COMP 790-088
Networked and Distributed Systems

Naming

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Types of Identifiers

- Names
  - » for human consumption
  - » location independent
- Addresses
  - » used internally in system
  - » encoding aids in locating entity

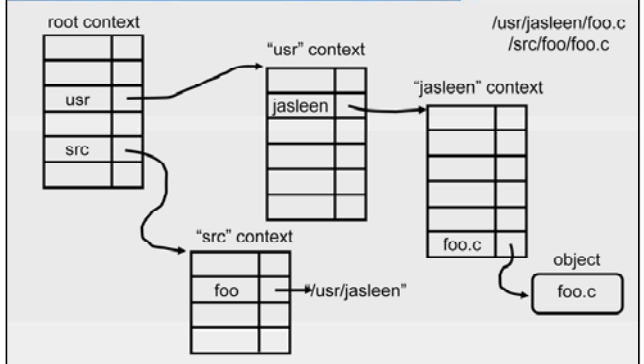
Saltzer's (1977) Naming Objectives

- Share objects by references to names
- Multiple, independent name creators
- Sharing (and naming) independent of location
- Objects can move without changing names or embedded references to names
- Object references can proceed even if some systems are down or isolated

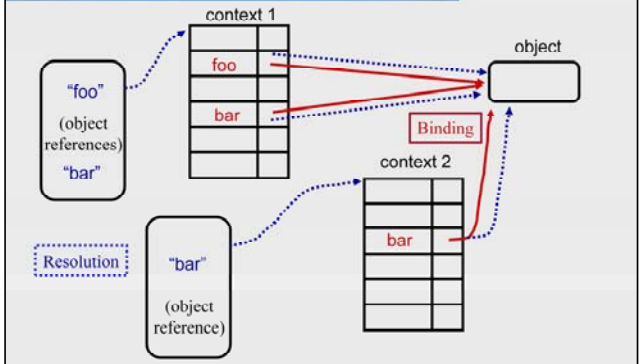
Lampson's (1986) Name Resolution Service adds:

- Universal (all distributed objects)
- Arbitrary number of names and administrative organizations
- Long duration with many changes in the name space and its configuration
- Mistrust among users

Names and Name Contexts



Name Binding and Resolution



Internet Names and Addresses

- Internet Names
  - » human consumable, location independent, identifiers for hosts, service aliases, etc.
  - » examples:
    - swift
    - capefear.cs.unc.edu
    - www.amazon.com

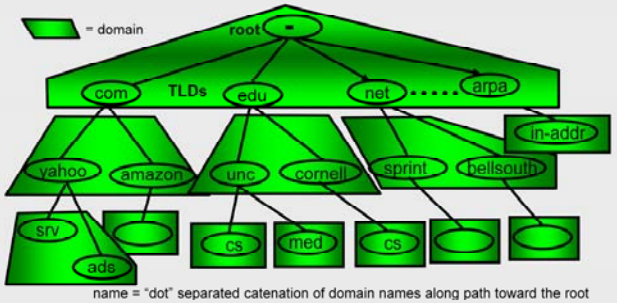
Internet Names and Addresses

- Internet Addresses
  - » 32 bit integer (IPv4) or 128 bits (IPv6)
  - » identifies connection to Internet
    - synonymous with network interface
  - » examples:
    - 152.2.128.19
    - 152.2.128.25
    - 208.33.218.15

Domain Name System

- Primary functions:
  - » map domain names for machines to Internet addresses
    - maps name to list of addresses {0, 1, N}
  - » e.g.,
    - capefear.cs.unc.edu 152.2.128.19
    - swift 152.2.128.25
    - www.llbean.com {65.124.170.23, 65.126.254.23}
  - » map domain names for service aliases (e.g, mail) to Internet addresses
    - mail.cs.unc.edu wren.cs.unc.edu 152.2.128.86

Name Hierarchy in DNS



name = "dot" separated catenation of domain names along path toward the root
e.g., unc.edu
cs.unc.edu
capefear.cs.unc.edu

Top Level Domains

Generic Domains

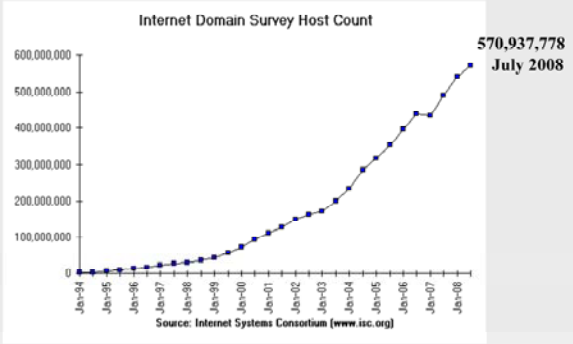
- Current
  - » .com, .org, .net, .edu, .gov, .mil, .int, ***.biz, .info, .name, .pro, .mobi***
- Special Sponsored names
  - » ***.aero, .coop., .museum, .jobs, .travel***

Country Code Domains

(.uk, .de, .jp, .us, .cn, .in, etc.)

Growth of DNS Registrations

Source: Internet Software Consortium (http://www.isc.org/)



Names Became Valuable!

New York Times, Monday, August 9, 1999, pp. C6

Net Address Sold at Auction for $823,456

LOS ANGELES, Aug. 8 (AP) — Bidding for use of the Internet address Drugs.com jumped wildly every few minutes before an auction closed with an offer of $823,456.

The business that submitted the winning bid on Friday wanted to remain anonymous.

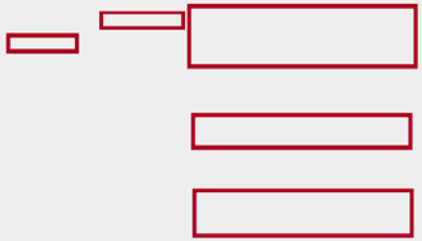
Several large drug companies and well-heeled speculators had expressed an interest, according to Eric MacIver, a 21-year-old Internet entrepreneur in Mesa, Ariz., who held an option on the Drugs.com domain name.

"The bidder will emerge as someone of note," possibly at a news conference in a week or so, said Steve Newman, executive vice president of the on-line broker Great Domains. Great Domains, based in Los Angeles, was joined by Dotbroker.com in conducting the auction.

Other Internet names currently on auction include Loans.com, with a high bid as of Friday at $180,000. "We're going to set an end date in two or three weeks," Mr. Newman said of the Loans.com name auction.

Names Became More Valuable!

New York Times,Tuesday, August 22, 2000, pp. C6



Some Recent Prices (BuyDomains.com, GreatDomains.com), 8/20/07

- SoulSeek.com $4,550,000
- healthscare.com $3,999,000
- shrimp.com $3,000,000
- message.com $750,000
- BeatStreams.com $380,000
- streetmaps.com $375,000
- LuvHomes.com $359,000
- defy.com $350,000
- lovelife.com $350,000
- ConnectingStudents.com $318,000
- WorkSearch.com $313,000
- Fun4Mobile.com $265,000
- sourcecodes.com $250,000
- main.com $250,000
- Grappa.com $250,000
- TeamSpeak.net $240,000
- PopcornMachine.com $225,000
- Muertos.com $215,000

The story of .tv domain

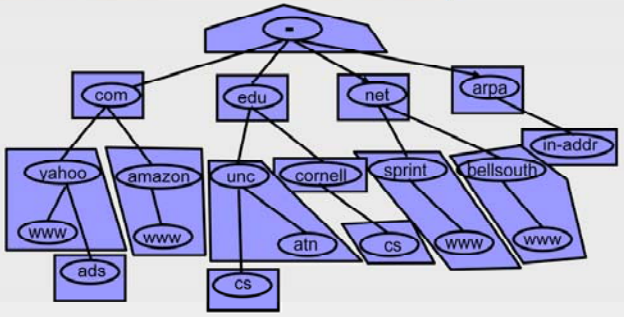
Since 1999, Tuvalu has been able to earn over several million dollars a year marketing it's Internet domain name through the American company .TV Corporation. Tuvalu's unique suffix, ".TV", attracts interest from many individuals, entities and television companies around the world, and some have been willing to pay large sums for internet addresses such as *www.china.tv* or *www.nbc4.tv*. The scheme got off to a rough start, but has now proven to be the largest source of income for the nation. *http://www.tuvaluislands.com/about.htm*

- videos.tv $250,000
- cinema.tv $250,000
- movie.tv $250,000
- trips.tv $250,000
- food.tv $125,000
- sx.tv $100,000
- channel.tv $85,000
- hamberger.tv $80,000

Characteristics of Domain Names

- Large database (proportional to number of users)
- Queries are much more frequent than updates
- Query rate is very high (millions/second?)
- Most data changes slowly (local exceptions)
- Access is more important than timeliness
- Strong shift in names that are queried most?
  - » "nearby" to "remote"

Zones in the Domain Name System

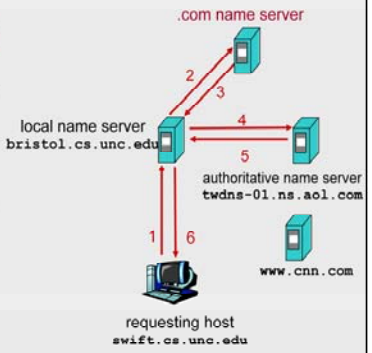


DNS Name Servers

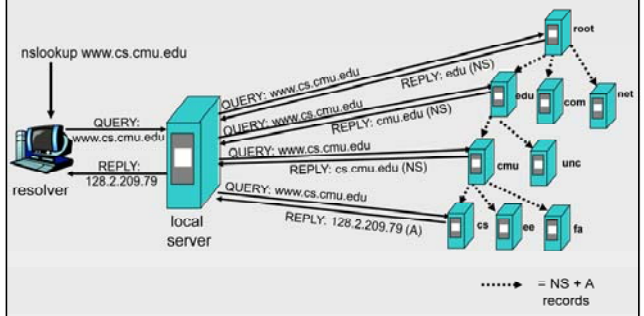
- authoritative name server:
  - »designated repository for a host's IP address and name
  - »performs name/address translation for that host name
- *local* authoritative name servers:
  - »each ISP, university, company, etc., has *local (default) name server* authoritative for its own hosts, routers, etc.
  - »*resolvers* always query a *local* name server to resolve *any* host name

DNS: Using Hierarchy for Resolving

- To resolve non-local name:
  - »local name server queries .com server -- "what server is authority for www.cnn.com?"
  - ».com server returns name and IP address of server it knows is closest match to query.
  - »local server sends same query to twdns-01.ns.aol.com
  - »process can be iterated until the local authoritative name server is found and responds



DNS Resolution - Iterated Query



DNS Records

DNS: distributed database storing Resource Records (RR)

RR format: `<name, value, type, time_to_live>`

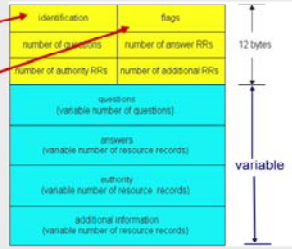
- Type=A
  - `name` is hostname
  - `value` is IP address
- Type=NS
  - `name` is domain (e.g. foo.com)
  - `value` is name of authoritative name server for this domain
- Type=CNAME
  - `name` is an alias name for some "canonical" (the real) name
  - `value` is canonical name
- Type=MX
  - `value` is name of mail server host associated with `name`

DNS Protocol and Messages

DNS protocol : *query* and *reply* messages, both with same *message format*

message header

- identification: 16 bit # for query, reply to query uses same # for matching
- flags:
  - query or reply
  - reply is authoritative
  - etc.



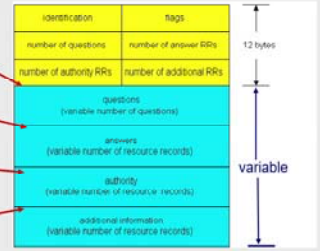
DNS Protocol and Messages

Name, type fields for a query

RRs that answer (resolve) the name; may not be present

RRs for authoritative servers

additional information (usually the IP address of authoritative servers)



Try it yourself: an interactive *resolver* program for XP is **`nslookup`**. In a Command Prompt window, use

```
C:\>nslookup
> ?
```

Gives usage information. Hint: configure window with 50 lines, turn on debugging

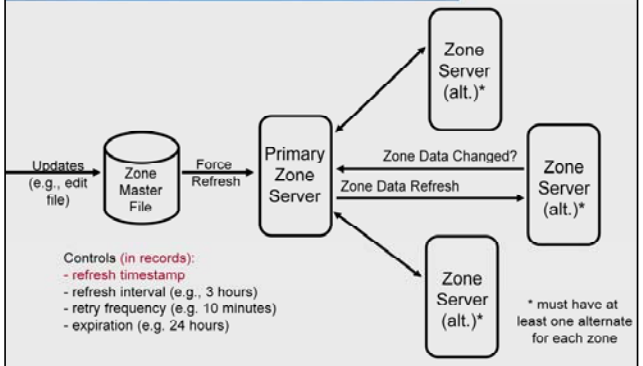
Example Reply from .edu Zone Server

Note: the reply message has been formatted by the resolver program `host` *for printing and differs slightly from the from given on the previous slide.*

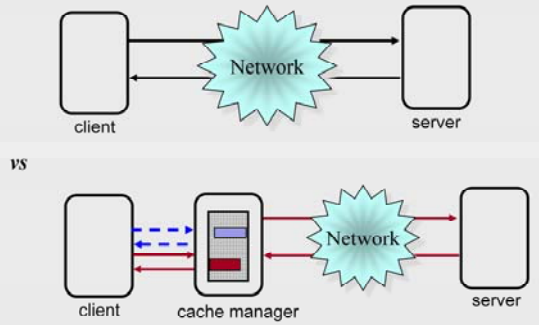
```
> host -v www.ohsu.edu
Trying null domain
rcode = 0 (Success), ancount=2
For authoritative answers, see:
ohsu.edu           73748 IN        NS      steele.ohsu.edu
ohsu.edu           73748 IN        NS      fremont.ohsu.edu
ohsu.edu           73748 IN        NS      medgon.ohsu.edu
ohsu.edu           73748 IN        NS      cse.ogi.edu
Additional information:
steele.ohsu.edu    73748 IN        A       137.53.1.40
fremont.ohsu.edu   73748 IN        A       137.53.1.30
medgon.ohsu.edu    91302 IN        A       137.53.203.5
cse.ogi.edu       122220 IN        A       129.95.20.2
```

name | time to live (seconds) | type | value

DNS Database Maintenance



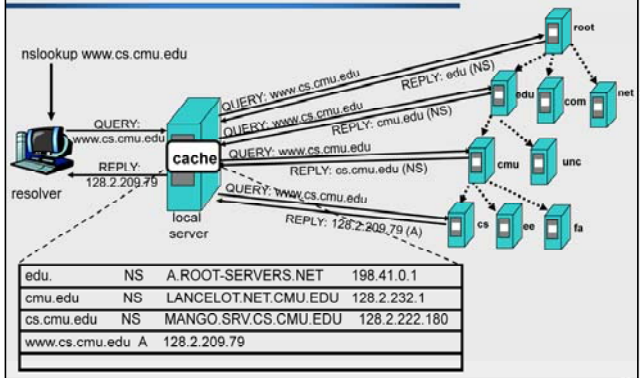
Performance of Object References



Cache Design Issues

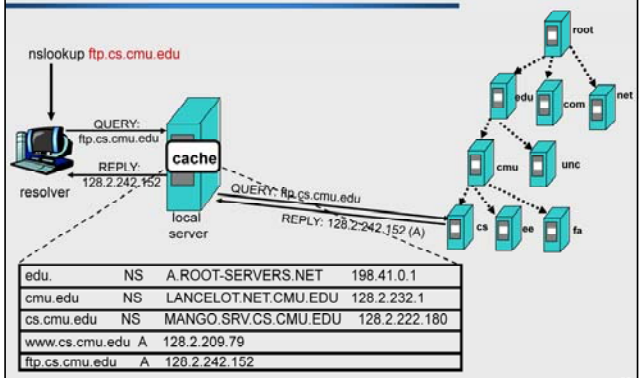
- Size
  - » major influence on "hit ratio"
  - » $T_{avg.}$ = hit_ratio * $T_{avg.-cache}$ + (1 - hit_ratio) * $T_{avg.-remote}$
- Location
  - » memory vs disk (speed vs size)
- Replacement
  - » free space for new data when full
- (in)Validation
  - » does the cache hold "current" information?

DNS Resolution with Cache



edu.	NS	A.ROOT-SERVERS.NET	198.41.0.1
cmu.edu	NS	LANCELOT.NET.CMU.EDU	128.2.232.1
cs.cmu.edu	NS	MANGO.SRV.CS.CMU.EDU	128.2.222.180
www.cs.cmu.edu	A	128.2.209.79	

DNS Resolution with Cache



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cmu.edu	NS	LANCELOT.NET.CMU.EDU	128.2.232.1
cs.cmu.edu	NS	MANGO.SRV.CS.CMU.EDU	128.2.222.180
www.cs.cmu.edu	A	128.2.209.79	
ftp.cs.cmu.edu	A	128.2.242.152	