



Introduction to the Domain Name System

The Domain Name System (DNS) handles the growing number of Internet users. DNS translates names, such as `www.cisco.com`, into IP addresses, such as `192.168.40.0` (or the more extended IPv6 addresses), so that computers can communicate with each other. DNS makes using Internet applications, such as the World Wide Web, easy. The process is as if, when phoning your friends and relatives, you could autodial them based on their names instead of having to remember their phone numbers.

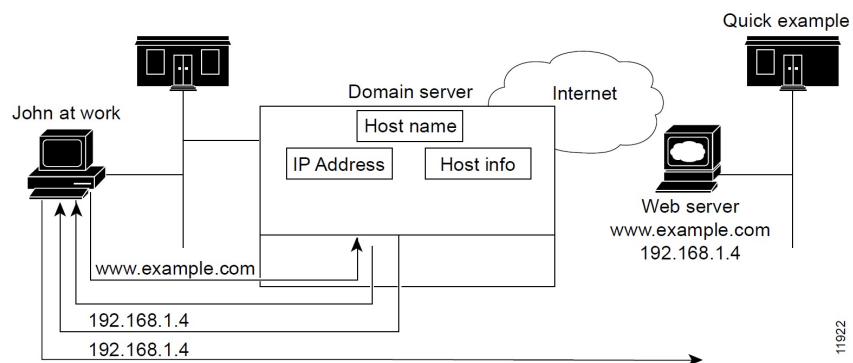
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How DNS Works

To understand how DNS works, imagine a typical user, John, logging in to his computer. He launches his web browser so that he can view the website at a company, ExampleCo (see the image below). He enters the name of their website—`http://www.example.com`. Then:

1. John's workstation sends a request to the DNS server about the IP address of `www.example.com`.
2. The DNS server checks its database to find that `www.example.com` corresponds to `192.168.1.4`.
3. The server returns this address to John's browser.
4. The browser uses the address to locate the website.
5. The browser displays the website on John's monitor.

Figure 1: Domain Names and Addresses



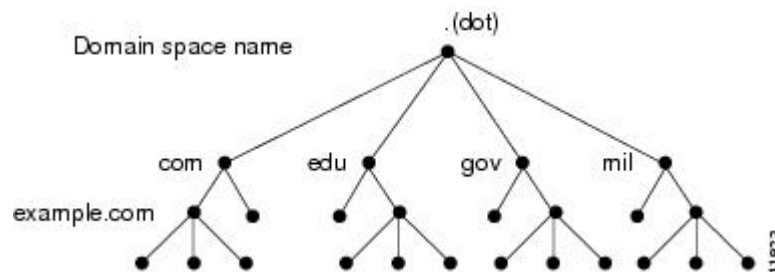
Overview of Concepts in DNS

This section provides an overview of the concepts in DNS.

Domains

John can access the ExampleCo website because his DNS server knows the `www.example.com` IP address. The server learned the address by searching through the domain namespace. DNS was designed as a tree structure, where each named domain is a node in the tree. The top-most node of the tree is the DNS root domain (`.`), under which there are subdomains, such as `.com`, `.edu`, `.gov`, and `.mil` (see the image below).

Figure 2: DNS Hierarchy

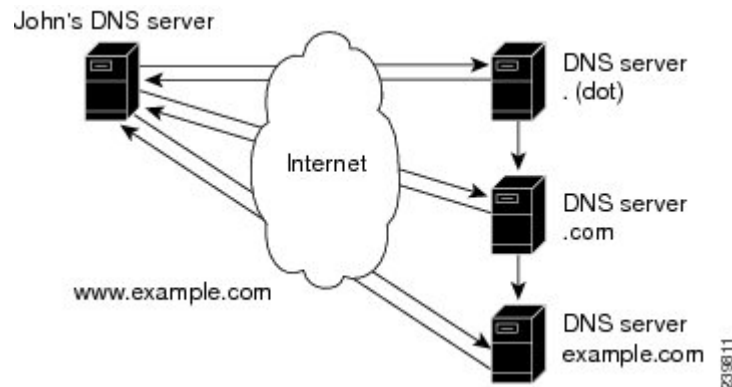


The fully qualified domain name (FQDN) is a dot-separated string of all the network domains leading back to the root. This name is unique for each host on the Internet. The FQDN for the sample domain is `example.com.`, with its domain `example`, parent domain `.com`, and root domain `“.”` (dot).

Learning ExampleCo Address

When John’s workstation requests the IP address of the website `www.example.com` (see the image below):

Figure 3: DNS Hierarchical Name Search



1. The local DNS server looks for the `www.example.com` domain in its database, but cannot find it, indicating that the server is not authoritative for this domain.
2. The server asks the authoritative root nameserver for the top-level (root) domain `“.”` (dot).
3. The root nameserver directs the query to a nameserver for the `.com` domain that knows about its subdomains.

4. The .com nameserver determines that example.com is one of its subdomains and responds with its server address.
5. The local server asks the example.com nameserver for the www.example.com location.
6. The example.com nameserver replies that its address is 192.168.1.4.
7. The local server sends this address to John's web browser.

Establishing a Domain

ExampleCo has a website that John could reach because it registered its domain with an accredited domain registry. ExampleCo also entered its domain name in the .com server database, and requested a network number, which defines a range of IP addresses.

In this case, the network number is 192.168.1.0, which includes all assignable hosts in the range 192.168.1.1 through 192.168.1.254. You can only have numbers 0 through 255 (28) in each of the address fields, known as octets. However, the numbers 0 and 255 are reserved for network and broadcast addresses, respectively, and are not used for hosts.

Difference Between Domains and Zones

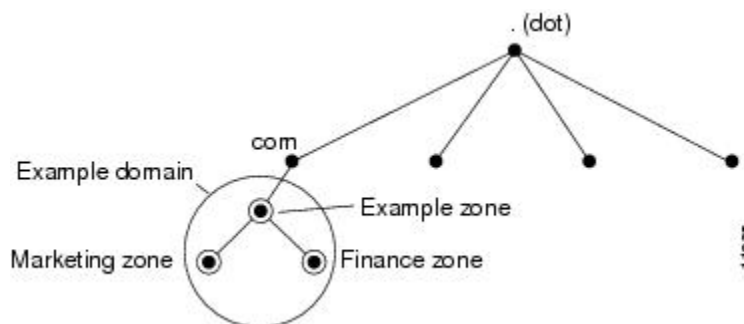
The domain namespace is divided into areas called zones that are points of delegation in the DNS tree. A zone contains all domains from a certain point downward, except those for which other zones are authoritative.

A zone usually has an authoritative nameserver, often more than one. In an organization, you can have many nameservers, but Internet clients can query only those that the root nameservers know. The other nameservers answer internal queries only.

The ExampleCo company registered its domain, example.com. It established three zones—example.com, marketing.example.com, and finance.example.com. ExampleCo delegated authority for marketing.example.com and finance.example.com to the DNS servers in the marketing and finance groups in the company. If someone queries example.com about hosts in marketing.example.com, example.com directs the query to the marketing.example.com nameserver.

In the image below, the domain example.com includes three zones, with the example.com zone being authoritative only for itself.

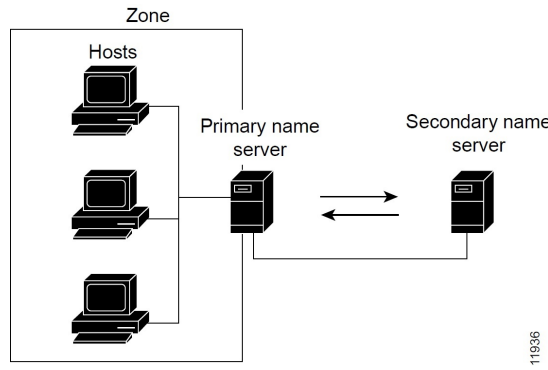
Figure 4: Example.com With Delegated Subdomains



ExampleCo could choose not to delegate authority to its subdomains. In that situation, the example.com domain is a zone that is authoritative for the subdomains for marketing and finance. The example.com server answers all outside queries about marketing and finance.

As you begin to configure zones by using Cisco Prime Network Registrar, you must configure a nameserver for each zone. Each zone has one primary server, which loads the zone contents from a local configuration database. Each zone can also have any number of secondary servers, which load the zone contents by fetching the data from the primary server. The image below shows a configuration with one secondary server.

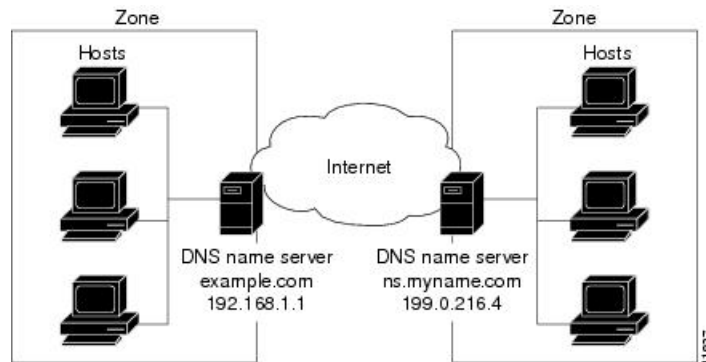
Figure 5: Primary and Secondary Servers for Zones



Nameservers

DNS is based on a client/server model. In this model, nameservers store data about a portion of the DNS database and provide it to clients that query the nameserver across the network. Nameservers are programs that run on a physical host and store zone data. As administrator for a domain, you set up a nameserver with the database of all the Resource Records (RRs) describing the hosts in your zone or zones (see the image below).

Figure 6: Client/Server Name Resolution



The DNS servers provide name-to-address translation, or name resolution. They interpret the information in an FQDN to find its address.

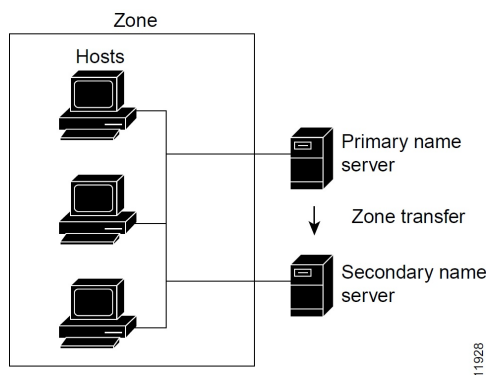
Each zone must have one primary nameserver that loads the zone contents from a local database, and a number of secondary servers, which load a copy of the data from the primary server (see the image below). This process of updating the secondary server from the primary server is called a zone transfer.

Even though a secondary nameserver acts as a kind of backup to a primary server, both types of servers are authoritative for the zone. They both learn about hostnames in the zone from the zone authoritative database, not from information learned while answering queries. Clients can query both servers for name resolution.

The DNS server functionality is enhanced to provide separate DNS servers for authorization and caching.

As you configure the Cisco Prime Network Registrar DNS nameserver, you specify what role you want the server to perform for a zone—primary or secondary. The type of server is meaningful only in context to its role. An Authoritative DNS server can only be a primary or a secondary server for a zone, it does not specify zones for caching servers.

Figure 7: DNS Zone Transfer



To configure the:

- Primary nameserver, see [Managing Primary DNS Servers](#).
- Secondary nameserver, see [Managing Secondary Servers](#).

Reverse Nameservers

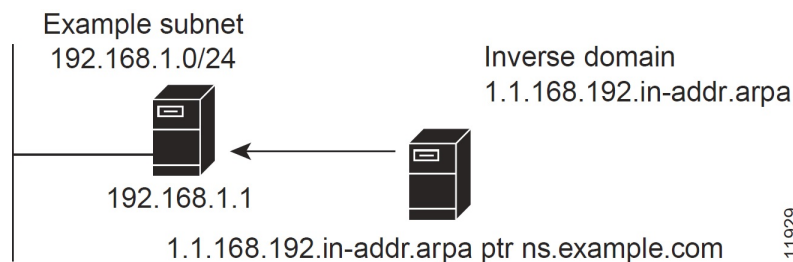
The DNS servers described so far perform name-to-address resolution. They can do this easily by searching through their database for the correct address, because they index all the data by name. However, there are times when you need address-to-name resolution so that you can interpret certain output, such as computer log files.

Finding a domain name when you only know the address, however, would require searching the entire namespace. DNS solves this problem by supporting a domain namespace that uses addresses as names, known as the `in-addr.arpa` or `.arpa` domain. This reverse zone contains subdomains for each network based on the network number. For consistency and natural grouping, the four octets of a host number are reversed.

The IP address as a domain name appears backward, because the name is in leaf-to-root order. For example, the ExampleCo network subnet is `192.168.1.0/24`. Its reverse zone is `1.168.192.in-addr.arpa`. If you only know the DNS server address (`192.168.1.1`), the query to the reverse domain would find the host entry `1.1.168.192.in-addr.arpa` that maps back to `example.com`.

Reverse domains are handled through Pointer (PTR) RRs, as indicated in the image below.

Figure 8: Reverse Domains



Authoritative and Caching DNS Servers

In Cisco Prime Network Registrar, the authoritative and caching services are separated, and are handled by two separate servers. The authoritative server holds authoritative zone data and responds only to queries for which it is authoritative. The caching server is the recursive/caching server and does not contain any authoritative zone data.

High-Availability DNS

Because there can be only one primary DNS server per zone, failure of this server makes it impossible to update the zone data. These updates can occur on the primary DNS server only; software such as DHCP servers, that update DNS resource records must send the updates directly to the primary server. A second primary server can become a hot standby that shadows the main primary server. This is called High-Availability (HA) DNS.

EDNS

To send a DNS message above 512 bytes over User Datagram Protocol (UDP), you need to use an extension of the DNS protocol known as Extended DNS (EDNS). The EDNS protocol expands the number of flags, label types, and return codes available to the DNS protocol. A version of EDNS specified by RFC 6891 is known as EDNS0. EDNS uses a pseudo resource record known as OPT Resource Record (OPT RR). OPT RR differentiates conventional DNS from EDNS. OPT RRs appear only in the route transmission between DNS clients and servers, they are not cached or persisted to disk. The DNS client is responsible for an EDNS0 OPT RR to indicate it accepts larger UDP responses.

The Authoritative and Caching DNS servers support the EDNS0 extension. You can modify the UDP payload size of the DNS server. The minimum UDP payload size of the DNS server is 512 bytes. The maximum UDP packet size is 64 KB, the default size for the DNS server is 1232 bytes. Also, the DNS servers will cap the UDP replies to 1232.



Note The DNS Server can handle requests from clients that do not support EDNS0, however, the DNS server is not permitted to use any extended capabilities, when it handles requests from clients that do not support EDNS0. The response to client requests are inserted into a default 512 byte message. Clients may indicate that they support EDNS by including an OPT RR in the query. If a server does not support EDNS (or the support is disabled), the server will return FORMERR and the client retries without EDNS. If an answer is larger than the size that the client has reported (either with EDNS or the default 512 bytes), the server will mark the result as truncated and the client may retry using TCP.



Note IP fragmentation is a problem on the Internet today, especially when it comes to large DNS messages. Even if fragmentation works, it might not be secure enough for DNS. These issues can be fixed by a) setting the EDNS buffer size lower to limit the risk of IP fragmentation and b) allowing DNS to switch from UDP to TCP when a DNS response is too big to fit in this limited buffer size. The default EDNS buffer size for both the Caching and Authoritative DNS servers is 1232 bytes.

Use the following commands to set the EDNS buffer size:

Authoritative DNS servers:

```
nrcmd> session set visibility=3
nrcmd> dns set edns-max-payload=2000
nrcmd> dns reload
```

Caching DNS servers:

```
nrcmd> session set visibility=3
nrcmd> cdns set edns-buffer-size=2000
nrcmd> cdns set max-udp-size=2000
nrcmd> cdns reload
```

DNS Views

DNS Views allow you to present alternate versions of zone data to different communities of clients using a single name server.

For example, a DNS server for example.com could maintain two views of the zone, where the view of example.com that can be queried internally includes many hosts that do not exist in the external view. Each zone view is treated as an independent copy of the zone. The DNS server, when answering queries on the zone, uses the match criteria defined in each view to determine the matching zone for the client. The query is then answered based on that zone contents.

Starting from Cisco Prime Network Registrar 11.0, zones can be referenced by multiple views without the need to make copies of the zone. Use the *alternate-view-ids* attribute for this purpose. For more information, see [Key Points to Remember While Working on DNS Views](#).

