Why HTTP needed extensions?

A taste of HTTP v1.1 additions

HTTP v1.1:
→ introduces many complexities
→ no longer an easy protocol to implement

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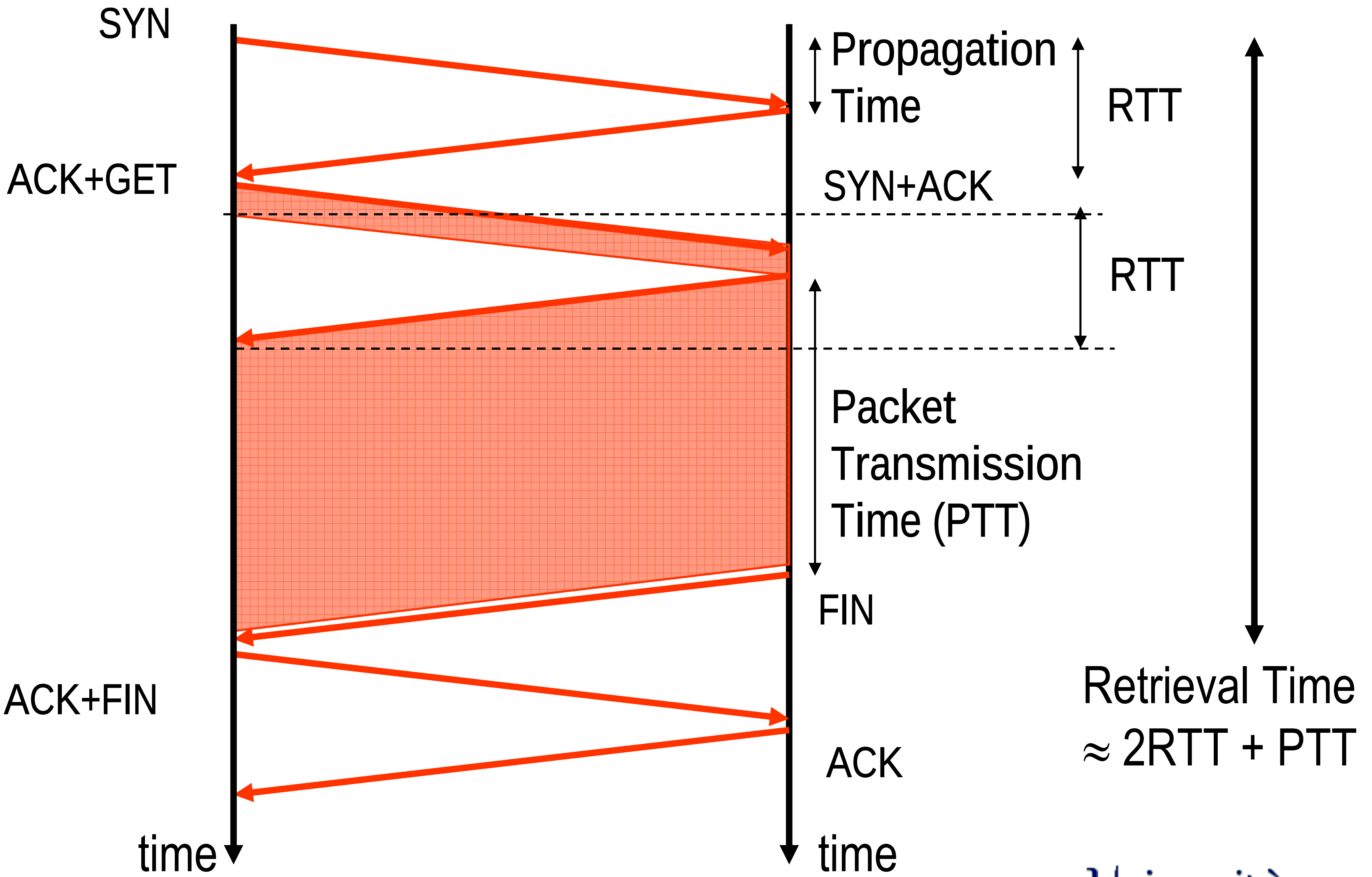
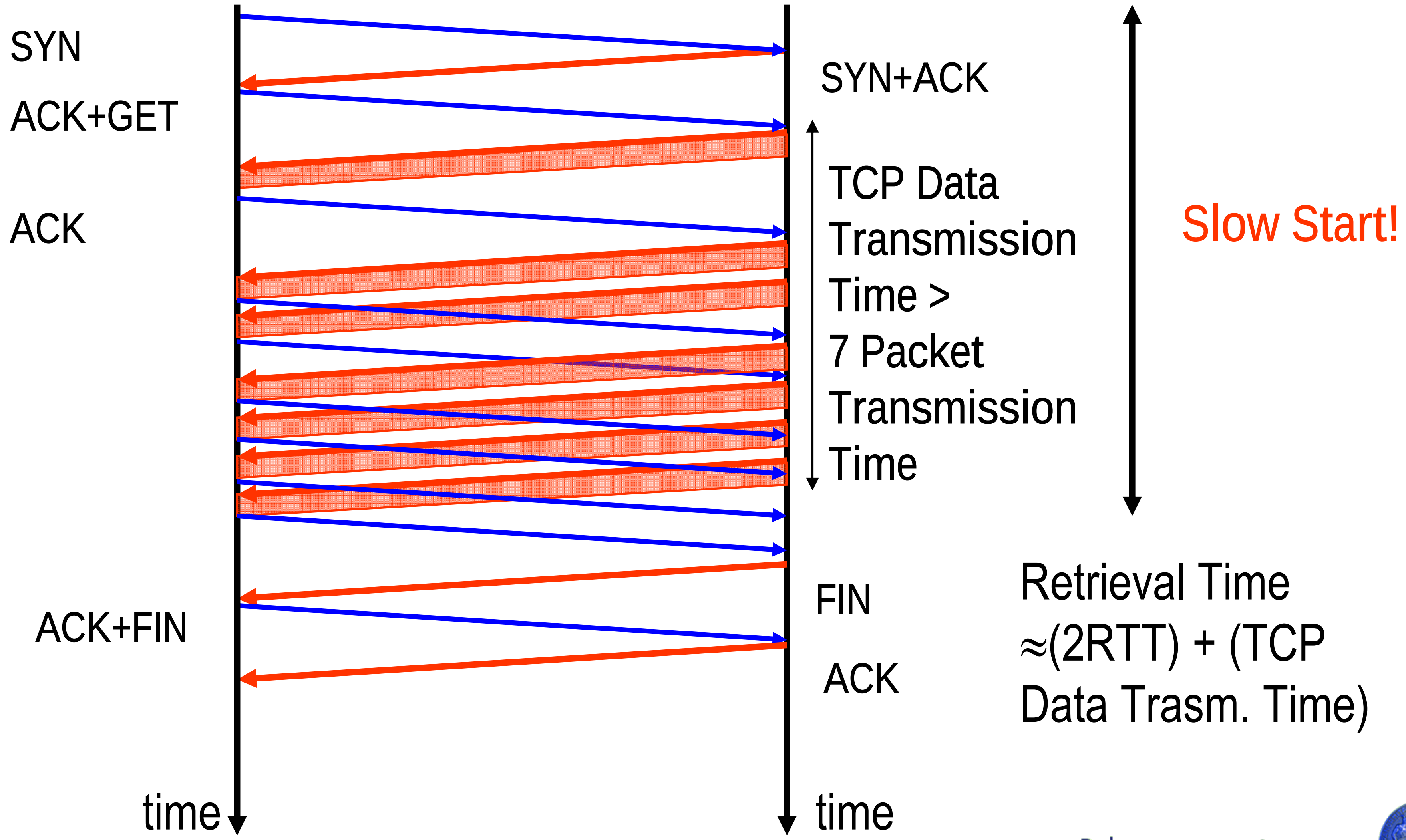
Simple (one packet) Web Page Retrieval Time



Bigger (7packets) Web Page Retrieval Time



Retrieval Time ≈(2RTT) + (TCP Data Trasm. Time)

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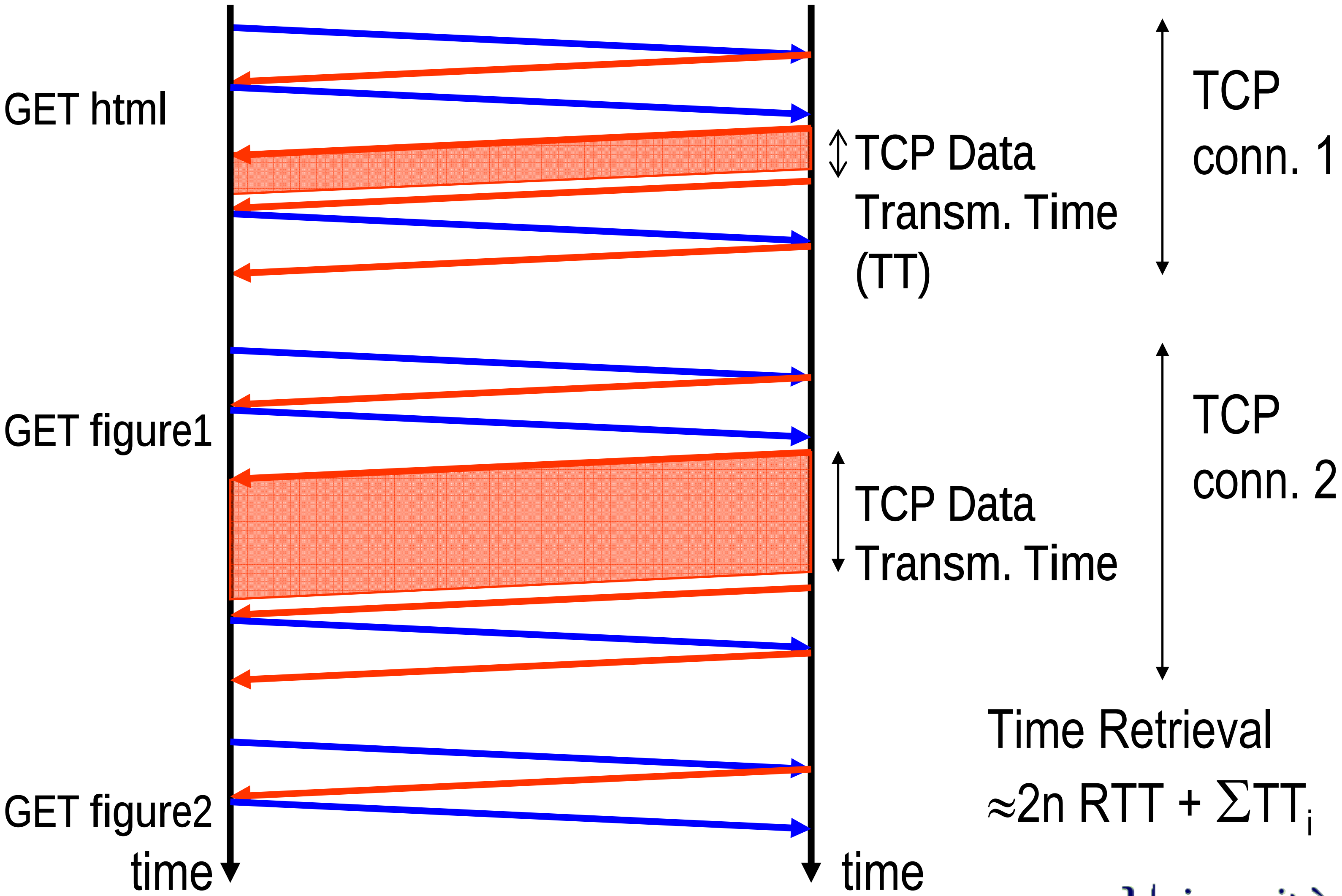
Complex (many objects) Web Page Retrieval Time with HTTP/1.0

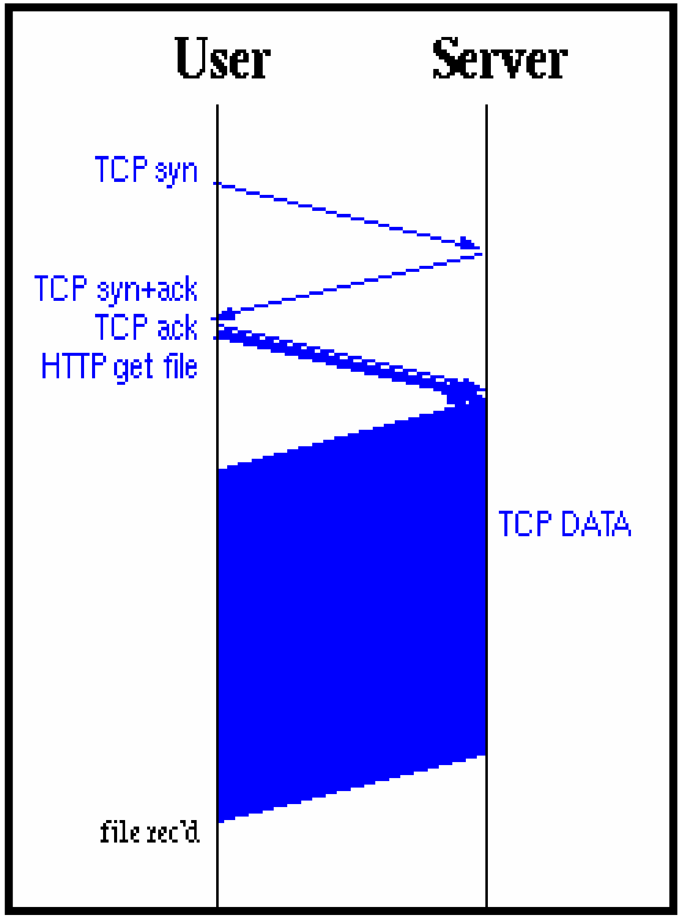


Time Retrieval

$\approx 2n\ RTT + \Sigma TT_i$

Performance drawbacks

- ➔ **Mandatory roundtrips**
  - ⇨ TCP three-way handshake
  - ⇨ get request, data return
  - ⇨ new connections for each image (parallelize)
  - ⇨ lots of extra syn or syn/ack packets
- ➔ **Slow-start penalties**
  - ⇨ Significantly affects fast networks
- ➔ **Lots of TCP connections to server**
  - ⇨ spatial/processing overhead in server (TCP stack)
  - ⇨ unfairness because of loss of congestion control info



Shorten Page Retrieval with HTTP/1.0

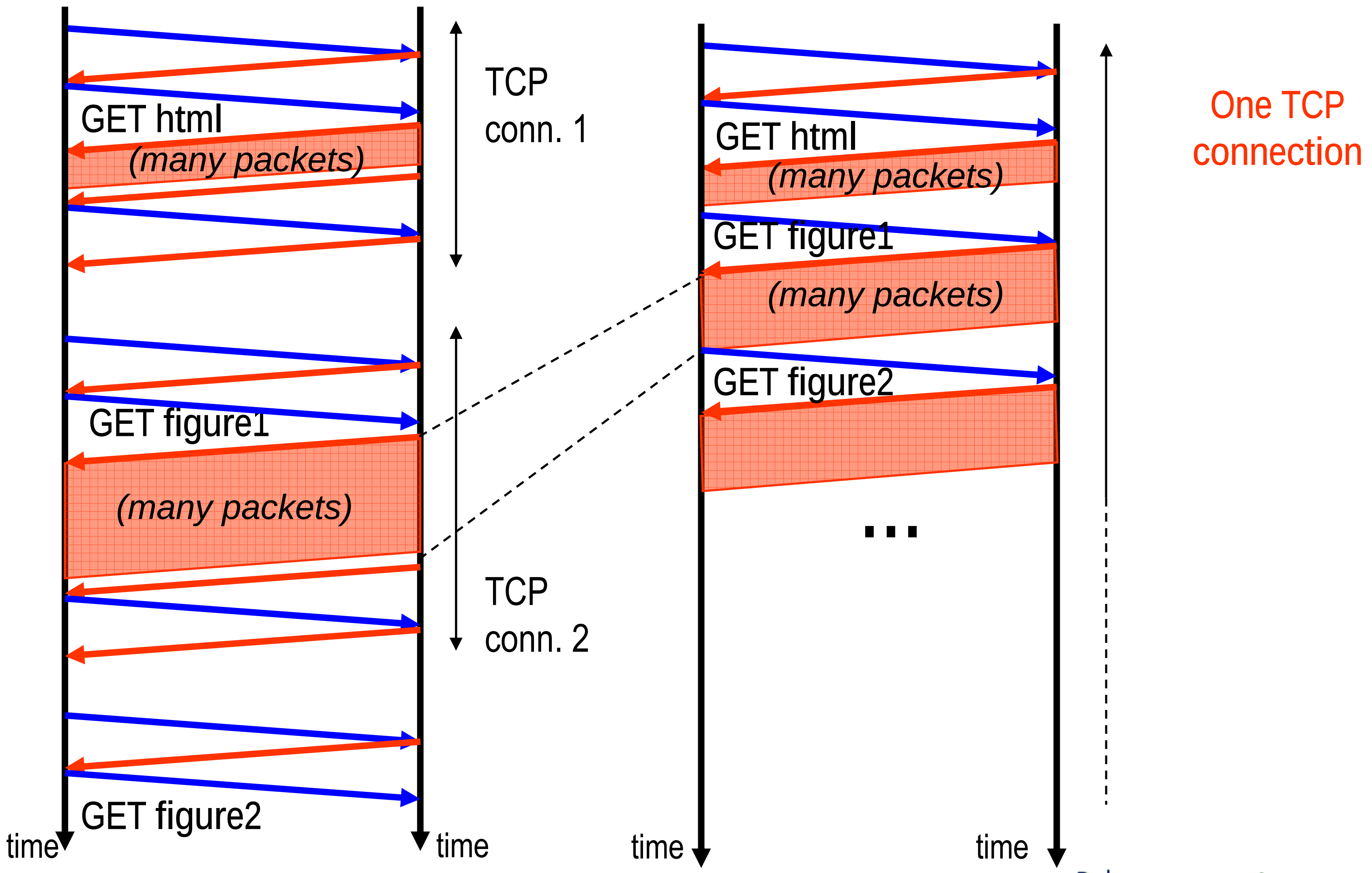
- ➔ After the retrieval of the html source, start many parallel TCP connections to download the objects embedded

  Time retrieval =

  $4\ RTT + TT_1 + \max(TT_i)$

- ➔ Overhead to manage n connections…
- ➔ and slow starts significantly affect performance

Persistent HTTP



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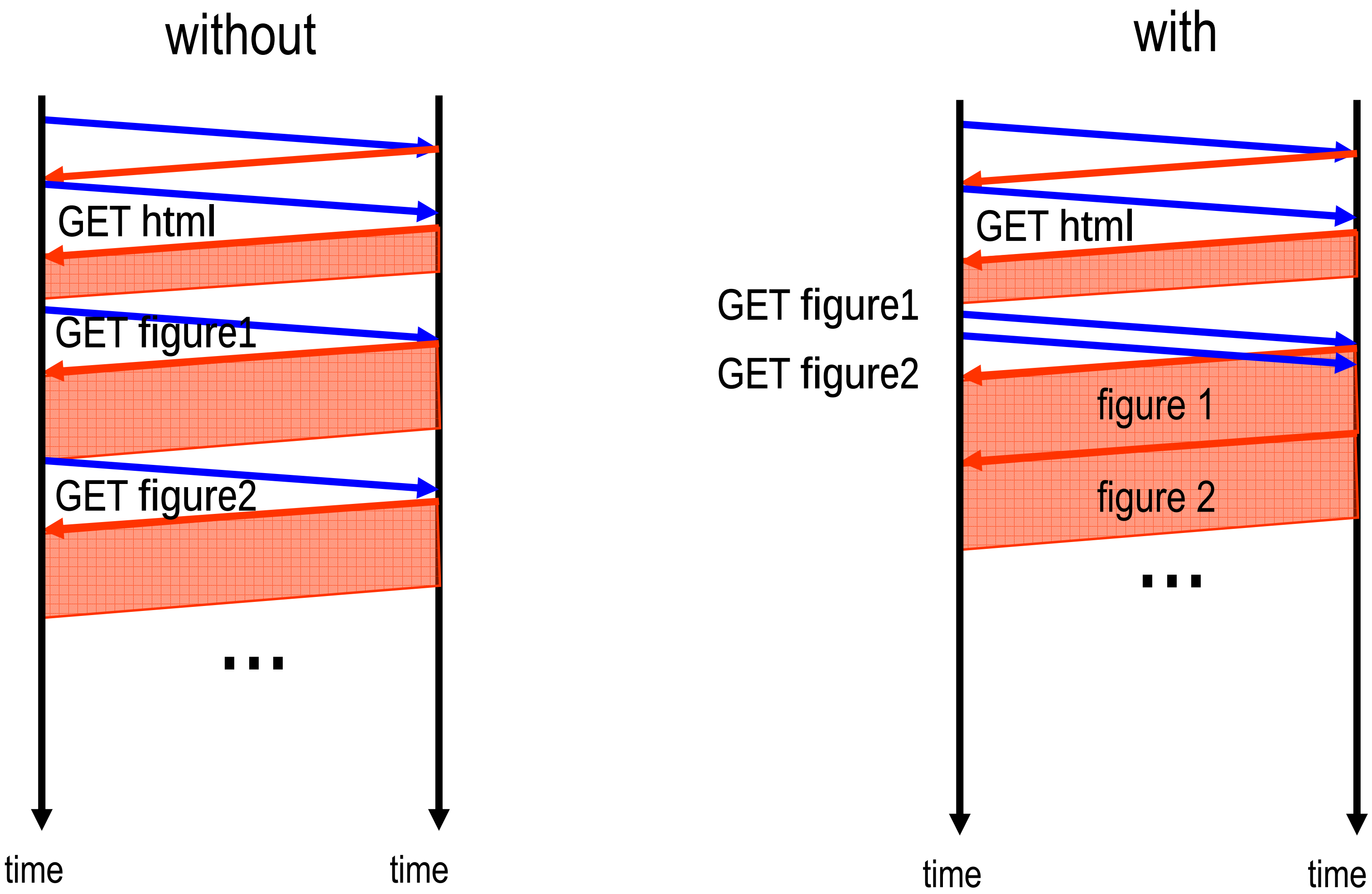
Performance improvements

- **Persistent HTTP**
  - in HTTP/1.0, add “Connection: Keep-Alive\r\n” header
  - in HTTP/1.1, P-HTTP built in

- **Does it help?**
  - server-side efficiency
    - TCP memory consumption at server is the bottleneck
    - … as well known by Denial Of Service attackers ☺
  - allows multiple requests on one connection
    - Faster retrieval

- **Pipelining**

Pipelining


without
GET html
GET figure1
GET figure2
...
time
time
with
GET html
GET figure1
GET figure2
figure 1
figure 2
...
time
time

More complex handshake

- **Persistent HTTP**
  - Move task of closing TCP connection from Server to Client
- **how does a client know when document is returned?**
  - Content-Length: header field:
    - In HTTP v1.0 used only in POST requests
      - When client needs to send a body entity
    - In HTTP v1.1 must be used also in response
      - To inform the client that retrieval is finished
- **when does the connection get dropped?**
  - idle timeouts on server side
  - client drops connections
  - server needs to reclaim resources

Chunking

- **HTTP v1.0**
  - connection dropped = lost data
    - no chunking
- **HTTP v1.1**
  - Concept of “chunking”
  - Range: bytes=300-304,601-993
    - useful for broken connection recovery (like FTP recovery)
  - “chunked” transfer encoding
    - segmenting of documents
    - don’t have to calculate entire document length.
    - useful for dynamic query responses..

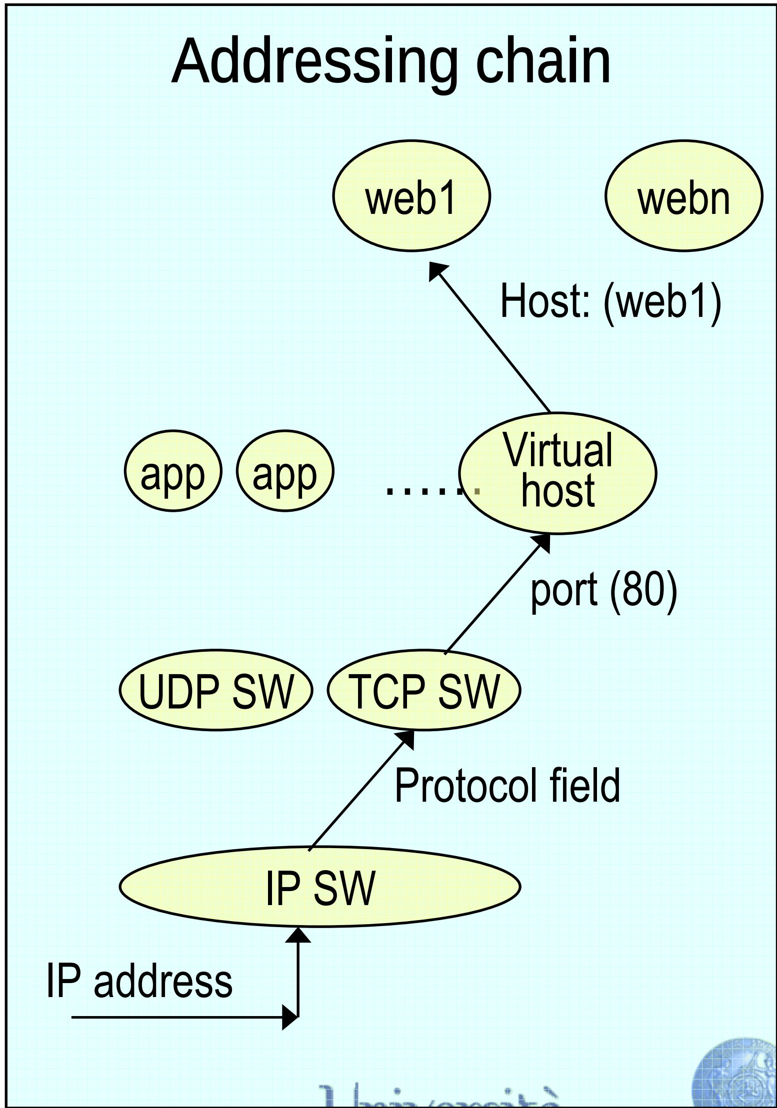
Multi-homing

- **Multi-homing:**
  - 1 IP address with multiple DNS names
  - ESSENTIAL for commercial deployment
    - Small companies need a web presence
    - With proper naming (e.g. www.joemushrooms.it)
    - But don't have ICT resources to administer on their own
      - Solution: web-hosting companies

- **The problem of multi-homing**
  - Web-host company: www.bianchihosting.it → IP=200.100.100.1
  - Customer1: www.joemushrooms.it
  - Customer2: www.frankbeans.it
  - Try resolving URLs:
    - http://www.bianchihosting.it/ → http://200.100.100.1:80/index.htm
    - http://www.joemushrooms.it/ → http://200.100.100.1:80/index.htm
    - http://www.frankbeans.it/ → http://200.100.100.1:80/index.htm
  - ALL EQUAL! No way to differentiate them
    - unless using different ports, but solution hardly appreciated by customers

Multi-homing solution

- ➔ **Host: <web server name>:**
  - ⇨ Example:
    - →Host: www.joemushrooms.it
  - ⇨ Additional header command in the HTTP request
  - ⇨ Mandatory sent by client
    - →Initially a patch in HTTP v1.0
    - →Fundamental feature in HTTP v1.1
- ➔ **Addressing:**
  - ⇨ Need a further level of indirection
  - ⇨ Process listening on port 80 shall not be a web server
  - ⇨ but a process redirecting the HTTP request to the proper server, based on host: content
  - ⇨ (virtual host)



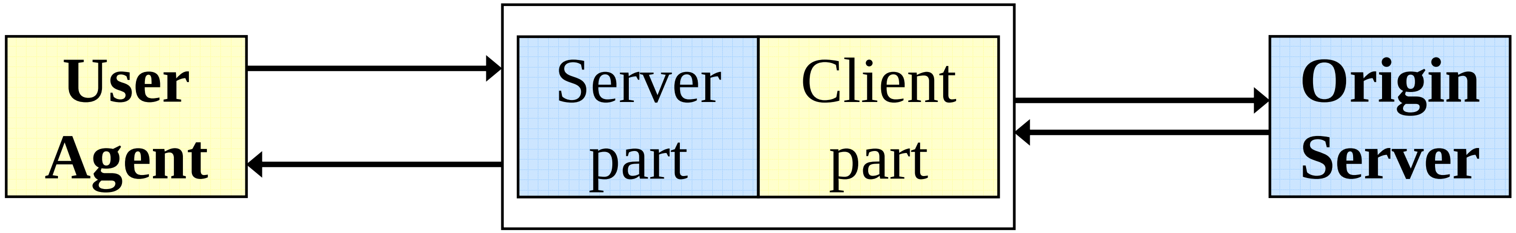
HTTP operation with intermediaries

- **Three form of intermediaries:**
  - Tunnel
    - intermediary program acting as a blind relay between two connections.
    - once active, a tunnel is not considered a party to the HTTP communication (does not understands HTTP)
    - e.g: firewall, Network Address Translator, etc
  - Proxy
    - intermediary program acting as both server & client (see later).
  - Gateway
    - server acting as intermediary for some other server.
    - unlike a proxy, a gateway receives requests *as if it were the origin server for the requested resource*; the requesting client may not be aware that it is communicating with a gateway.
    - e.g. portals

Proxy

An intermediary program which acts as both a server and a client for the purpose of making requests on behalf of other clients.

Usage: client-side portal through firewalls; helper applications to handle requests not supported by user agent

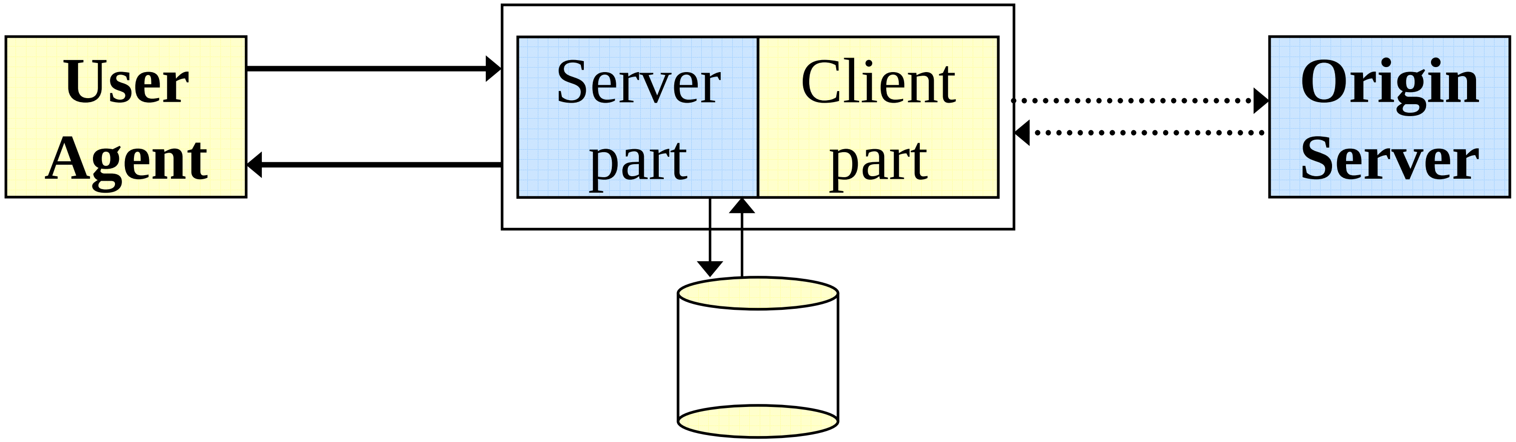


Transparent proxy: does not modify request or response beyond authentication and identification

Non Transparent proxy: provides added services (media transformation, anonimity filtering, protocol reduction)

Caching

Fundamental in reducing Internet traffic

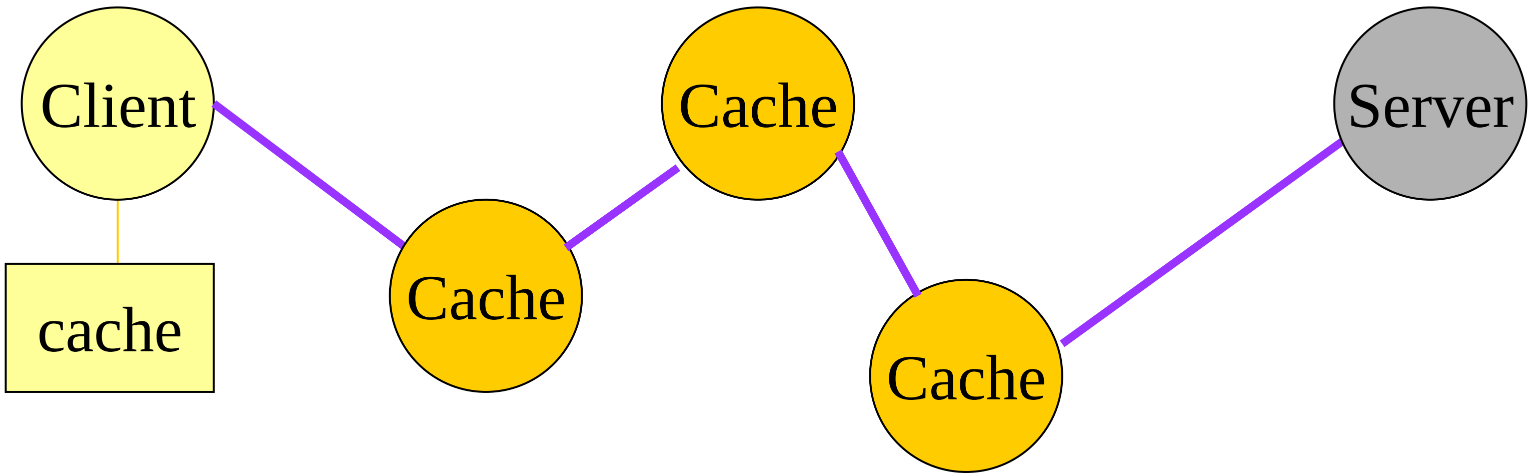


Proxy and **Gateway** may cache. Tunnel cannot.

Why caching?

- ⇨reduce latency
- ⇨reduce data traffic
- ⇨distribute (reduce) requests

➔HTTP: hierarchical caching



Some problems with caching

- **Consistency**
  - cached pages might not be the most recent...
- **Security**
  - what happens if I infiltrate a cache?
  - servers/clients don't even know this is happening
  - e.g.: AOL used to have a very stale cache, but has since moved to Inktomi
- **Ad clickthrough counts**
  - how does Yahoo know how many times you accessed their pages, or *more importantly*, their ads?

Additional http v1.1 features (mainly for caching purposes)

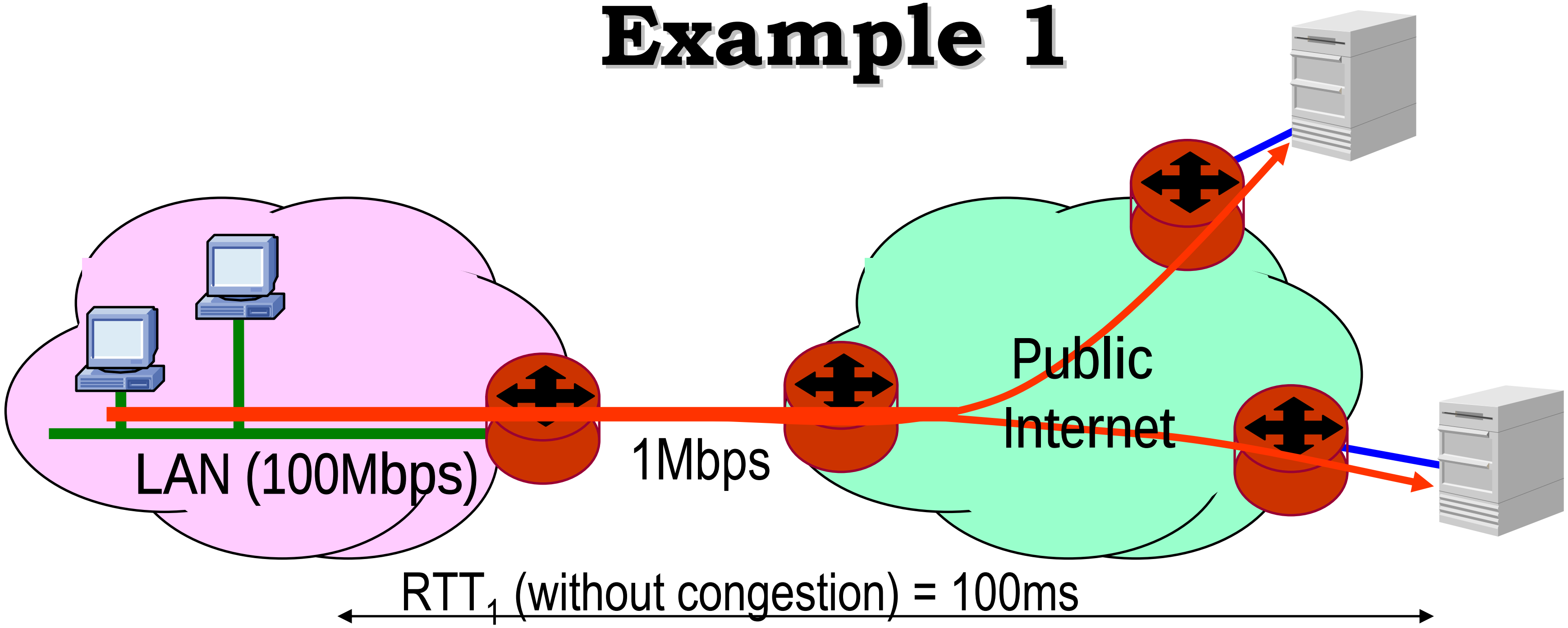
- **HTTP/1.0: lots of problem associated to caching**
  - Very poor cache consistency models
- **HTTP/1.1: very improved caching model**
  - Refer to RFC 2616 for details (too long to deal with here)

- **Additional header commands:**
  - Age: <seconds, date>
    - sender's estimate of the amount of time since the response (or its revalidation) was generated at the origin server
  - Etag: fa898a3e3
    - unique tag to identify document (strong or weak forms)
  - Cache-control: <command>
    - marking documents as private (don't keep in caches)

Caching saving

some numerical examples

Example 1



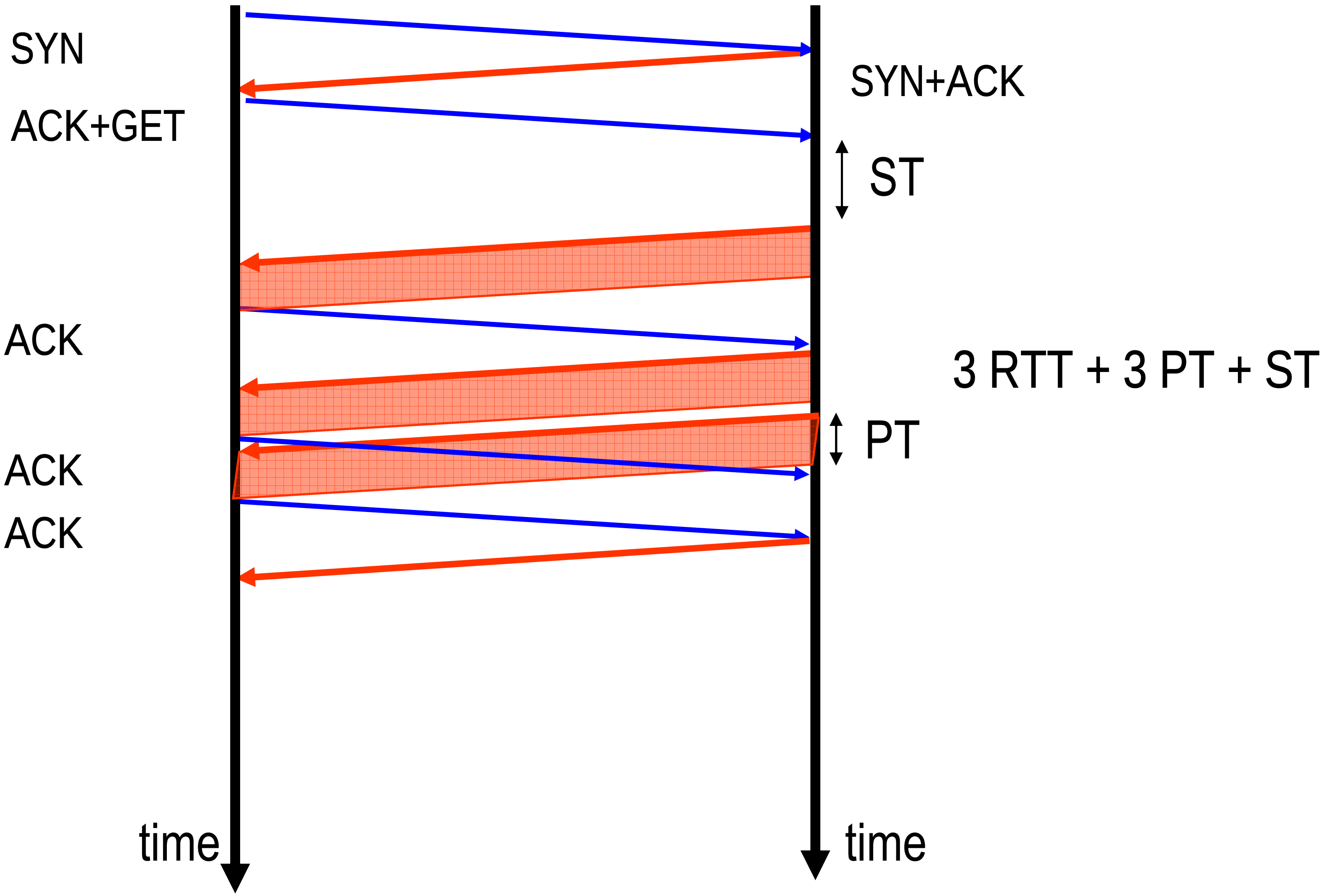
Server Response Time (ST_1) = 20ms

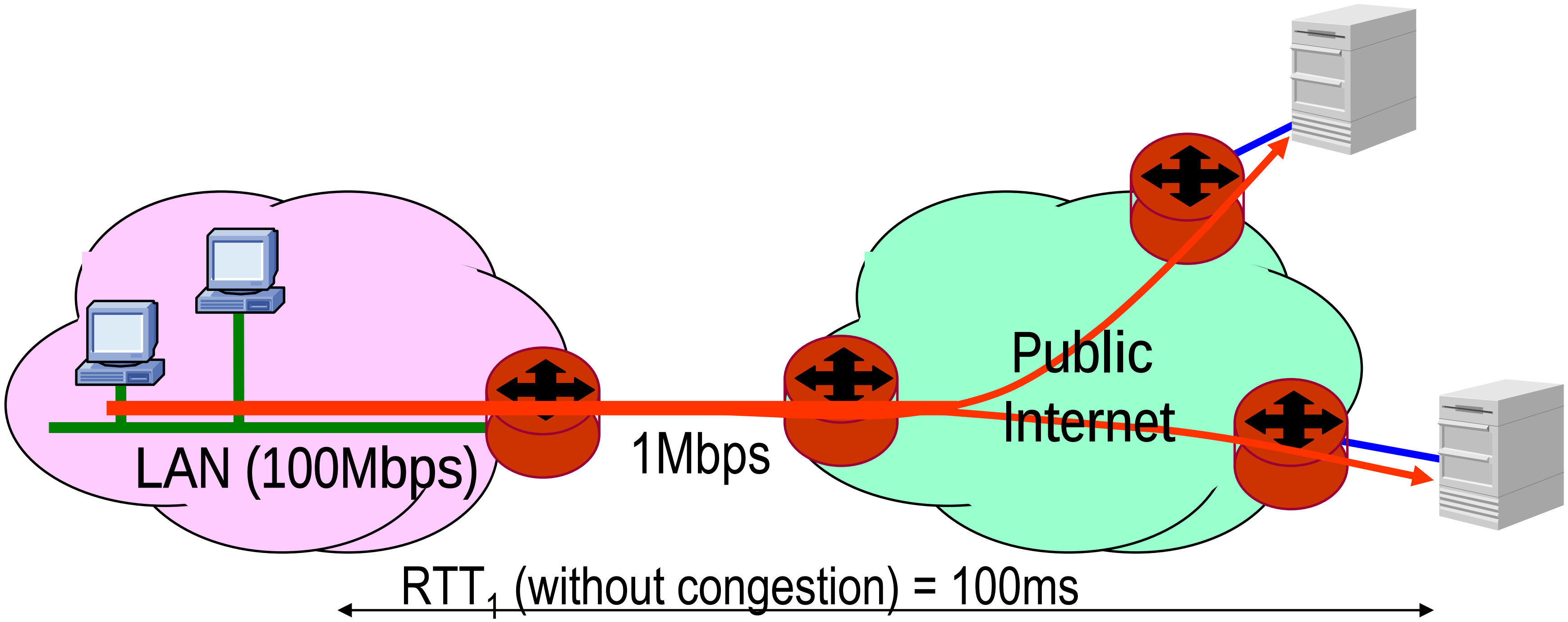
Assume 3*1460B pages

1500B packet size, 40B header

Consider only bottleneck transmission time

Web Page Retrieval

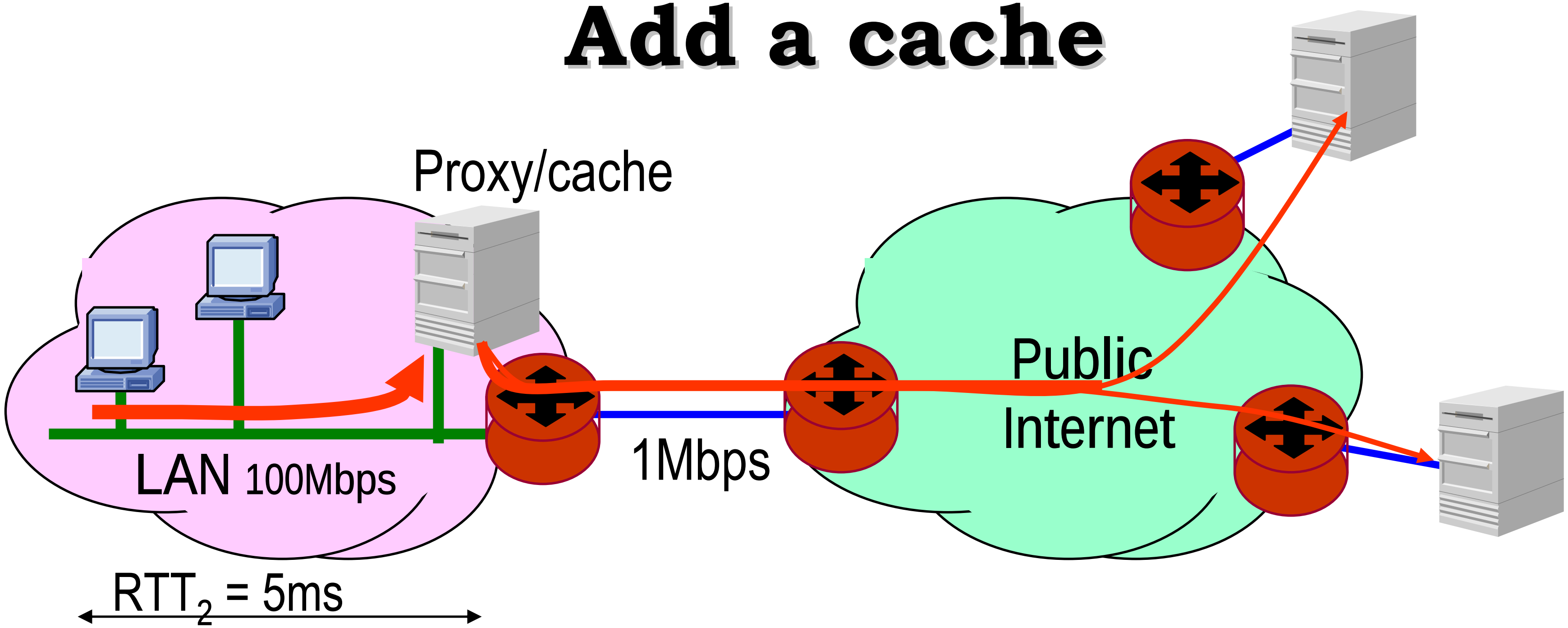




PT_1 = 12 ms, ST_1= 20 ms

Retrieval Time (1) = 3*100+3*12+20=356ms

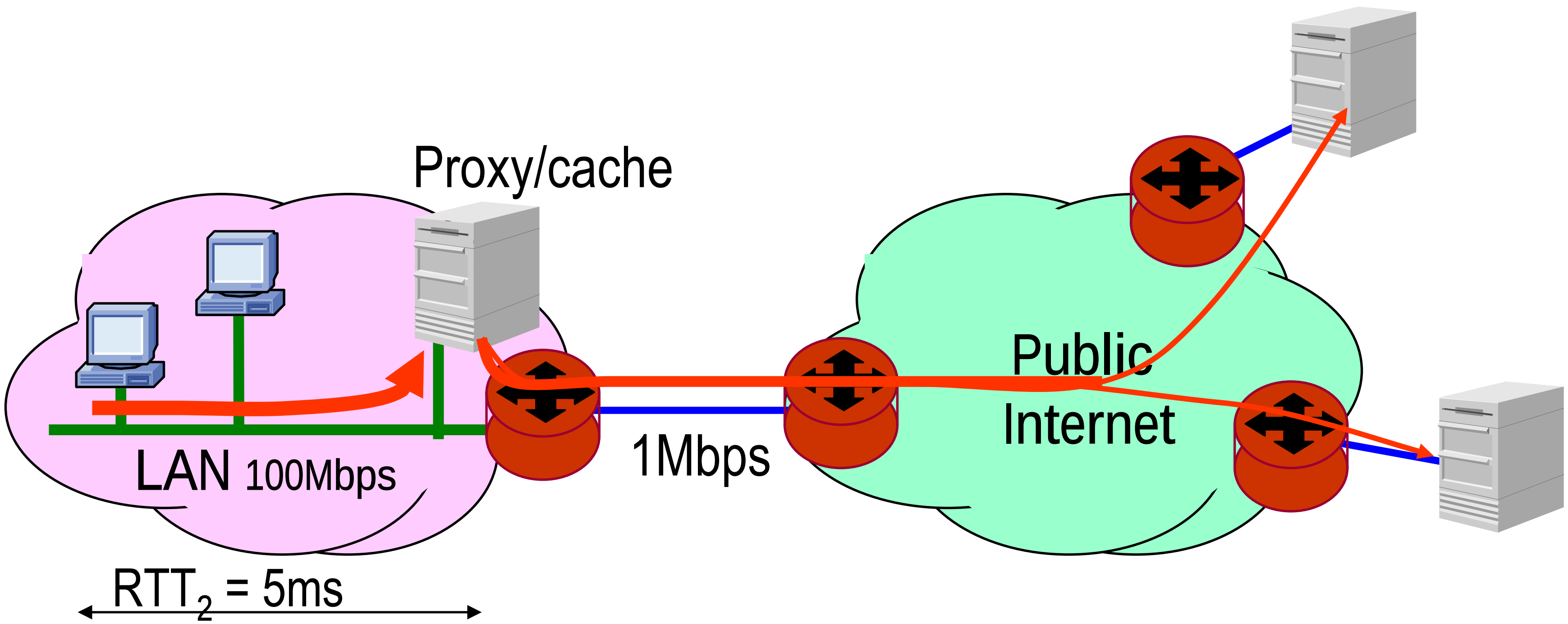
Add a cache



Hit rate = 20%

ST_2 = 20ms $PT_2 \approx$ 0ms

Retrieval Time(2) = 3*5+3*0+20=35ms

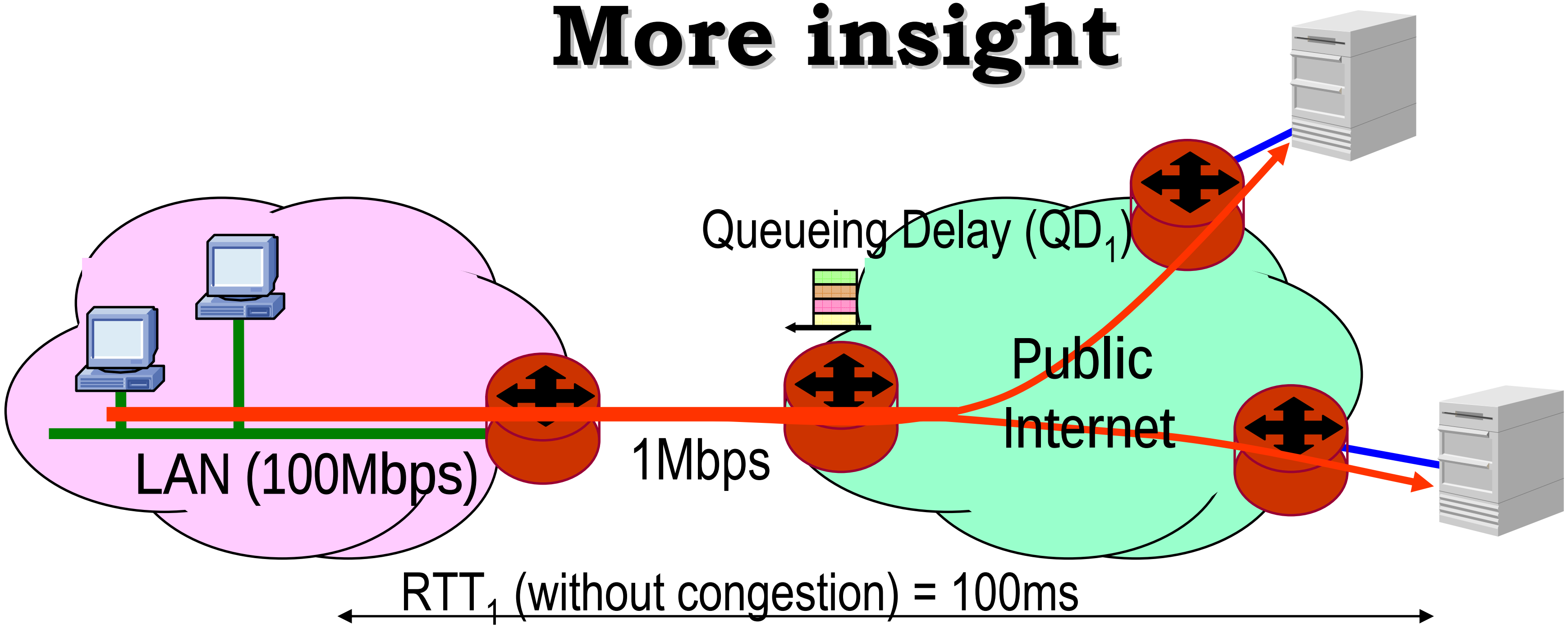


Hit rate = 20%

Average Retrieval Time = 0.2*35+0.8*356= 292 ms

64 ms saving! (18%)

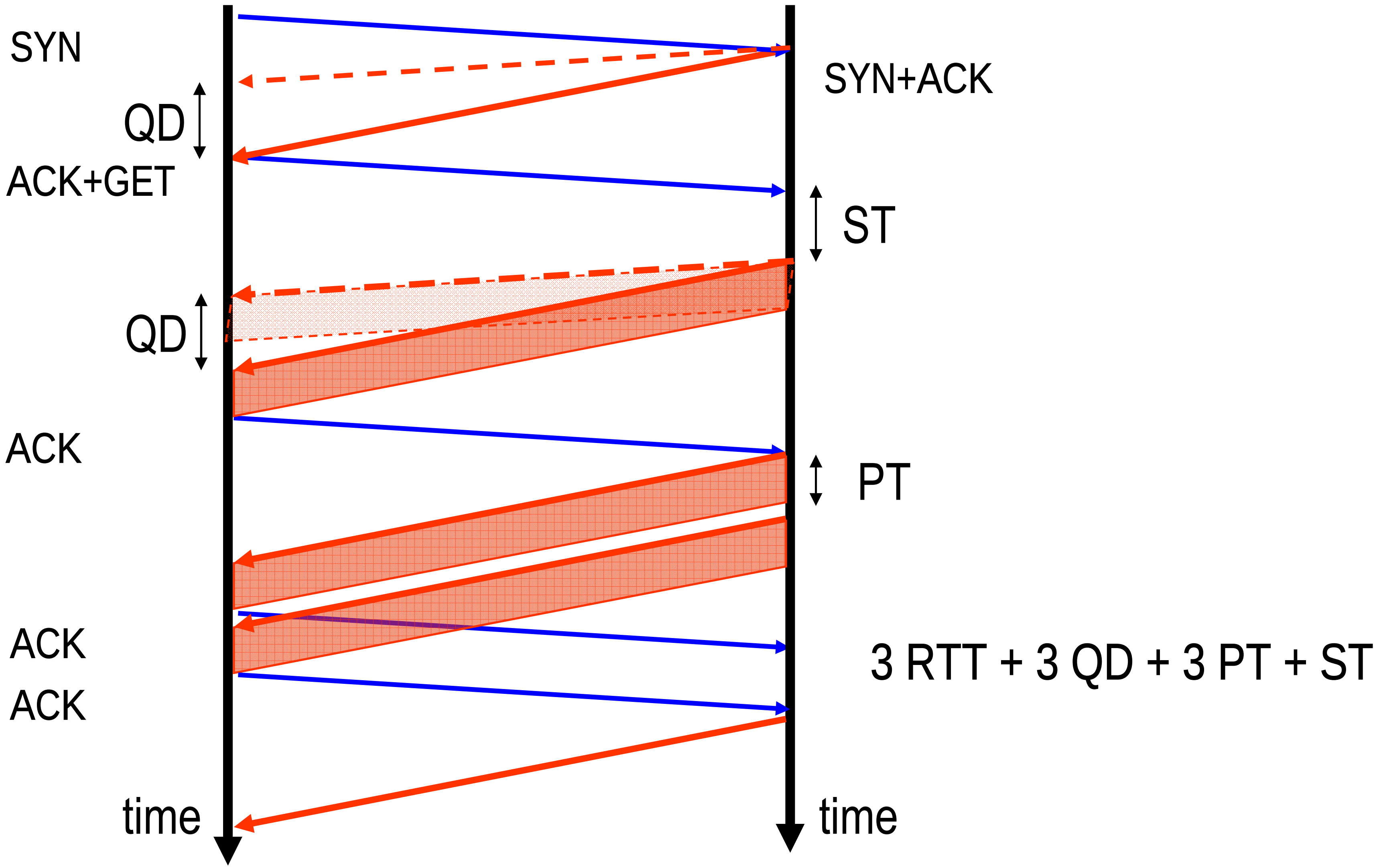
More insight



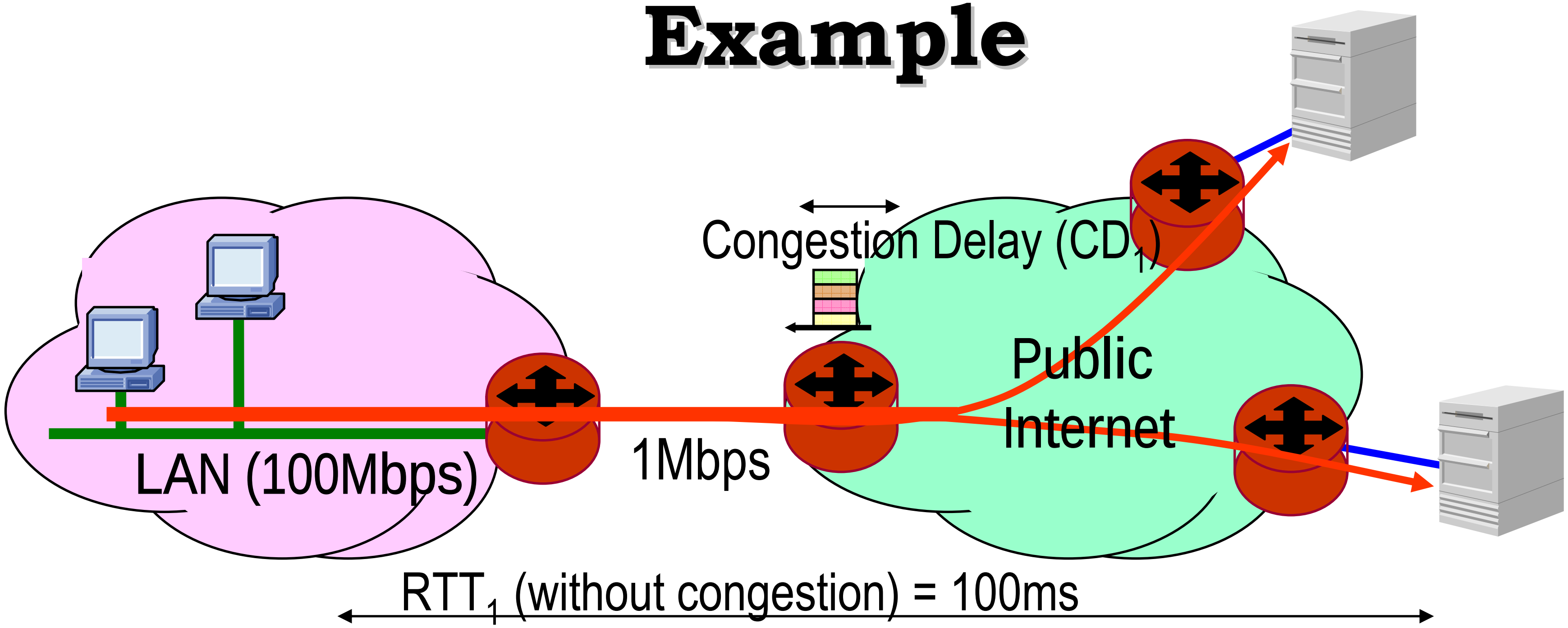
Server Time (ST_1) = 20ms

Assume 3*1500B pages

Web Page Retrieval



Example

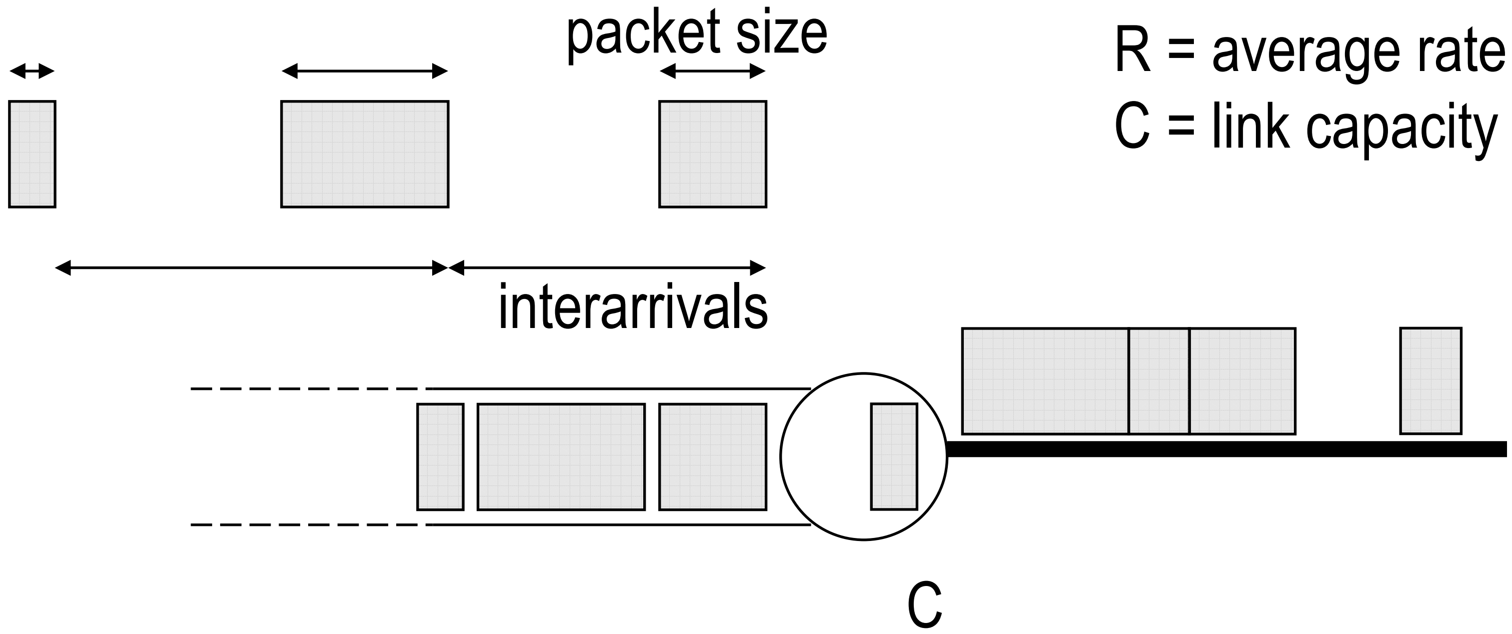


PT_1 = 12 ms

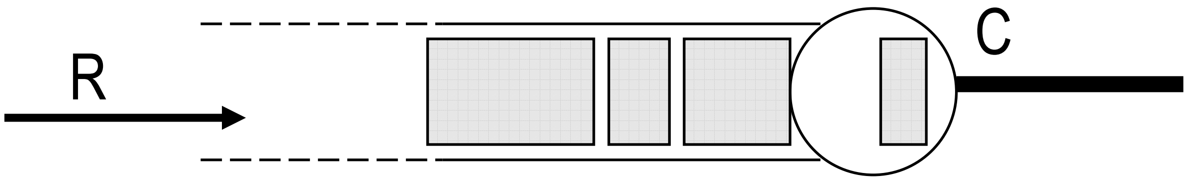
QD_1 =?

Bits of Queueing Theory M/M/1/∞

➔ **interarrival time and packet size exponentially distributed**



Bits of Queueing Theory M/M/1/∞



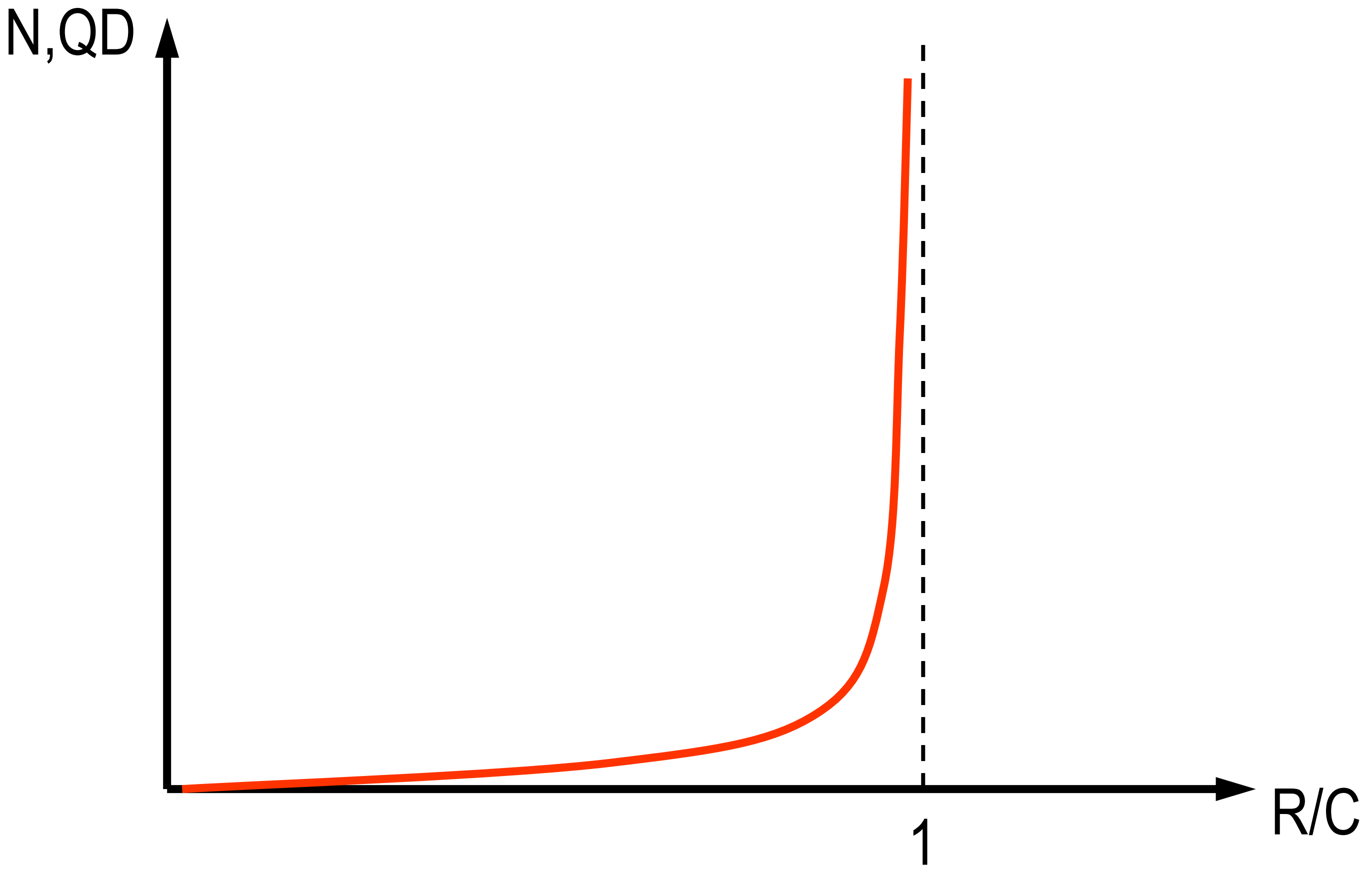
R/C = offered load, an important quantity in queueing theory

$$N = \frac{R/C}{1-R/C}$$ Average packet # in the queue

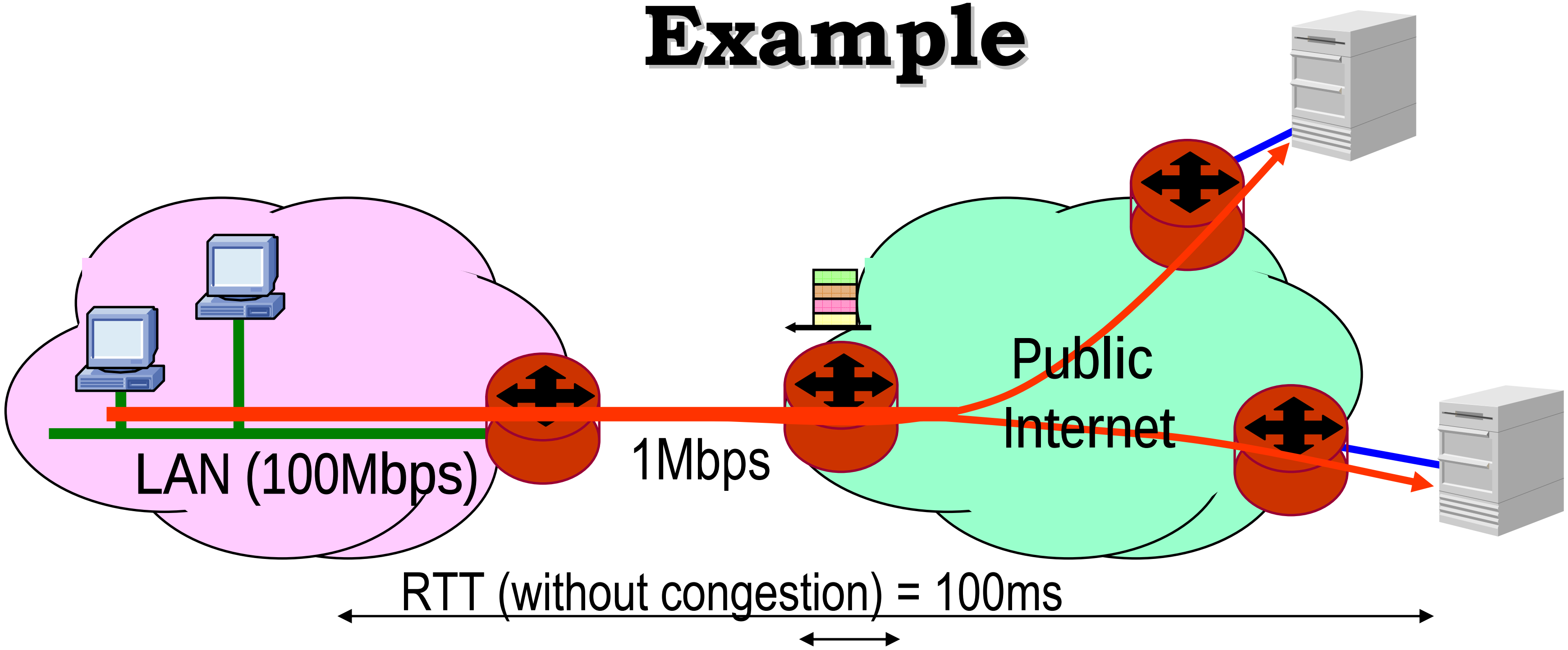
$$QD = \frac{N}{C}$$ Average queueing delay (if C packet/s)

$$QD + \frac{1}{C} = \frac{1/C}{1-R/C}$$ Average service time

Bits of Queueing Theory
M/M/1/∞



Example



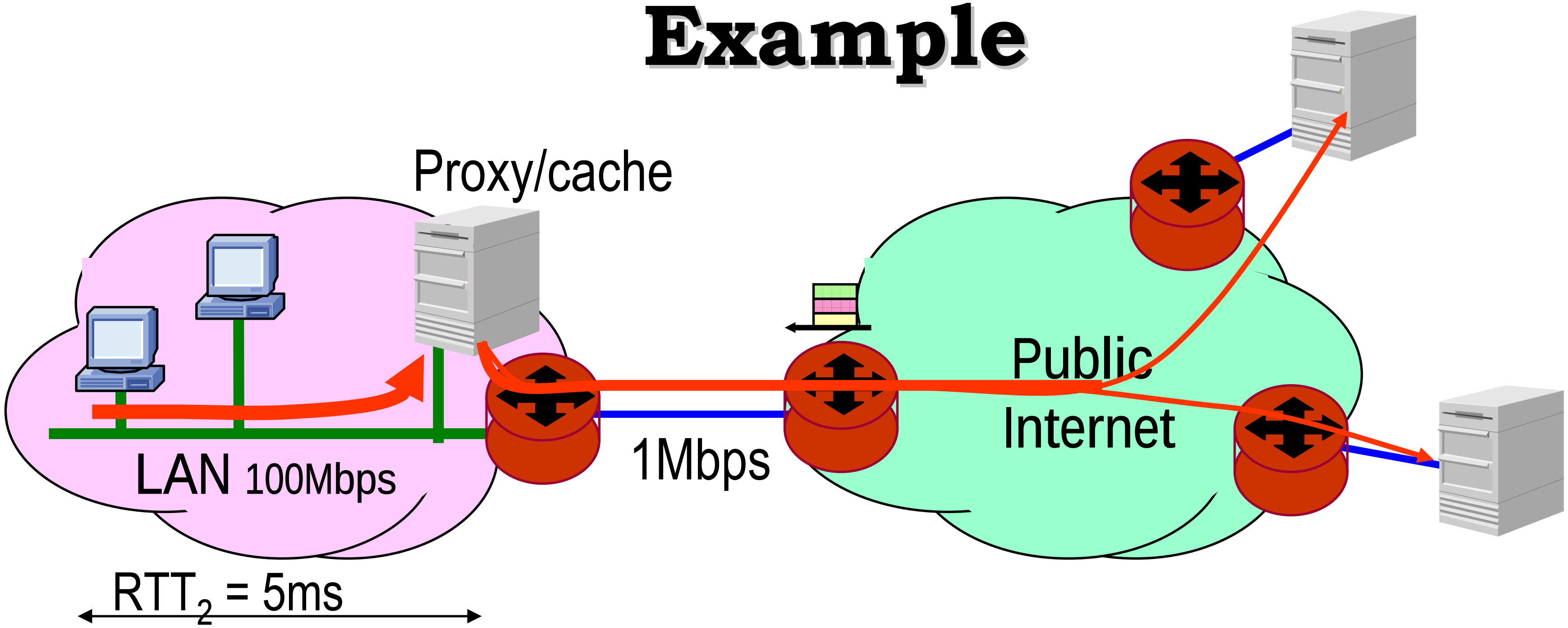
QD_1= ?

- ≈36kbit/request
- 26 request/s

⇨ 936kbps ⇨ R/C=93.6% ⇨ QD_1=176ms

Retrieval Time = 3*100+3*176+3*12+20=884ms > 356ms

Example

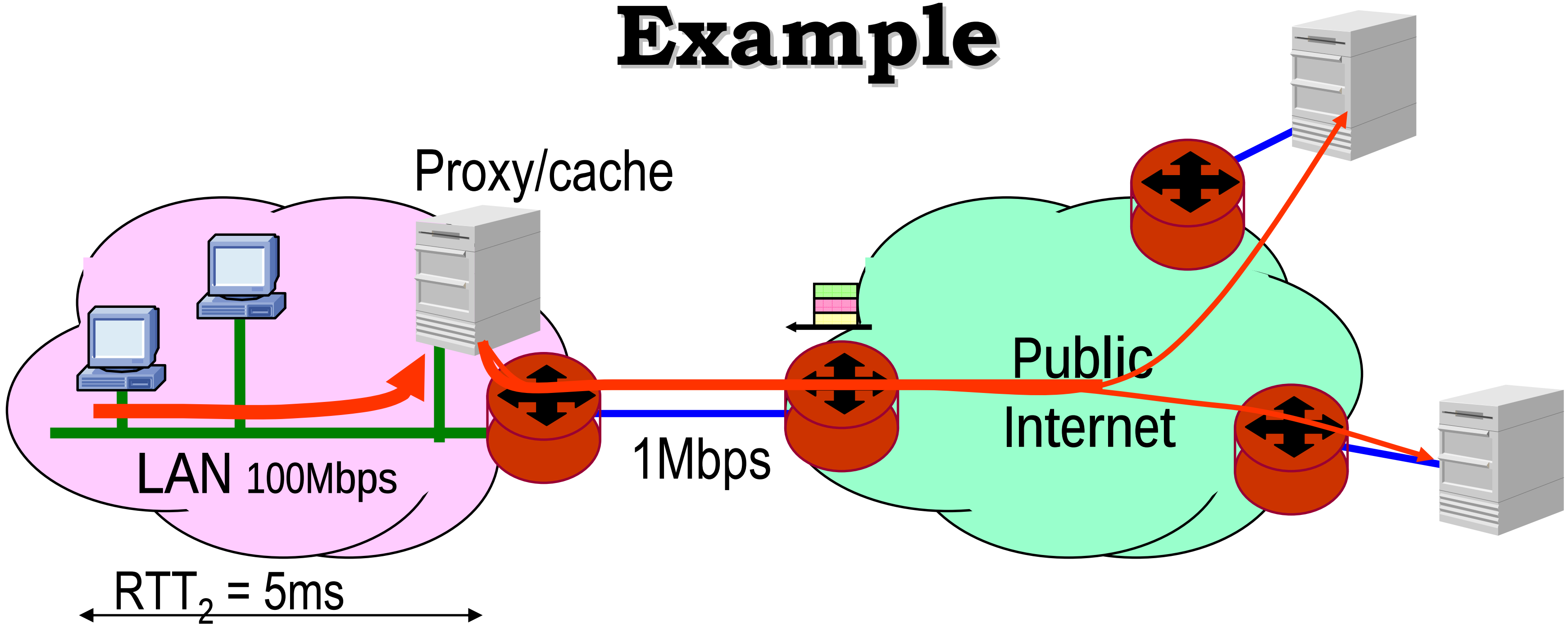


Hit rate = 20%

ST_2 = 20ms $PT_2 \approx$ 0ms $QD_2 \approx$ 0ms

Retrieval Time(2) = 3*5+3*0+3*0+20=35ms

Example



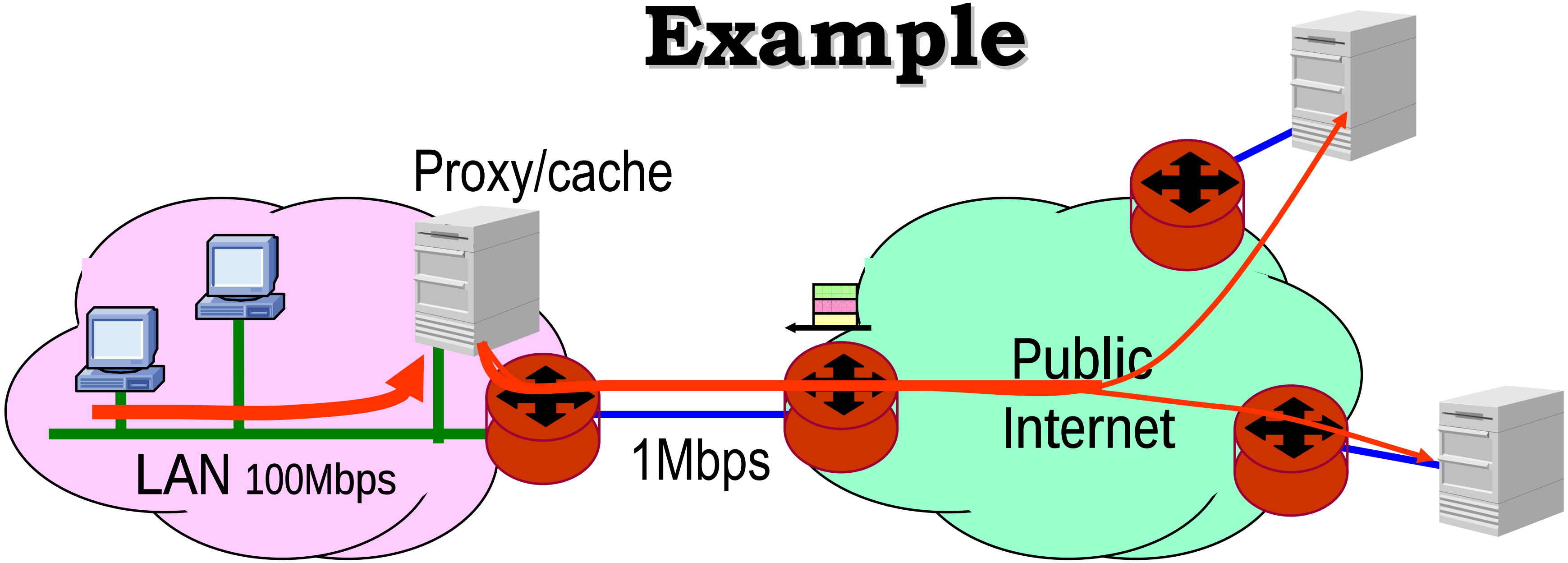
PT_1 = 12 ms ST_1 = 20 ms QD_1= ?

- 36kbit/request
- 21 request/s

⟹ 749kbps ⟹ ρ=74% ⟹ QD_1=34ms

Retrieval Time(1) = 3*100+3*34+3*12+20=458ms < 884ms

Example



Hit rate = 20%

Retrieval Time(1) = 35ms   Retrieval Time(1) = 456ms

Average Retrieval Time = 0.2*35+0.8*456 = 372ms

512 ms saving! (58%)

Some HTTP examples

- ➔Download an image
- ➔Need for Host in http/1.1
- ➔Connection: permanent/close
- ➔HTTP stateless
- ➔Conditional GET