Computer Networking: Supervision 6

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Topic 06 - Network Applications

22. Internet Applications

    (a) HTTP is an application protocol, built on TCP, which was originally designed to allow retrieval of hypertext documents. Firewalls are application-level gateways (or routers) which aim to filter out malicious, illegal or unauthorised IP traffic based on the contents of packet payloads.

        i. Explain why network firewalls traditionally accept inbound HTTP traffic, but may not accept traffic for other services such as network filesystems or e-mail transfer (SMTP).

        > Web servers are very common and almost always designed to be accessible to the internet, where as access to networked file systems should be restricted to the local network.

        ii. Describe the similarities and differences between an e-mail gateway (as might have been found joining two wide-area networks before the advent of IP) and an application-level firewall.

        > They are similar in that they form the boundary between two networks and can control what travels across the boundary but are different since one is concerned with the security of a network and the other is not.

        iii. In modern networks, HTTP is used as a transport for remote procedure call, e-mail and even networked filesystems. A network engineer proposes that, to counter security concerns regarding some types of HTTP traffic, there is a need for a higher-level firewall which can selectively filter these. Suggest why this is more difficult than a firewall operating at the levels of TCP and UDP, and explain why this does not solve the security problem.

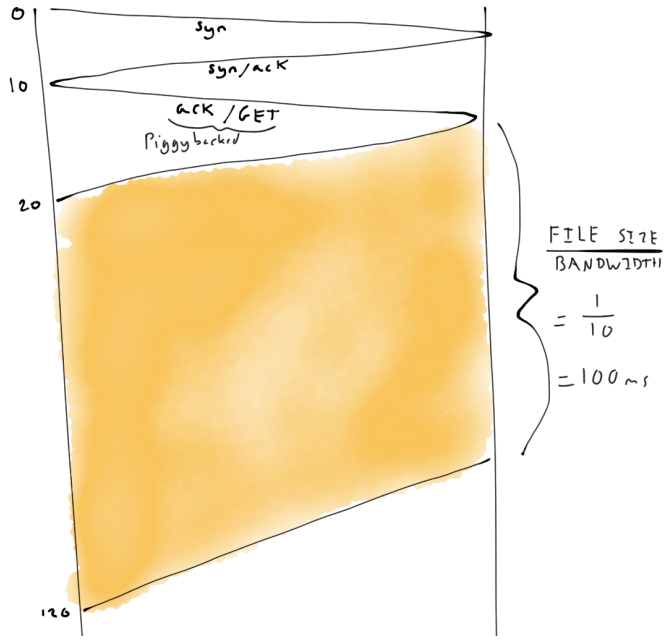
This is much more difficult as the firewall would have to parse and analyse the entire HTTP request which may be split across many packets and thus it would have to hold the packets until it could identify what they were.

It would always be possible to tunnel any disallowed protocol over an allowed one.

(b) Consider a case where a client A is retrieving files F and G from web site B. F and G are both 125 KB (i.e., one megabit).

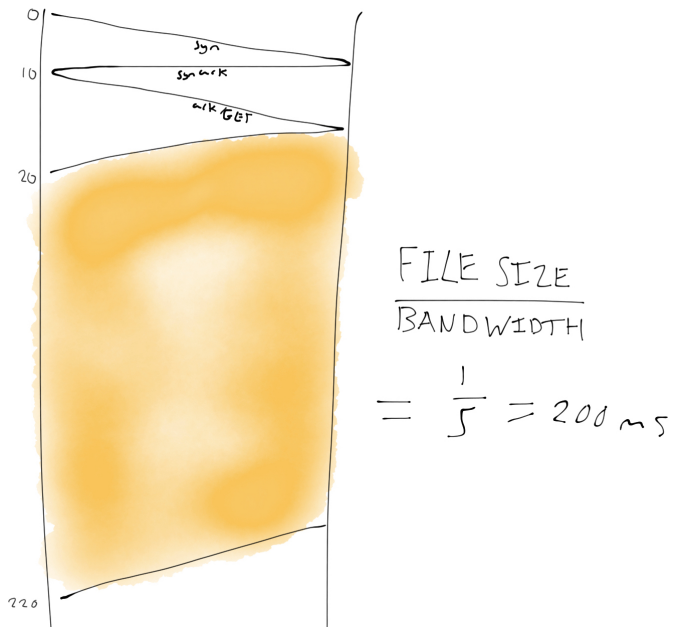
i. The RTT between A and B is 10 ms (note, these are roundtrip-times, not one-way latencies), and the bandwidth between the sites is 10 Mbps. Assume all TCP SYN/ACK packets and HTTP request packets are negligible in size. How long does it take A to retrieve both files under the following circumstances:

α) Sequential (one-at-a-time) requests with non-persistent TCP connections?



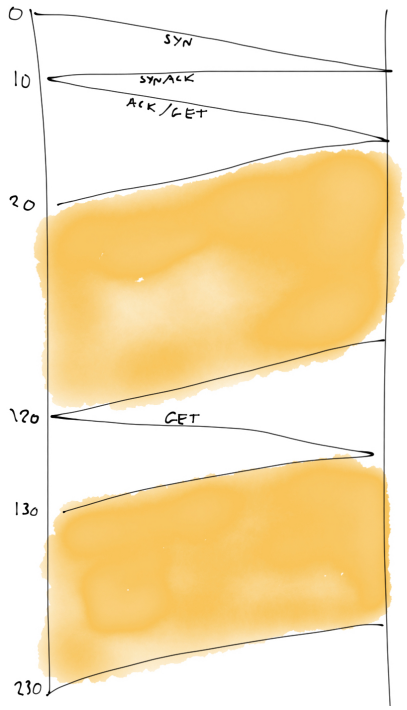
Since the connection is non persistent the above transmission happens twice (serially) and thus the total time taken is 240 ms.

β) Concurrent requests with non-persistent TCP connections?



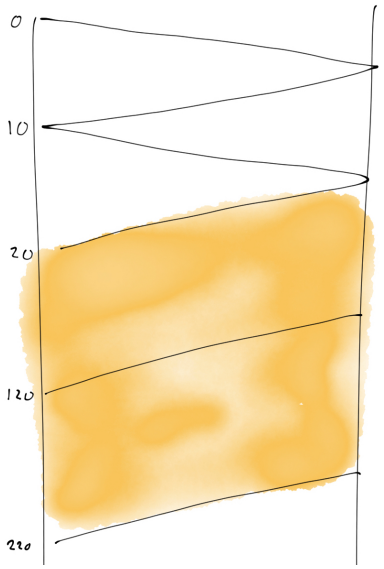
Since the connections are concurrent only half the bandwidth is available to each one. Total time is 220 ms.

γ) Sequential requests within a single persistent TCP connection?



Total time is 230 ms.

δ) Pipelined requests within a single persistent TCP connection?



Total time is 220 ms.

ii. Consider the same situation as above, but assume that rather than a dedicated link there is a large shared link with many flows traversing it, and each TCP connection gets 10Mbps (adding additional flows does not significantly change the bandwidth per TCP connection, because there are thousands of flows on the link). Now, how long does it take A to retrieve both files under the following circumstances:

α) Sequential (one-at-a-time) requests with non-persistent TCP connections?

Same as above, 240 ms.

β) Concurrent requests with non-persistent TCP connections?

120 ms as both requests get 10 mbps of bandwidth.

γ) Sequential requests within a single persistent TCP connection?

> Unchanged from previous question, therefore 230 ms.

δ) Pipelined requests within a single persistent TCP connection?

> Unchanged from previous question, therefore 220 ms.

iii. Consider the first situation, except that A is only downloading file F and there is now a cache C between A and B. All requests from A to B go through cache C, and assume the bandwidth along the path from A to C is 1 Gbps and the RTT between A and C is negligible, while the bandwidth along the path from C to B is 10 Mbps with an RTT of 10 ms. Note, these are round-trip times, not one way latencies. As above, assume that the file is 125 KB (i.e., one megabit) and that all TCP SYN/ACK packets and HTTP request packets are negligible in size.

Assume the cache operates as follows: (where the origin server refers to the site named in the URL)

- If the object is not in the cache, the request is forwarded to the origin server.
- If the object is in the cache, and the cache entry has not timed out (i.e., the cache TTL has not expired), the object is returned to the client.
- If the object is in the cache, but the cache entry has timed out, the cache issues a conditional-GET to the origin server, asking if the object has changed since this object was cached: if the origin server responds that it hasn't, the cache returns the cached object, otherwise the origin server responds with the updated object which the cache forwards to the client.

How long does it take for A to retrieve the file under the following circumstances:

α) The file is not in the cache.

> This depends whether the cache streams the response from the origin server, or stores and forwards it.
>
> In the former case it is 120 ms as 20 ms is required to setup the TCP connection between the cache and the origin server and 100 ms to transfer between the origin server and the cache (since we have assumed streaming and the connection

between A and C is faster than the connection between B and C, the additional time is simply the RTT between A and C which is negligible.).

In the latter case it is 121 ms since an additional 1 ms is required to transfer from C to A.

β) The file is in the cache and the TTL has not expired?

1 ms ($\frac{filesize}{bandwidth}$)

γ) The file is in the cache, the TTL has expired, but the file has not been changed.

20 ms is required for the SYN/ACK handshake and GET request to the origin server from the cache. Since the file has not been modified the response from the origin server will be negligible in size and the cache then takes a further 1 ms transmitting the file back to A.

Total time = 21 ms

δ) The files is in the cache, the TTl has expired and the file has changed?

This is the same as the file not being in the cache as the overhead of adding an `Is-Modified-Since` is negligible. It therefore takes 121 ms.

iv. Why is this question answerable *before* you have even discussed TCP?

Well, you need to know about the connection setup part of TCP.

23. DNS as an Internet application

(a) Consider the host `here.eye.am`, with a local DNS server `nameserver.eye.am`. `here` asks `nameserver` to resolve the hostname `there.you.ar`. Assume there are no cached entries relevant to this request and that `nameserver.eye.am` utilises recursive resolution by default.

i. Write down the steps taken to resolve `there.you.ar` and respond to `here.eye.am`.

This question is a little silly as this is not possible over the internet, since the root servers do not support recursive DNS queries.

1. The nameserver makes a recursive request to the root server.
2. The root server makes a recursive request to the TLD DNS server.
3. The TLD server makes a recursive request to the authoritative DNS server.
4. The authoritative DNS server responds to the TLD server.
5. The TLD server responds to the root server.
6. The root server responds to the nameserver.

ii. Describe the differences between this solution and one achieved using an iterative DNS enquiry.

With iterative DNS queries, every reply goes back to the host and it is up to them to then continue the query against the next host.

This method restricts the advantage of having a cache at the resolver since if the query was not in the cache it will not be added, as the server will simply refer the client to a different server.

25. P2P

(a) Peer-to-Peer systems might typically do some combination of three tasks, searching (e.g., keyword search), lookup (mapping name to location), and download.

Of the following phrases pick the most appropriate for each question.

- Some form of flooding
- Distributed Hash Tables
- Chunking
- Number of participating peers
- Asymmetry of bandwidth
- Lack of centralised control
- Self-scaling

i. Which approach is often used for download?

> Chunking

ii. Which approach is typically used for search?

> Some form of flooding

iii. Which approach is typically used for lookup?

> Distributed hash tables

iv. Which factor is most responsible for making chunking advantageous?

> Asymmetry of bandwidth

(b) Skype and iPlayer both have a P2P heritage. Skype - a P2P success, iPlayer less so.

i. Considering Metcalfe's law, why has Skype been a success?

> Even if products come along that have feature/reliability/cost parity (or even better features/reliablility/cost) they will find it hard to penetrate the market as "everyone is on skype".

ii. Why did iPlayer P2P not succeed whereas iPlayer most definitely has succeeded.

> The peer to peer client would upload data even when idle, which was not what users were expecting and may have been charged by their ISP for. After user backlash and significant investment into their streaming infrastructure they moved to HTTP downloading.

iii. Skype is described as a hybrid application - both P2P and client-server. Explain this.

> Before Microsoft acquired Skype this statement was accurate since it had a central server (actually several server farms) that

handled authentication, presence, billing etc. Skype calls would then be made peer to peer.

After Microsft acquired Skype its infrastructure has changed such that almost all skype calls now go via Skype's network.