COMP312-09A Communications and Systems Software

Lecture 4 – DNS, HTTP, Apps

Pages 588 to 611 – Tanenbaum 4th Ed.

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DNS

- We know a fair amount of DNS from COMP202-08B
  - Root servers
  - DNS uses UDP by default
  - Top level domains (TLDs), second level domains (SLDs)
  - Iterative protocol
  - TTLs
- This lecture will add a couple of details to that
- Pages 579-588 in Tanenbaum 4th Ed.

DNS record types

- A: Address.
  - Maps name to IP address
- PTR: Pointer.
  - Maps IP address to name
- MX: Mail exchanger.
  - Host willing to accept mail
- NS: Name server
  - Who will answer DNS requests for specified domain
- TXT: Text record
  - Arbitrary text
- CNAME: Canonical name
  - Maps alias to a single true name

- Client has name: www.amazon.com
  1. Ask root server: what is the IP address for www.amazon.com?
     - reply: I don't know. Try
       .com NS a.gtld-servers.net
       a.gtld-servers.net A 192.5.6.30
       or 15 other servers they also specify
  2. Ask .com name server: IP address for www.amazon.com?
     - reply: I don't know
       amazon.com NS udns1.ultradns.net
       amazon.com NS udns2.ultradns.net
       udns1.ultradns.net A 204.69.234.1
       udns2.ultradns.net A 204.74.101.1
  3. Ask amazon.com NS: IP address for www.amazon.com?
     - Reply: ask www.amazon.com NS ns-923.amazon.com
     - ns-923.amazon.com A 72.21.204.20
  4. Ask ns-923.amazon.com NS: IP address for www.amazon.com:
     - Reply: www.amazon.com A 72.21.210.250

You can play along at home

- dig www.amazon.com @a.root-servers.net
- dig www.amazon.com @a.gtld-servers.net
- dig www.amazon.com @udns1.ultradns.net
- dig www.amazon.com @ns-923.amazon.com

Correct at March 9th 2009

- Use:
  - dig <name to look up> <optional server to query>
  - If server to query is not specified, answer will come from name server your machine has configured
  - Answer is likely to be cached from previous lookup if querying local name server

```
[mluckie@sorcerer mjl]$ dig www.google.com

;; QUESTION SECTION:
;www.google.com.                        IN      A

;; ANSWER SECTION:
www.google.com.         568515  IN      CNAME   www.l.google.com.
www.l.google.com.       280     IN      A       209.85.171.104
www.l.google.com.       280     IN      A       209.85.171.147
www.l.google.com.       280     IN      A       209.85.171.99
www.l.google.com.       280     IN      A       209.85.171.103

;; AUTHORITY SECTION:
google.com.             83534   IN      NS      ns2.google.com.
google.com.             83534   IN      NS      ns3.google.com.
google.com.             83534   IN      NS      ns4.google.com.
google.com.             83534   IN      NS      ns1.google.com.

;; ADDITIONAL SECTION:
ns1.google.com.         163922  IN      A       216.239.32.10
ns2.google.com.         163922  IN      A       216.239.34.10
ns3.google.com.         163922  IN      A       216.239.36.10
ns4.google.com.         163922  IN      A       216.239.38.10
```

Answer comes from local name server

HTTP

- We know a fair amount of HTTP from COMP202-08B
  - Hypertext Transfer Protocol
  - Protocol spoken by web browsers
  - Assignment 2 was to implement a basic web server
  - Uses TCP
    - Reliable, byte-stream, connection oriented transport protocol
  - Well known port 80
  - request/response protocol
- Pages 611 to 662 Tanenbaum 4th Ed.
  - Though 652 to 662 are the most important
  - Won't be considering HTML etc, there are whole other courses on that

HTTP

- http://www.wand.net.nz/~mluckie/
- URL consists of
  - Protocol (http)
  - name of machine where resource is found (www.wand.net.nz)
  - File (/~mluckie/)

HTTP

- http://www.wand.net.nz/~mluckie/
- Protocol steps follow from URL
  1. Parse the URL for its components
  2. Ask DNS for IP address of www.wand.net.nz
  3. DNS replies with 130.217.250.15
  4. Make a TCP connect to port 80 on 130.217.250.15
  5. Request /~mluckie/
  6. Server sends file associated with this resource (index.html)
  7. Close TCP connection
  8. Display page
  9. Fetch all images and media in page, using steps 1-8

HTTP GET

```
GET /~mluckie/ HTTP/1.1
Host: www.wand.net.nz
User-Agent: Mozilla/5.0 (X11; U; FreeBSD i386; rv:1.9.0.5)
Accept: text/html,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Pragma: no-cache
Cache-Control: no-cache
```

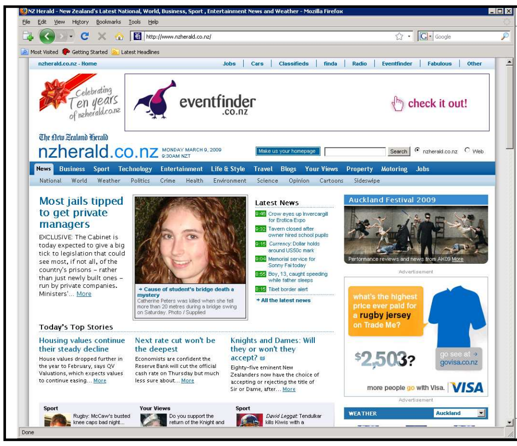
HTTP/1.1 200 OK

```
HTTP/1.1 200 OK
Date: Sun, 08 Mar 2009 20:38:04 GMT
Server: Apache/2.0.54 (Debian GNU/Linux)
Last-Modified: Mon, 15 Dec 2008 20:52:54 GMT
ETag: "6c3810b-965-6dbb580"
Accept-Ranges: bytes
Content-Length: 2405
Keep-Alive: timeout=15, max=99
Connection: Keep-Alive
Content-Type: text/html; charset=ISO-8859-1
```

Main Problem with HTTP 1.0

- Protocol: each request uses a separate TCP connection
  - This worked fine when a web page was marked-up text
- Problem:
  - These days web pages contain lots of images in them
  - Each image requires a separate TCP connection
    - 3-way handshake
    - Data
    - 3 or 4-packet disconnect
    - Overhead is magnified for people living far from most of the web's content. i.e. NZ to US round-trip-times.
  - TCP connections would rarely get out of slow-start
    - i.e. would go slow, rarely using the available capacity in the network

How many images on this page?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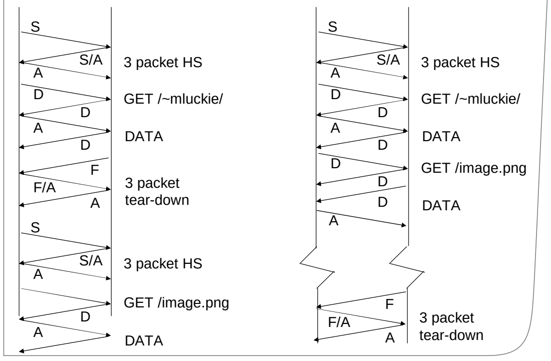
HTTP/1.1

- Persistent connections
  - Establish TCP connection
  - Send a request, get a response
  - Send further requests and get further responses
    - Good for fetching images to be displayed inline
  - Keep TCP connection open for a short period (about a minute)
    - Good for fetching other web pages from the same server when the user clicks a link
- Pipelining
  - Send multiple requests simultaneously over single TCP connection

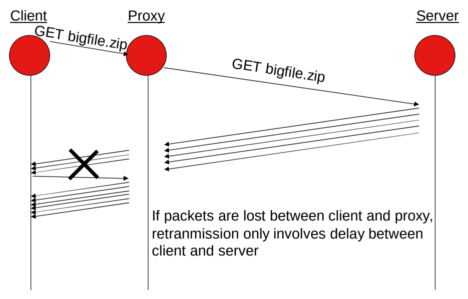
HTTP 1.0 vs 1.1



Further Performance Enhancements

- Browser Caching
  - HTTP headers provide information on when a file was last modified, information on if the data should be cached, etc
  - HTTP protocol support for fetching If-Modified-Since
- Proxy Server Caching
  - Server whose job it is to cache files
  - Multiple clients can use, some benefit to be had in addition to browser caching if clients tend to visit the same sites
  - Useful for authentication and billing
  - Client has shorter TCP retransmission domain

TCP retransmission domain

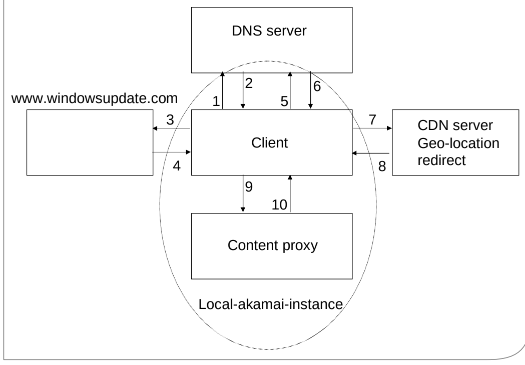


If packets are lost between client and proxy, retranmission only involves delay between client and server

Content Delivery Networks

- Company pays ISPs to host servers which replicate large websites
  - ISPs will happily take this service because it makes them money, gives their users better user-experiences
  - Content providers (windows update, etc) pay CDN to host their website
  - CDN needs to have some way to map a user to their closest replica, i.e. IP to geo-location service
- Akamai largest CDN example

Example



Summary

- DNS has multiple record types
- HTTP good example of protocol which can be optimised in ways designers had not first thought about
  - Persistent connections
  - Pipelining
  - Proxy servers
  - CDNs
- For a protocol to be worth optimising, it must first get critical mass
  - Bittorrent another example of protocol where significant research into optimisation is taking place.