Input parameters

- LAN BANDWIDTH : in Megabits/sec
- Max PDU : maximum Protocol Data Unit size for the LAN's network layer protocol (in bytes)
  (MTU : Maximum Transmission Unit at Network Layer)
- Frame Ovhd : frame overhead of the LAN's link layer protocol (in bytes)
- Router Latency : router latency in microseconds per packet
- Link Bandwidth : bandwidth of the connection to the ISP (in megabits/sec.)
- Internet Delay RTT : Internet Round Trip Time (in milliseconds)
- Internet Data Rate : Internet data transfer rate (in Kbps)
- Browser Rate : rate, in HTTP operations/sec, at which a browser requests a new document when the user is in the think mode : the inverse of the user's think time

- NumberClients: number of client workstations
- PercentActive: percent of client workstations using the Web
- AvgSizeHTTPRequest: average size of the HTTP request sent by the browser to the server, in bytes
- Document requested
  - R: number of categories
  - DocumentSizer: average document size (in KB), of category r (r: 1...R)
  - PercentSizer: percent of documents requested that are in category r (r: 1...

$$\text{DocumentSize} = \sum_{r=1}^{R} \text{DocumentSize}_r \cdot \text{PercentSize}$$

in Kibbytes

CALCOLO DELLE SERVICE DEMAND

7 new

service demand at queue 2 : LAN

- 2 TCP segment (without "body" message)
  x synchronization del protocollo HTTP
  (il terzo è "piggybaked" nella richiesta HTTP)

  ∴ diventano 2 DATAGRAMS

- 1 TCP segment
  x la HTTP request

  diventano N1 datagrams, funzione
  delle dimensioni della richiesta
  (Avg Size HTTP Request)

- Trasmissione del documento richiesto

  diventano N2 datagrams, funzione
  delle dimensioni del documento
  (1.024 x Document size)

- 3 TCP segments to close connection

$$D_{LAN} = 2 \cdot \text{NetworkTime}(0, \text{LANBandwidth}) +$$

$$\text{NetworkTime}(\text{AvgSizeHTTPRequest}, \text{LANBandwidth}) +$$

$$\text{NetworkTime}(1024 \times \text{DocumentSize}, \text{LANBandwidth}) +$$

$$3 \cdot \text{NetworkTime}(0, \text{LANBandwidth})$$

dove

$$\text{NetworkTime}(m, B) = \frac{8 \times \lceil m + \text{Overhead}(m) \rceil}{10^6 \cdot B}$$

Caso senza frammentaz. IP
& $m \leq 65515$

$$\text{Overhead}(m) = (\text{NDatagrams}(m) - 1) \cdot (\text{IPOvhd} + \text{FrameOvh}$$

$$+ \text{TCPOvhd} + \text{IPOvhd} + \text{FrameOvhd} =$$

$$= \text{TCPOvhd} + \text{NDatagrams}(m)(\text{IPOvhd} + \text{FrameOv}$$

$$\text{NDatagrams}(m) = \left\lceil \frac{m + \text{TCPOvhd}}{\min_n \{\text{MTU}_n - \text{IPOvhd}\}} \right\rceil$$

Caso senza frammentaz. IP

$L_m \leq 65515$ p.e. 40'000 byte

segmento TCP

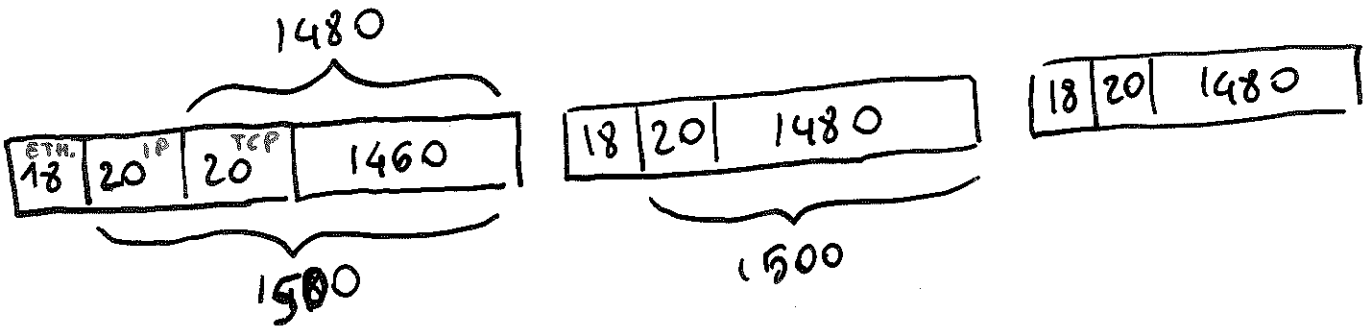
20	40'000

hp: rete "Ethernet"

Overhead: 18
Max data area: 1500
} Max PDU Size = 1518

senza framm. IP: i datagram vengono generati con

Overhead: 20
Max data area: 1480
} Max PDU Size = 1500



... 

$$N_{Datagram}(m) = \left\lceil \frac{40\,000 + 20}{1480} \right\rceil = 28$$

Caso senza framm. IP

& $m > 65515$ p.e. 100'000

Segment. TCP

20	65515

20	34485

hp: rete Ethernet

senza framm. IP

1° SEGMENTO

18	20	20	1460

18	20	1480

18	20	1480

...

18	20	1480

18	20	415

2° SEGMENTO

18	20	20	1460

18	20	1480

18	20	1480

...

18	20	1480

18	20	465

$$N_{segments} = \left\lceil \frac{Message\ Size}{65515} \right\rceil \quad \text{i.e.} \quad \left\lceil \frac{100'000}{65515} \right\rceil = 2$$

$$N_{Datagrams}(I\ segm) = \left\lceil \frac{m + TCPOvh}{\min_m \{MTU_m - IPOverh\}} \right\rceil =$$

$$\text{i.e.} \quad \left\lceil \frac{65515 + 20}{1480} \right\rceil = 45$$

$$N_{Datagrams}(II\ segm) = \left\lceil \qquad \right\rceil =$$

$$\text{i.e.} \quad \left\lceil \frac{3485 + 20}{1480} \right\rceil = 24$$

$$N_{Datagrams} = N_{datagrams}(I\ segm) + N_{datagrams}(II\ segm)$$

stima approssimata

$$N_{datagrams} = \left\lceil \frac{Message\ Size + N_{Segments} \times TCPOvh}{\min_m \{MTU_m - IPOvh\}} \right\rceil$$

$$Overhead_n = N_{segments} \times TCP\ Ovh + N_{Datagrams} \times (IP\ Ovh + Frame\ Ovh_n)$$

$$Service\ Time(m) = Network\ Time(m, B) =$$

$$= \frac{8 \times [msg\ size^{(m)} + Overhead(m)]}{10^6 \cdot B}$$

Service demand at queue 3: router

$$D_{router} = [N_{DATAGRAMS}(1024 \times DocumentSize) + 6] \times RouterLatency \times 10^{-6}$$

↑ microsecond

6: 2 + 1 for synchronization segments
1 is piggy-backed in the HTTP request

1 for HTTP request

3 TCP segments to close connection

Service Demand at queue 4: OUTGOING LINK

$$D_{OUT_L} = \text{NetworkTime}[\text{Avg Size HTTP Request, Link Bandwidth}] + 3\,\text{NetworkTime}[0, \text{Link Bandwidth}]$$

↑ # of TCP synchronization segments to open and close the HTTP protocol

Service Demand at queue 5: ISP, Internet and WS

$$D_{int} = \frac{\text{Internet Delay RTT}}{10^3} + \frac{1}{2}\frac{\text{Internet Delay RTT}}{10^3} + \frac{\text{Document Size}}{\text{Internet Data Rate}}$$

↑ Time to establish a TCP connection

[redacted]

Time to send the HTTP request

↑ time to transfer the document from the WS to the client

Service Demand at queue 6: INCOMING LINK

$$D_{INL} = NetworkTime[DocumentSize, LinkBandwidth]$$

$$+$$

$$2\ NetworkTime[0, LinkBandwidth]$$

↑ 2 TCP synch. segments to open and close the connection

Esempio 10.4

	Residence Time (sec)	Utilization (%)
LAN	0.019	0.56
Router	0.001	0.03
Outgoing Link	0.076	2.18
Incoming Link	46.62	99.33

Throughput : 0.210 pkt/sec

Response Time : 48.0 sec

$$\lceil 3.2 \rceil + \lceil 1.7 \rceil \neq \lceil 4.9 \rceil$$

$4 \quad 2$

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