

CSE/EE 461 – Lecture 22

Naming and the DNS

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Last Time

- Network support for QOS
- Focus
 - What network mechanisms provide which kinds of quality assurances?
- Topics
 - Scheduling and Buffer management
 - Fair Queuing
 - Intserv
 - Diffserv

Application
Presentation
Session
Transport
Network
Data Link
Physical

This Lecture

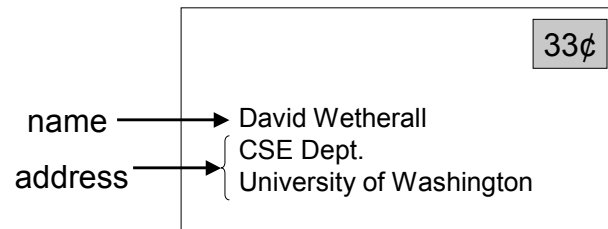
- Naming
- Focus
 - How do we name hosts etc.?
- Topics
 - Domain Name System (DNS)
 - Email/URLs

Application
Presentation
Session
Transport
Network
Data Link
Physical

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Names and Addresses



- Names are identifiers for objects/services (high level)
- Addresses are locators for objects/services (low level)
- Resolution is the process of mapping name to address
- But, addresses are really lower-level names; many levels used

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Naming in Systems

- Ubiquitous
 - Files in filesystem, processes in OS, pages on the web, ...
- Decouple identifier for object/service from location
 - Hostnames provide a level of indirection for IP addresses
- Naming greatly impacts system capabilities and performance
 - Ethernet addresses are a flat 48 bits
 - flat → any address anywhere but large forwarding tables
 - IP addresses are hierarchical 32/128 bits
 - hierarchy → smaller routing tables but constrained locations

Internet Hostnames

- Hostnames are human-readable identifiers for end-systems based on an administrative hierarchy
 - galah.cs.washington.edu is my desktop machine
- IP addresses are a fixed-length binary encoding for end-systems based on their position in the network
 - 128.95.2.106 is galah's IP address
- Original name resolution: HOSTS.TXT
- Current name resolution: Domain Name System
- Future name resolution: ?

Original Hostname System

- When the Internet was really young ...
- Flat namespace
 - Simple (host, address) pairs
- Centralized management
 - Updates via a single master file called HOSTS.TXT
 - Manually coordinated by the Network Information Center (NIC)
- Resolution process
 - Look up hostname in the HOSTS.TXT file

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Scaling Problems

- Coordination
 - Between all users to avoid conflicts
- Inconsistencies
 - Between update and distribution of new version
- Reliability
 - Single point of failure
- Performance
 - Competition for centralized resources

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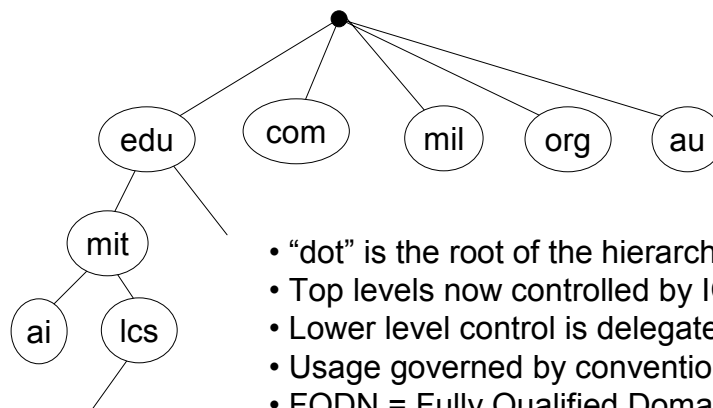
Domain Name System (DNS)

- Designed by Mockapetris and Dunlap in the mid 80s
- Namespace is hierarchical
 - Allows much better scaling of data structures
 - e.g., galah.cs.washington.edu
- Namespace is distributed
 - Decentralized administration and access
 - e.g., galah managed by CSE
- Resolution is by query/response
 - With replicated servers for redundancy
 - With heavy use of caching for performance

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DNS Hierarchy



- “dot” is the root of the hierarchy
- Top levels now controlled by ICANN
- Lower level control is delegated
- Usage governed by conventions
- FQDN = Fully Qualified Domain Name

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DNS Distribution

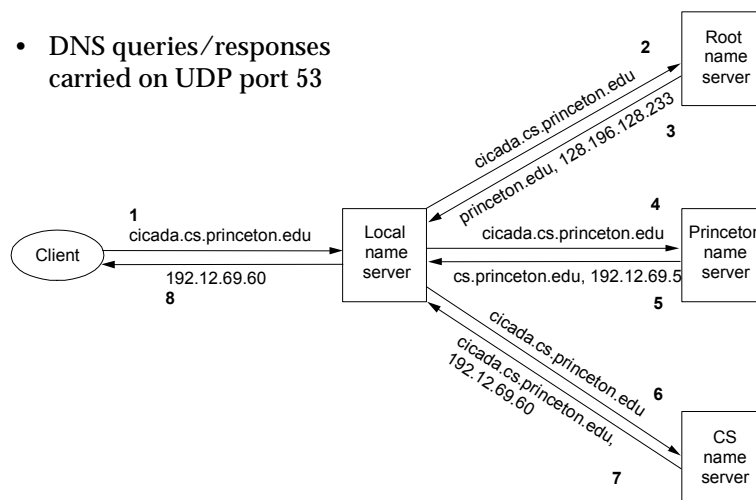
- Data managed by zones that contain resource records
 - Zone is a complete description of a portion of the namespace
 - e.g., all hosts and addresses for machines in washington.edu with pointers to subdomains like cs.washington.edu
 -
- One or more nameservers manage each zone
 - Zone transfers performed between nameservers for consistency
 - Multiple nameservers provide redundancy
- Client resolvers query nameservers for specified records
 - Multiple messages may be exchanged per DNS lookup to navigate the name hierarchy (coming soon)

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DNS Lookups/Resolution

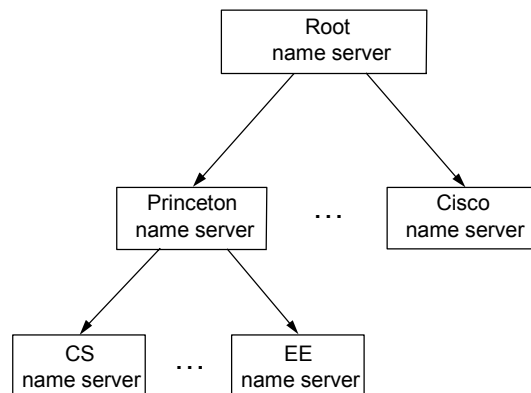
- DNS queries/responses carried on UDP port 53



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Hierarchy of Nameservers



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Caching

- Servers and clients cache results of DNS lookups
 - Cache partial results too (e.g., server for princeton.edu)
 - Greatly improves system performance; lookups the rare case
- Cache using time-to-live (TTL) value from provider
 - higher TTL means less traffic, lower TTL means less stale info
- Negative caching is used too!
 - errors can cause repeated queries for non-existent data

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DNS Bootstrapping

- Need to know IP addresses of root servers before we can make any queries
- Addresses for 13 root servers ([a-m].root-servers.net) handled via initial configuration (named.ca file)

Building on the DNS

- Other naming designs leverage the DNS
- Email:
 - e.g., djw@cs.washington.edu is djw in the domain cs.washington.edu
- Uniform Resource Locators (URLs) name for Web pages
 - e.g., www.cs.washington.edu/homes/djw
 - Use domain name to identify a Web server
 - Use “/” separated string to name path to page (like files)

Future Evolution of the DNS

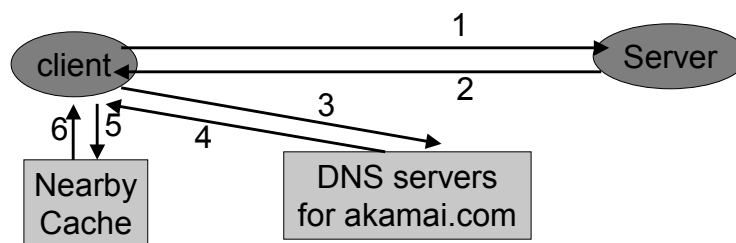
- Design constrains us in two major ways that are increasingly less appropriate
- Static host to IP mapping
 - What about mobility (Mobile IP) and dynamic address assignment (DHCP)
- Location-insensitive queries
 - What if I don't care what server a Web page comes from, as long as it's the right page?
 - e.g., a yahoo page might be replicated

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Akamai

- Use the DNS to effect selection of a nearby Web cache



- Leverage separation of static/dynamic content
- Beware DNS caching

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Key Concepts

- The design of names, addresses and resolution has a significant impact on system capabilities
- Hierarchy, decentralization and caching allow the DNS to scale
 - These are general techniques!