note that your vendor’s *resolver* may be out of date with respect to the one shipped with BIND, and that you might want to build BIND’s resolver library and install it, and its include files, into your system’s compile/link path so that your own network applications will be able to use the newer features.

‡VAX is a Trademark of Digital Equipment Corporation

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