Domain Name Services

DNS

Application Layer Protocols

Domain Name Server (DNS)

- DNS is actually an application layer protocol, and so sits above the TCP layer.
- It is one of the more important and commonly recognised protocols.

- DNS provides a translation between names and IP addresses

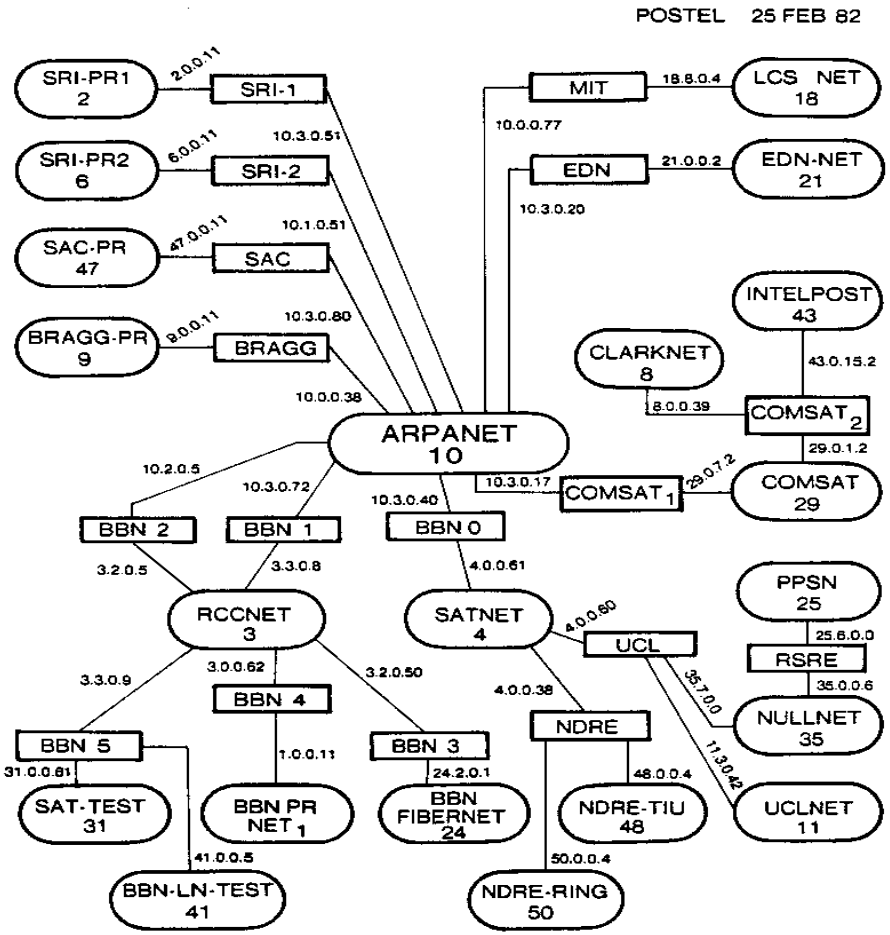
- From a hardware standpoint, it is not really necessary, since messages can be sent using IP addresses and port numbers

Naming Hierarchy

- However humans find IP addresses hard to remember.
- rmit.edu.au is a lot easier than 131.170.0.5
- The idea of using names for hosts, rather than IP numbers started to be developed in the 1970's and 80's

- Initially a "flat" system was used where each host had a single name and a centrally held table contained the mapping of host names to IP addresses

- As the internet grew, this quickly became unmanageable, so a distributed system with a naming hierarchy was developed



Map of the entire internet created in 1982 by Jon Postel, early internet pioneer, first person responsible for doamin names, founder of IANA.

https://en.wikipedia.org/wiki/Jon_Postel

Domains

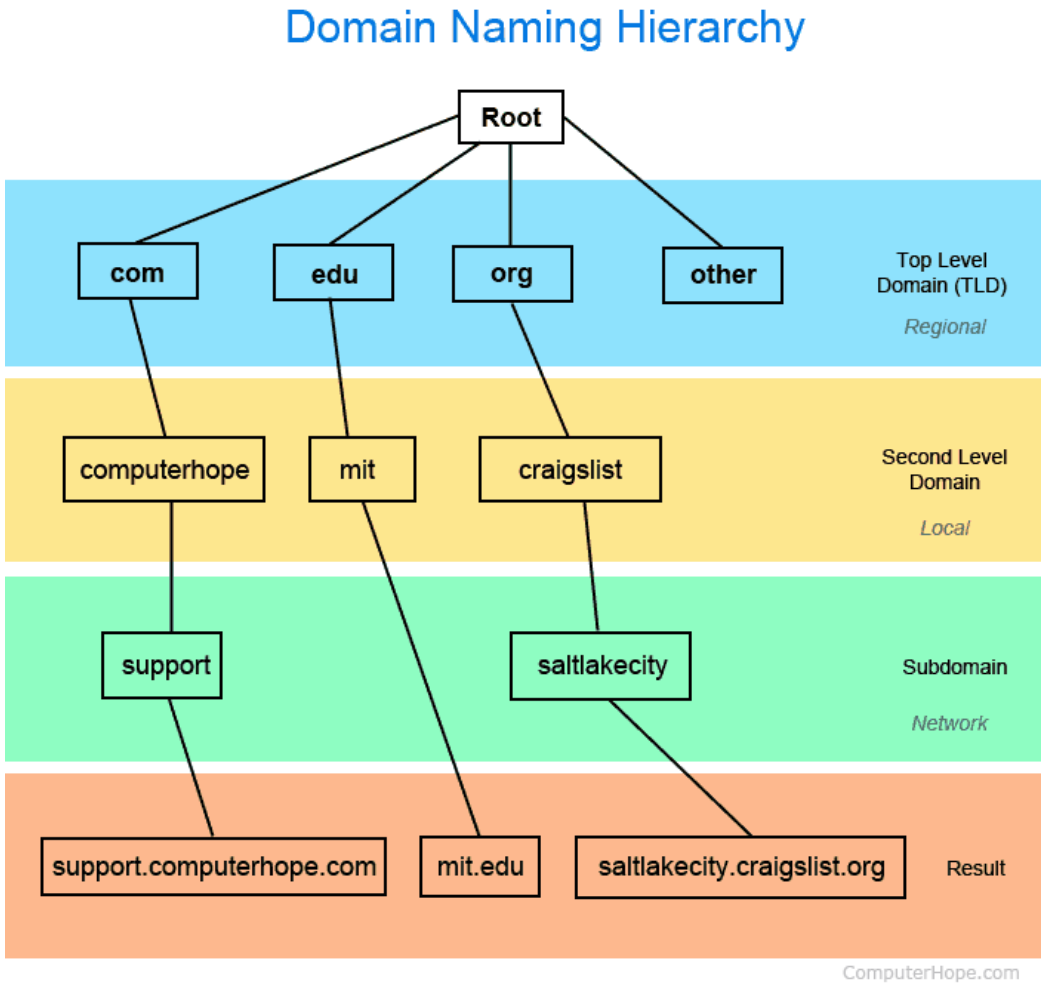
- Rather than a flat list of names, the concept of domains and domain hierarchy was introduced
  - There are top level domains, eg .com, .org, .net
  - As well as country domains: /us, .uk, .au, …

Each of these top level domains can in turn contain domains (sub domains), or in this case second level domains and so on.

Naming Hierarchy

- Conceptually, the internet name space is a tree structure[1] with Top Level Domains (TLDs), such as *.com*, *.au,* being at the first level, and *edu.au*, *au.com* etc. called second level domain names.
- The leaf nodes are the host machines

- All names within the ".au" domain are administered by the ".au" domain administration.
- All names within rmit.edu.au are administered by rmit.
- As well as the naming hierarchy, the information is distributed across the network to avoid bottlenecks


Domain Naming Hierarchy
Root
com
edu
org
other
Top Level Domain (TLD)
Regional
computerhope
mit
craigslist
Second Level Domain
Local
support
saltlakecity
Subdomain
Network
support.computerhope.com
mit.edu
saltlakecity.craigslist.org
Result
ComputerHope.com

Domain Administrators

- There is an administration authority for each node in the tree, which licences and registers use of names at the level.
- The administrator for the top level is the internet assigned number authority (IANA), which also regulates global IP numbers.
- Lower level domains are administered at the country level (eg .au sub domans), or by an organisation (eg rmit.edu.au)
- Conceptually, there is a Domain Name Server (DNS) at each node, operated by that domain which is responsible for providing information about all the names at the next layer down. Such a name server is called an *Authoritive Name Server* for that domain.

- For reliability reasons there is always a primary and a secondary DNS server for each sub domain
- In practice there may be multiple name servers for the one domain, especially the top level and large sub domains
- There are several hundred DNS servers for top level domains scattered around the world. These are called Root Name Servers. www.root-servers.org
- A DNS server may also serve multiple domains, know as a *zone*.

For example, many ISP's provide a facility to for individuals to register domain names. In the case the ISP's DNS will be the name server for these domains.

Resolving names to IP numbers

- Converting a domain name to an IP address is done by a *name resolver* process sending messages to one or *more Domain Name Servers*.

- There are two major parts to this process
  - Finding the DNS that has the information needed
  - Sending that DNS a request to convert the name to an IP address

- The first part is the complicated part

Example

- Suppose you type *rmit.edu.au* into you browser. The browser needs to find the IP address for the domain rmit.edu.au

- It will first send the request to the nearest DNS. This is likely to be your ISP's name server.

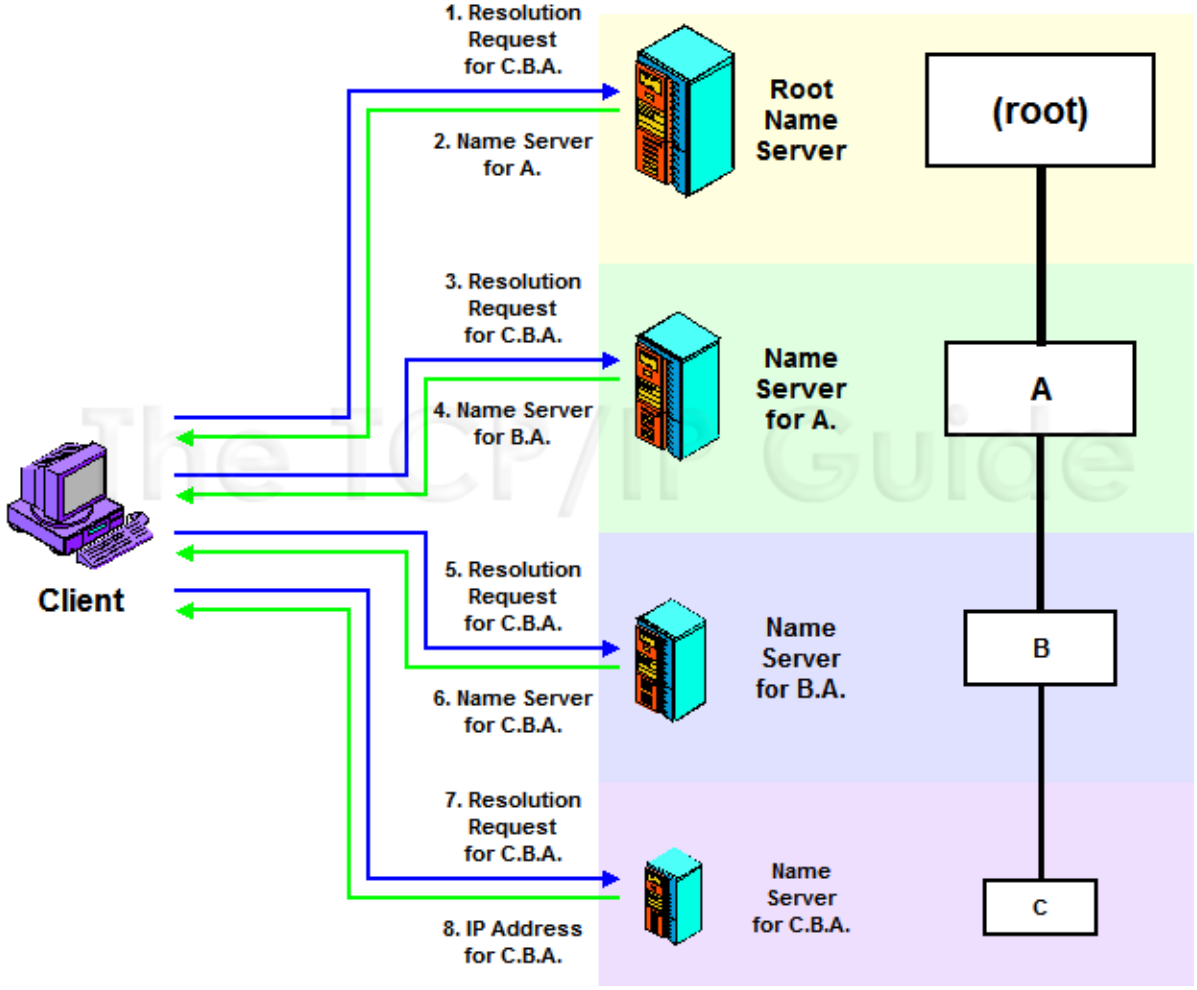
- The local ISP may or may not know the IP address for this domain. DNS servers employ extensive caching. If any of the ISP's other customers had recently visited *rmit.edu.au*, the IP address would be in cache, and the name server would return the IP address

- If the nearest DNS cannot resolve address it will instead return the address of another server that may have the required information.

- Formally, the address resolution starts with the highest level domain, the .au
- If the local DNS has no information about the domain, it will provide an address of a root name server to the resolver.
- The resolver then queries the root name server.
- The root name server will likely not know the IP address of rmit.edu.au

- However it will know the location of the name server responsible for the .au domain, and can return that address
- The resolver can then interrogate that server and will most likely get the address of the DNS for .edu.au
- That DNS will have the IP address for rmit.edu.au since it is directly within in the .edu.au sub domain, so it can return the IP address to the browser.

Recursive name resolution.



In this diagram the client is looking to resolve the IP of host C.B.A

The host name is not cached locally, so the client name resolver sends a message to the root name server, which responds with the name server for A. The process continues until the client finds the name server for C.B.A

- This process seems very slow, however it only happens occasionally, as a lot of caching takes place and it is rare to have to go all the way to the top level DNS.

- As well as there being (sometimes multiple) DNS servers for each node there are caching-only name servers

- These name servers get information from authorative name servers and use that to answer requests from name resolvers.
- The name resolver on a client machine also caches recently resolved domains

DNS message format

Section	Description
Header	Contains fields that describe the type of message and provide important information about it. Also contains fields that indicate the number of entries in the other sections of the message.
Question	Carries one or more “questions”, that is, queries for information being sent to a DNS name server.
Answer	Carries one or more resource records that answer the question(s) indicated in the Question section above.
Authority	Contains one or more resource records that point to authoritative name servers that can be used to continue the resolution process.
Additional	Conveys one or more resource records that contain additional information related to the query that is not strictly necessary to answer the queries (questions) in the message.

Application Level protocols

- We have seem how each layer of the protocol stack uses the services of the layer below it to implement some functionality that is provided to the layer above it.

- Application layer protocols provided functions that can be used directly by application programs (and programmers)

Some common application layer protocols

- NFS Network File System
  - Allows users on one host to access files on a remote server as though they were part of the host file system
- DHCP Dynamic Host Configuration Protocol
  - Allows hosts to by dynamically assigned IP numbers within the local network
- FTP File transfer protocol
  - Used to transfer files frol one host to another (downloads / uploads)

- Mail Protocols
  - POP3, SMTP, IMAP
  - Mail protocols, especially SMTP (Simple Mail Transport Protocol),were very developed very early, in concert with the development of the internet, as email was one of the major early uses of the internet, well before the World Wide Web was conceived.
  - The DNS protocol also has special message types to tell mail servers and client where to send messages

- Telnet
  - Another early protocol, allows client machine to log in to a remote host