Client side models
no cache proxy server case

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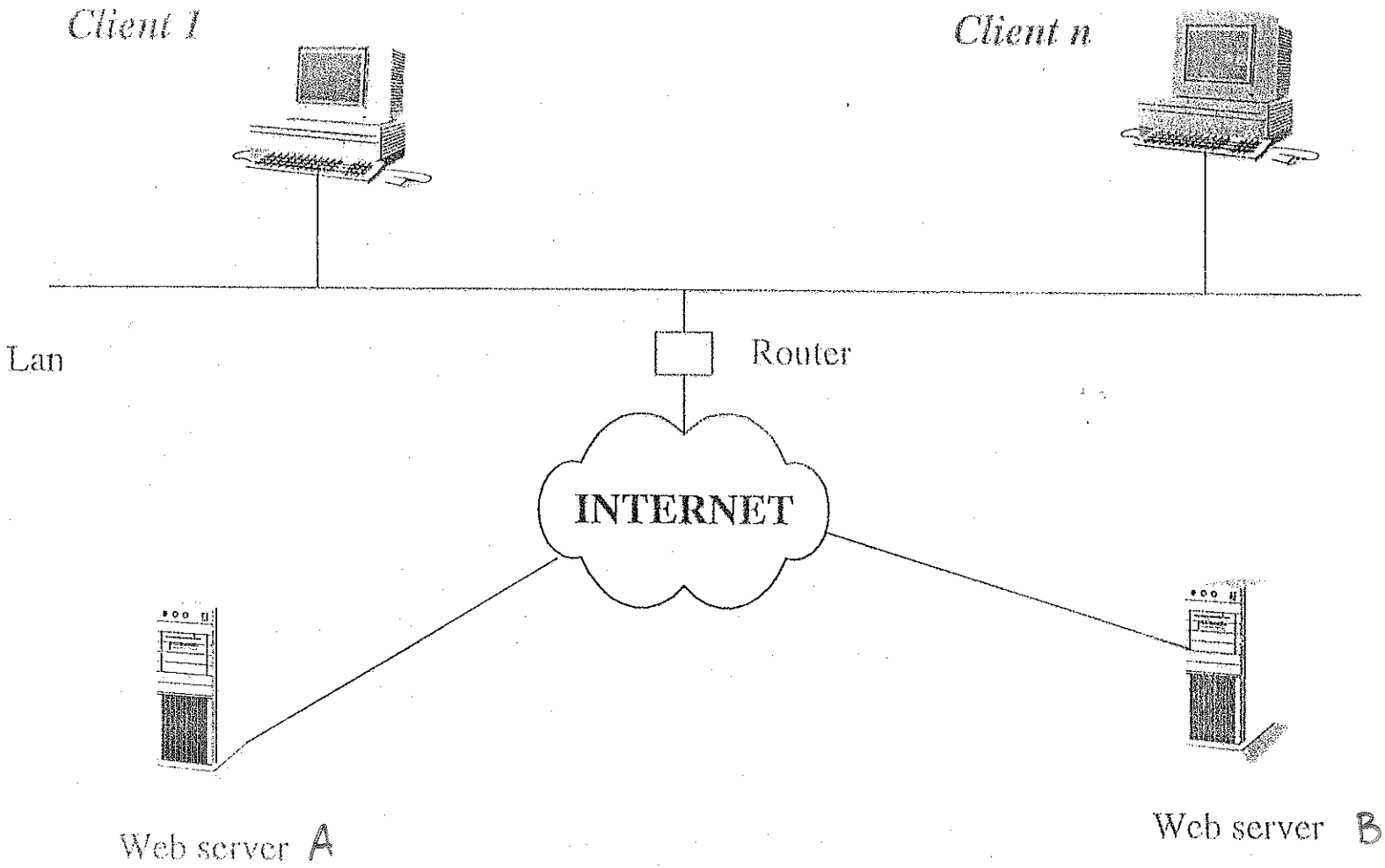
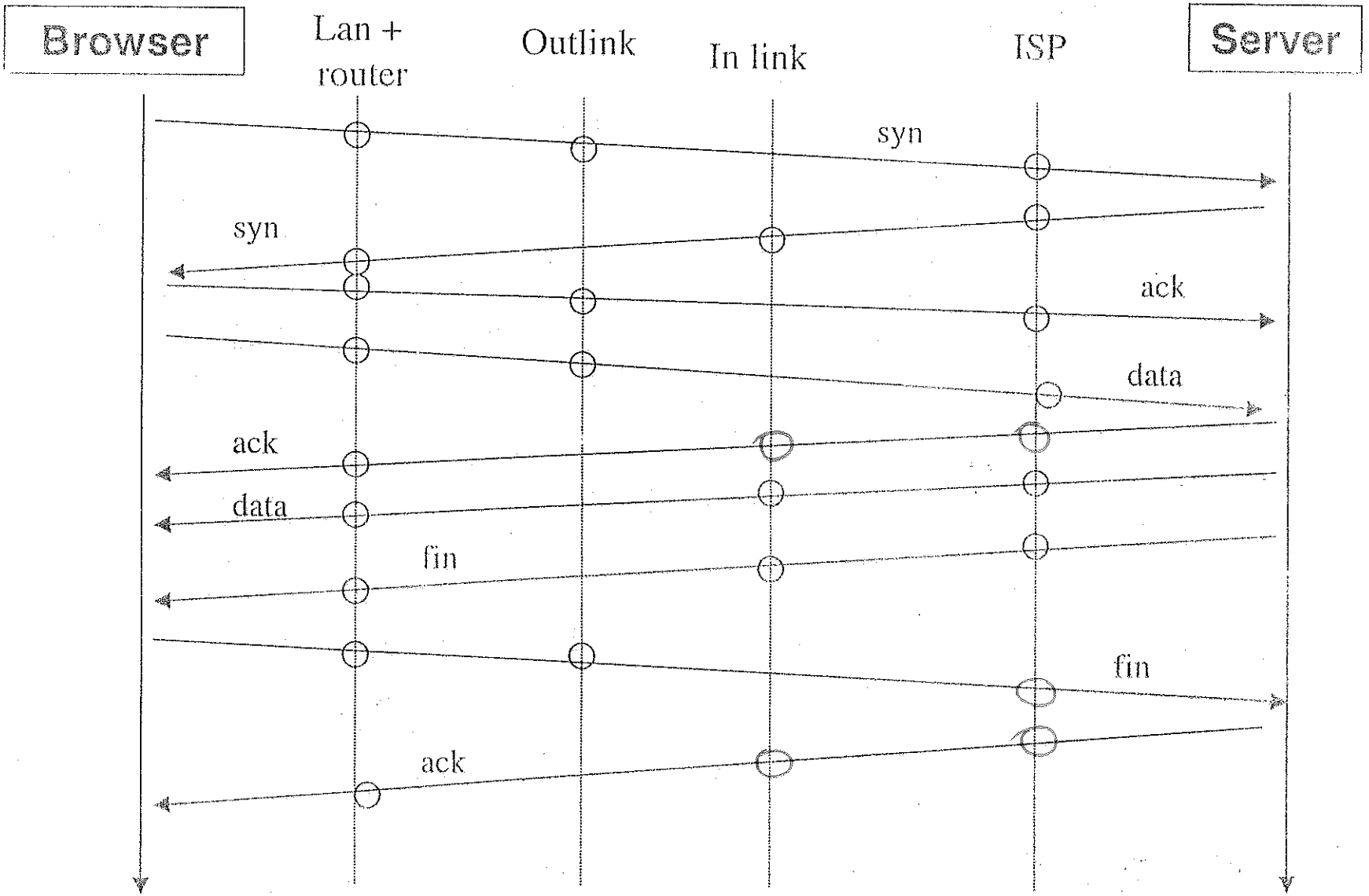
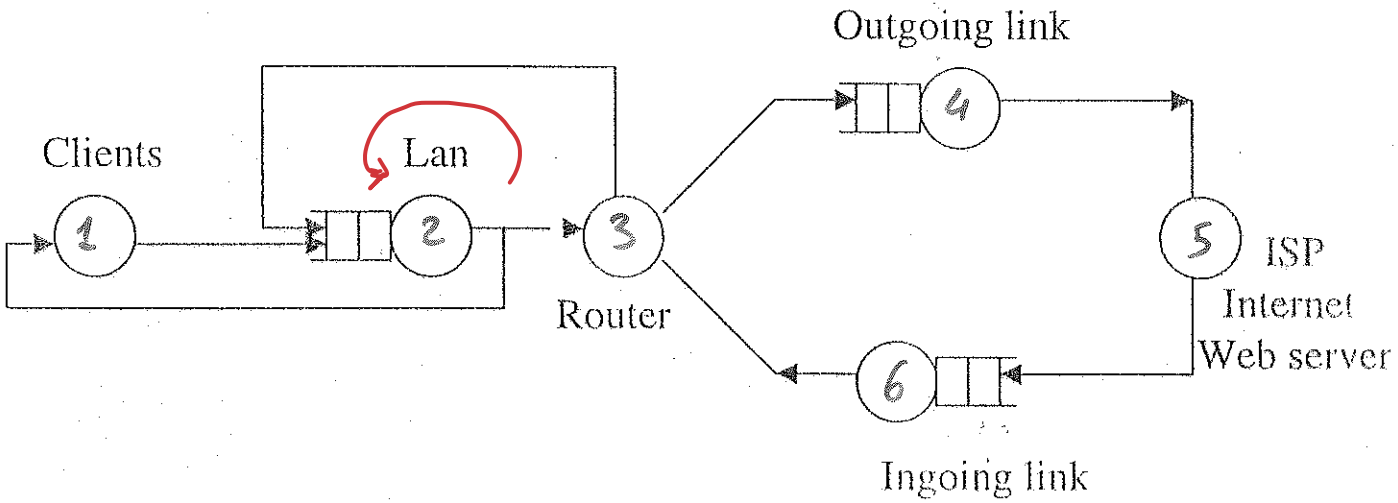
Accesso di un client al server senza proxy



Connessione TCP



QN model


Outgoing link
Clients
Lan
1
2
3
4
5
6
Router
ISP
Internet
Web server
Ingoing link

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
- Avg Size HTTP Request: average size of the HTTP request sent by the browser to the server, in bytes
- Document requested
  - R: number of categories
  - DocumentSize$_r$: average document size (in KB), of category r ($r: 1 \ldots R$)
  - PercentSize$_r$: percent of documents requested that are in category r ($r: 1 \ldots R$)

$$\text{Document Size} = \left(\sum_{r=1}^{R} \text{DocumentSize}_r \cdot \text{PercentSize}_r \right) / \text{In Kibbytes}$$

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

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

$$NetworkTime(AvgSizeHTTPRequest, LANBandwidth) +$$

$$NetworkTime(1024 \times DocumentSize, LANBandwidth) +$$

$$3\ NetworkTime(0, LANBandwidth)$$

dove

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

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

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

$$+ TCPOvhd + IPOvhd + FrameOvhd =$$

$$= TCPOvhd + NDatagrams(m) \cdot (IPOvhd + FrameOv$$

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

Caso senza framment. 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

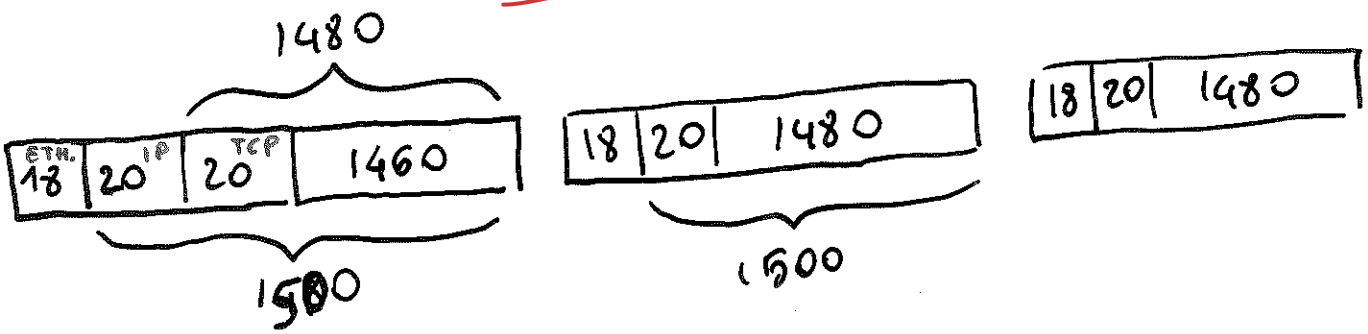
↓

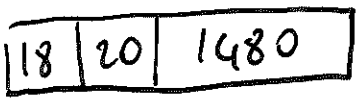
senza framm. IP: i datagram vengono generati con

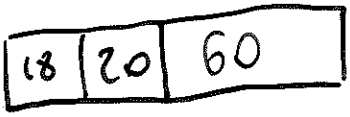
Overhead: 20

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

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

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

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

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

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

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

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

$$D_{router} = \left[N_{DATAGRAMS} \left(1024 \times Document\ Size \right) + 6 \right] \times Router\ Latency \times 10^{-6}$$

↑ 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

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

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

Service Demand at queue 5: ISP, Internet and WS

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

- $\frac{\text{Internet Delay RTT}}{10^3}$ → Time to establish a TCP connection
- $\frac{1}{2}\frac{\text{Internet Delay RTT}}{10^3}$ → Time to send the HTTP request
- $\frac{\text{Document Size}}{\text{Internet Data Rate}}$ → 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 : 0.2910 pkt/sec

Response Time : 48.0 sec

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

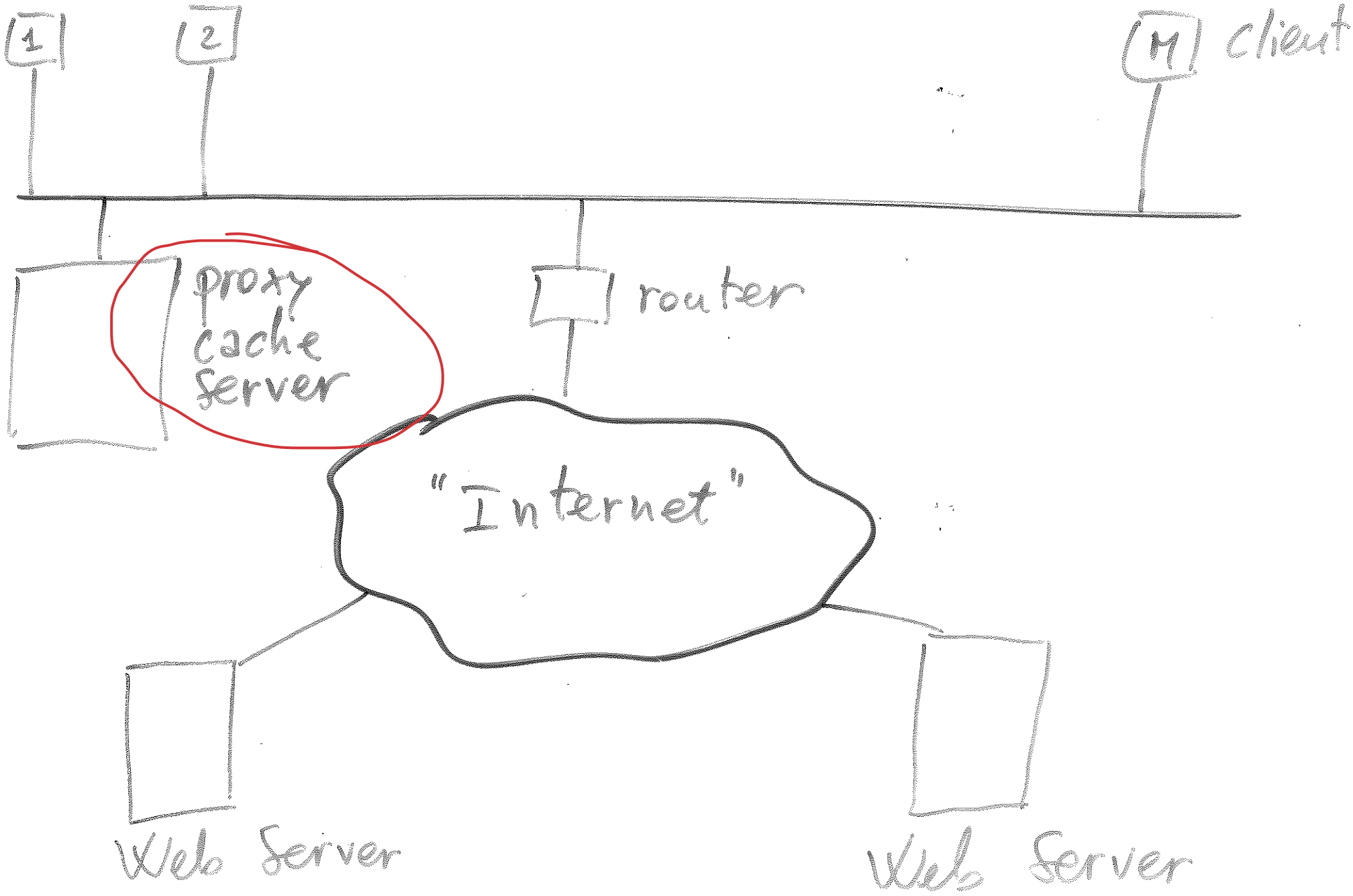
$$4 \qquad 2$$

=

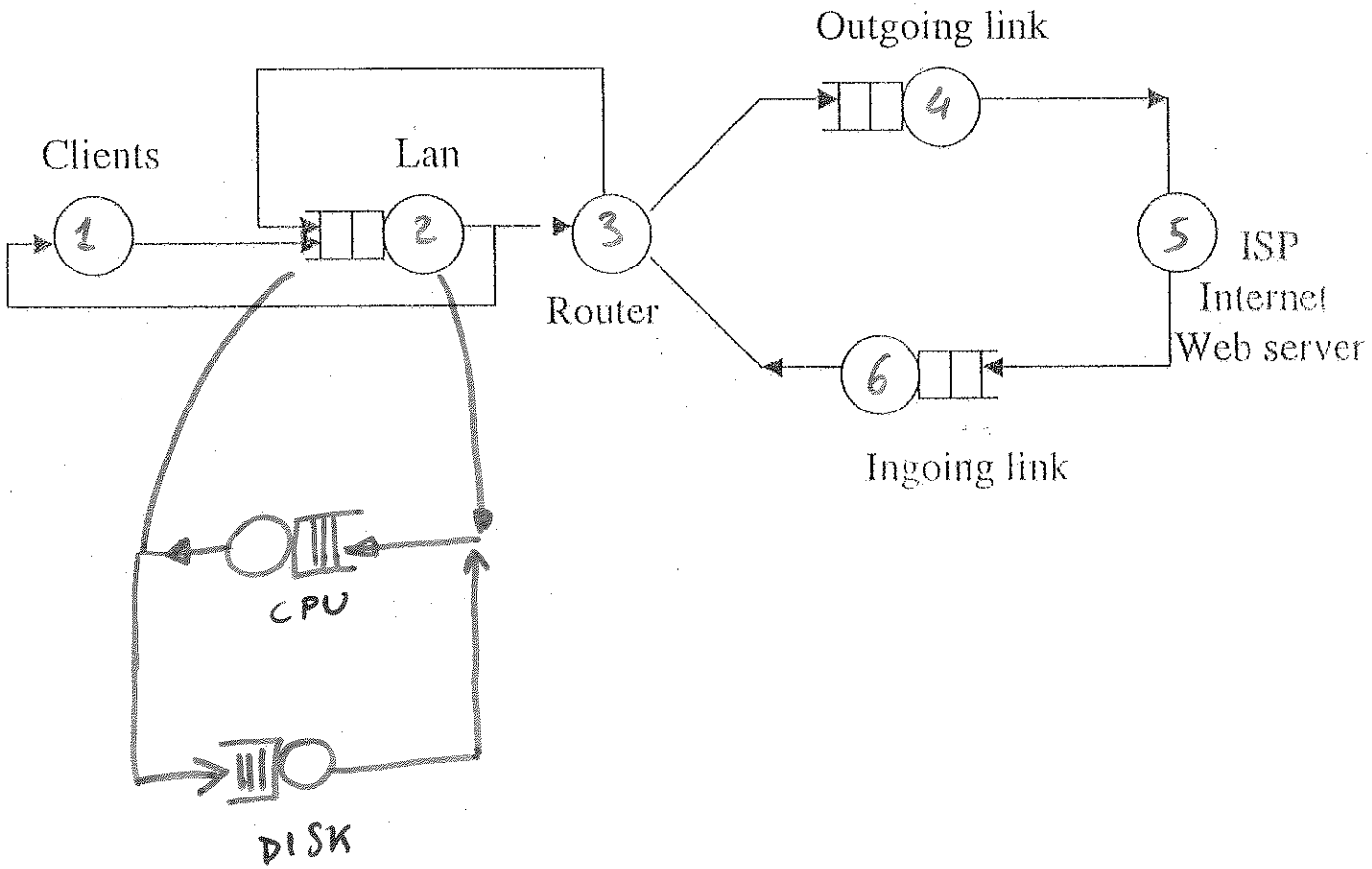
CLIENT SIDE MODELS

CACHE PROXY SERVER

CASE


1
2
M
client
proxy
cache
server
router
"Internet"
Web Server
Web Server

QN model


Outgoing link
Clients
Lan
1
2
3
4
5
6
Router
ISP
Internet
Web server
Ingoing link
CPU
DISK

Phit: fraction of requests that can be served from the proxy server's cache

Hit CPU time: CPU time, in seconds, needed to process the request at the cache proxy server in case of hit

Miss CPU time: CPU time, in seconds, needed to process a request at the cache proxy server in case of miss:

- process the request
- ask the request to the WS
- store the document
- replace a document
- send the document to the client

Disk-time: disk time for kilobyte at the cache proxy server (in millisecond)

$D'_{LAN} = p_{hit} D_{LAN} + (1 - p_{hit}) 2 D_{LAN}$

$D'_{router} = (1 - p_{hit}) D_{router}$

$D'_{OutL} = (1 - p_{hit}) D_{OutL}$

$D'_{Internet} = (1 - p_{hit}) D_{Internet}$

$D'_{InL} = (1 - p_{hit}) D_{InL}$

$D'_{CPU} = p_{hit}$ Hit CPU time +
$(1 - p_{hit})$ Miss CPU time

$D'_{Disk} = $ Disk time $\times \frac{\text{Document size}}{1000}$

Esempio 10.5

stessi parametri di 10.4

+

CPU Time x hit : 0.25 msec

CPU Time x miss : 0.50 msec

Disk service time : 6 msec x Kilobyte

Phit	Throughput (req/sec)	Response Time (sec)
0.20	0.364	37.82
0.30	0.416	32.72
0.40	0.483	27.61
0.50	0.581	22.50
0.0	0.292	48.0

Esempio 10.6

Stessi parametri di esempi 10.5 e 10.4

Link sostituito con un T1 link (1.544 Mbps)

Cache hit ratio : 40%

↓

new bottleneck : disk 45% utilz.

Response time 1.149 sec.

Throughput 3.347 rep/sec.