$$\text{prop. delay} = \tau = \frac{1000\times10^3\ m}{2\times10^8\ ms^{-1}}\times10^3\ ms$$

$$RTT = 2\tau + \frac{2\times10\,kb}{15\,Mbps}$$

$$OTT = \frac{20\,MB + 250\,kb}{15\,Mbps}$$

$\therefore$ Total time $= 11\times2\times RTT + OTT$

CSE421 Assignment 1

1. Consider a client and server are **1000 km** apart. They are connected through a cable where the signal can propagate at **2x10^8 ms^{-1}**. The client sends a request to load a webpage which contains **10** images all of which are **20 MB**. The webpage itself is **250 Kb**. All other data are of **10 Kb** in size. Now, the server takes **10 ms** time to process each HTTP request before sending a reply. The client has an internet connection of **15 Mbps**. Now **calculate** the total time needed to load the webpage if the client is using a non-persistent connection. **Show** your work.

2. You are planning to replace an existing cache server, Server X, with a more advanced but more costly cache server, Server Y. The network you are using has a LAN delay of **10 ms**, Access delay of **1.5 s** and Internet delay of **30 ms**. Your existing server X has a hit ratio of **35%**. Its current market price is **$1000**. For each millisecond gain in response time, **$10** is earned more (in a year). The price of a new cache server is **$3000**. **Calculate** the expected hit ratio of the new cache server so that the new buy is financially justified, i.e. cost is recovered within a year.

Server X time (X_{time}) $= (0.35\times10 + 0.65\times1540)$ ms

Let new server hit ratio be h

$\therefore$ New server timing (Y_{time}) $= h\times10 + (1-h)\times1540$

$\therefore$ Income $= 10\times(X_{time} - Y_{time})$

Solve for h

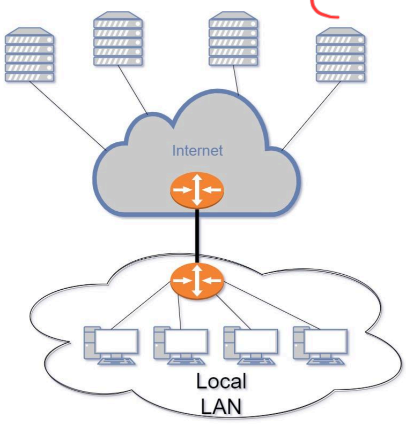
$10(X_{time} - Y_{time}) = 2000$

3. A user wants to receive **N** number of data each of **M bytes** from an HTTP server. The network bandwidth is **B Mbps** and all other messages are of **T bytes** each. How much time will it take for the HTTP response in the case of non-persistent HTTP and persistent HTTP? Compare and determine which is more expensive.

$$N\times\left(2\times2\times\frac{T}{B} + \frac{M}{B}\right)$$

$$2\times\frac{T}{B} + N\times\left(2\times\frac{T}{B} + \frac{M}{B}\right)$$

4.



Consider the above figure, for which an institutional network is connected to the Internet. Suppose that the average object size is **1,000,000 bits** and that the average request rate from the institution's browsers to the origin servers is **12 requests/s**. Also, suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is **3 s** on average. Model

$$\text{Avg access delay} = \frac{\Delta}{1-\Delta b} = 333.35\ ms$$

$$\Delta = \frac{1\,Mb}{15\,Mbps} = 66.67\ ms$$

the total average response time as the sum of the average access delay (that is, the delay from the Internet router to the institution router) and the average Internet delay. For the average access delay, use **$\Delta/(1 - \Delta b)$**, where Δ is the average time required to send an object over the access link and b is the arrival rate of objects to the access link. The bandwidth of the local LAN is **100 Mbps** and the bandwidth of the access link is **15 Mbps**.

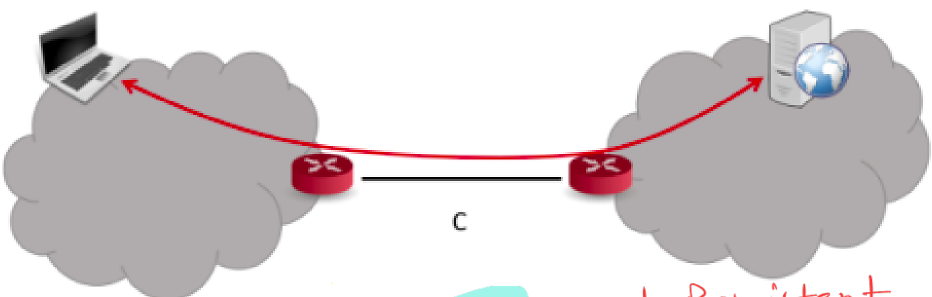
a. Find the total average response time. → 3s + 333.35 ms
b. Now suppose a cache is installed in the institutional LAN. Suppose the miss rate is 0.4. Find the total response time. 0.6 × LAN_delay + 0.4(←)

5. In the following you can find the content of an HTTP Request. Answer to the following questions, indicating where (e.g., in which field) in the HTTP Request you can find the answer:

GET /martignon/index.html HTTP/1.1
Host: cs.unibg.it
User Agent: Mozilla/5.0 (Macintosh; U; PPC Mac OS X; en)
AppleWebKit/124(KHTML, like Gecko) Safari/125
Accept: ext/xml, application/xml, application/xhtml+xml, text/html;q=0.9, text/plain;q=0.8, image/png,*,*;q=0.5
Accept-Language: it
Keep-Alive: 300
Connection: keep-alive

a. What is the requested URL? → cs.unibg.it/martignon/index.html
b. Which version of HTTP is used? → 1.1
c. What will be the language of the webpage? → Italian
d. Does the browser ask for a persistent or a non-persistent connection?
e. What is, in your opinion, the utility in indicating the type (and version) of browser used by the client in the HTTP Request? Mozilla Firefox

6. An HTTP client requests to an HTTP server a web page constituted by one main object (an HTML file) and **10** other objects. Each object has a size equal to **L=200 kbit**. The bidirectional connection between the client and the server has a capacity of **C=100 kbps**. The control messages used to open the TCP connection between the client and the server, as well as the HTTP "GET" message, have a size **m=100 bits**. The propagation delay of the link is **τ = 100 ms**.
Compute the total time necessary for the client to receive the web page and the **10** objects in the two following cases:



N.P.

(a)

$RTT = 2\tau + \frac{200b}{100/11}$

$\therefore$ Total time $= 2 \times RTT + \frac{200kb}{100/11 kbps}$

Persistent

(b)

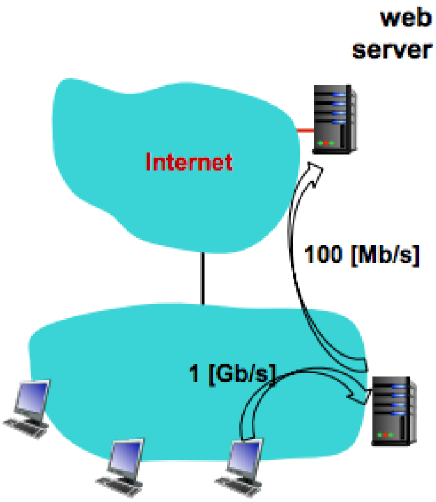
$RTT = 2\tau + \frac{200b}{100}$

Total time

$= RTT + 11 \times (RTT + \frac{200kb}{100})$

a. The HTTP client opens in parallel and in a non-persistent way all TCP connections necessary to download the web page and the 10 related objects (let us assume that the transmission rate of all TCP connections is equal to **r=C/N**, where N is the number of connections open in parallel).
b. The HTTP client opens serially 11 TCP connections, in a non-persistent way.

7. An organization owns a Local Area Network (LAN) with an HTTP proxy having a local cache (see Figure below).



Clients are connected to the HTTP proxy with a dedicated high-speed connection having capacity **C=1 Gbps**. The probability that the content (a web page) requested by a generic client is found in the cache of the local proxy (cache hit rate) is **P=0.4**. **Calculate** the average delay experienced by a generic client, from the instant in which it sends the HTTP request for a web page to the time in which it obtained the requested page.
Let us assume that: the http request messages have size of **100 B**, the requested web page has size equal to **100 kB**, the HTTP proxy has a communication channel with equivalent capacity **c=100 Mbps** towards the origin server that hosts the requested webpages

a. The opening and closing time for TCP connections between the client and the proxy as well as between the proxy and the server is negligible,
b. propagation delays are negligible.

$$\text{LAN delay} = \frac{100\,B}{1\,Gbps} + \frac{100\,kB}{1\,Gbps}$$

$$\text{Access \& Internet delay} = \frac{100\,B}{100\,Mbps} + \frac{100\,\cancel{k}B}{100\,Mbps}$$

$$\therefore \text{Total delay} = 0.4 \times \text{LAN delay} + 0.6 \times (\text{Access \& Internet delay})$$