NETWORK DESIGN & MANAGEMENT
TCP basics, Quality of Service, Service model & evaluation
C. Pham

Exercice 1: TCP

We consider a TCP connection with RTT=70ms, packet size S=1500 bytes on a link with capacity C=10Mbps. Give time t at which the TCP connection will have sent 56794 packets ?

Remember that $\sum_{i=1}^{n} i = \frac{(n+1)n}{2}$

Exercise 2 : TCP (again)

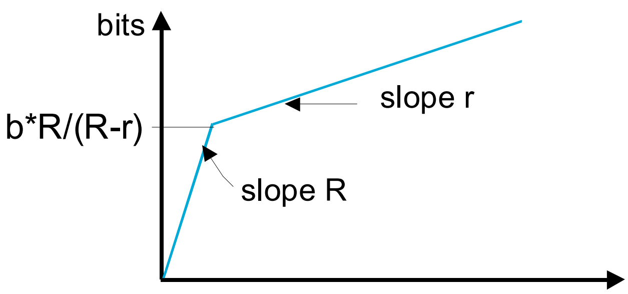
TCP in its steady state uses an AIMD (Additive Increase, Multiplicative Decrease) process which can be described as follows :

When no loss : cwnd=cwnd+a ; with a=1
Upon loss : cwnd=cwnd*b ; with b=0.5

Considering a starting TCP connection, give the time *t* at which the TCP sender will be sending at the rate of R=3Mbps. We give the following parameters : RTT=70ms, packet size S=1024 bytes, initial *slow-start/congestion avoidance threshold*=32. We will suppose that there are no errors and that packet's processing time is neglectible.

Exercise 2 : QoS, Token Bucket

A/ Some communication lines are leased to an operator with a negociated throughput of 6 Mbps. This operator uses a *Token Bucket* mechanism to regulate the user's traffic at each location of the company. The *token bucket* is described by the following parameters **(b, r, R)** where b is the capacity of the bucket in number of tokens, r the token rate generation and R the maximum rate of transmission (e.g., R = link capacity). We assume that sending one bit consumes 1 token.



Explain why the second part of the curbe above, which indicates the total number of transmitted bits as a function of time, has a slope of r.

At which time t will we move from throughput R to r ? Give the litteral expression first, then do the numerical application : b=3Mbit, r=6.10^6 token/s and R=10Mbps.

Assume a token bucket TB (6000, 2.10^3 token/s, 2Mbps), how many 512-bit packets can we send in a burst ?

If we consider that at time t_0 we begin sending packets, at which time t_1 will we have sent n=500 packets ?

The user wants to send 6 packets as fast as possible. At which time t_2 would he be able to send these 6 packets in a row?

Exercise 3 : Basic operational analysis, service model

A/ We measured on a router during 1 hour that it received R=768999 packets and sent S=203789 packets.

What is the mean output throughput Λ of the router in packet/s?

The manufacturer of the router indicates that the router is able to process 1024000 bps with a cost of 5ms per packet.

What is the mean service time T of a 1300-bytes packet ? What is in bps the maximum throughput of the router when considering 1300-bytes packets? If a 10MB file has to be sent, in how many time the file will be transmitted ?

We assume that the R packets previously mentioned are 1300-bytes packets.

What is the utilization rate U of the router during the observation period ? When comparing R and S, and knowing U what can you deduce about the router?

B/ We consider an interactive system ...

- Measures have been done for 1 hour
- Disk x has been busy for 30 mninutes
- Each transaction generates about 20 access requests on the disk
- The mean service time per request of the disk is 25 ms
- There are 25 terminals connected to the main system, with a mean reflexion time of 18s

What is the throughput Λ in transactions/s of the system ?

Knowing that the mean response time R of an interactive system is given by

$$R = \frac{N}{\Lambda} - Z$$

where Λ is the throughput, Z the mean reflexion time and N the number of connected terminals, **what is the mean response time of the system?**

C/ A router can handle real-time traffic and best-effort traffic (FTP). The real-time traffic has priority on FTP traffic and the scheduling is a WRR on 2 queues with the following weights: W_{TR}=0,75 for real-time and W_{FTP}=0,25 for FTP.

The real-time traffic comes with a constant throughput of T_{TR}=2Mbit/s, the FTP traffic comes with a mean throughput of T_{FTP}=8Mbits/s. We suppose that packets size are S_{TR}=300 bytes et S_{FTP}=1500 bytes.

What is the number of packets processed per cycle of CT=100ms by the WRR scheduler on each of the queue ? We assume that the weights represent the proportion of time in a cycle during which the router has full access to the output capacity of the router, set to C=10Mbps.

We suppose that the router reserves B_{FTP}=10MB of memory for the FTP traffic and B_{TR}=5MB of memory for the real-time traffic.

Which traffic will first encounter packet losses ? At what time t ? How can we avoid that ?

To do so, you could try to find the amount of input information (N_{in}) and processed (N_{out}) per traffic type during a cycle (ex : $N_{in,x}$ with x={FTP,TR})