DLB: A novel real-time QoS Control Mechanism for Multimedia Transmission

Jian Li, PhD student of LORIA, supervised by YeQiong Song

Introduction and Motivations

Multimedia transmission over Internet

Common characteristics

- Timely deliverance of packets
- Packet loss-tolerance

Neither Diffserve or Interserv can effectively handle them.

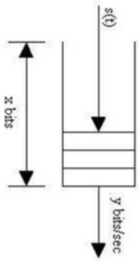
We propose to selectively drop packets during network congestion → queue management

Problem:

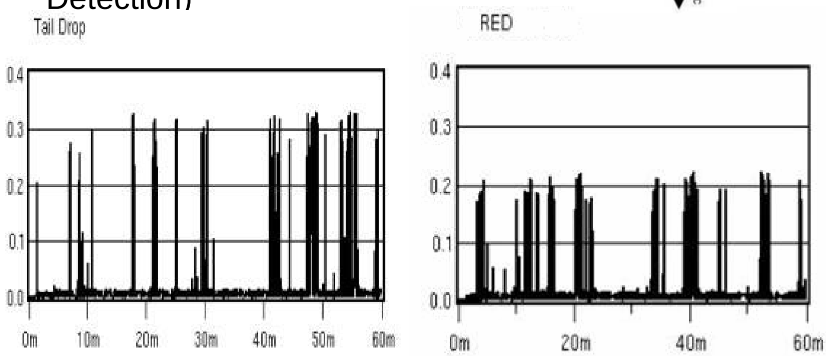
- Loss rate (1%--10% loss can be tolerated by VoIP)
- Consecutive packet loss

  long consecutive packet losses will significantly degrade the quality of the voice.

State of the art



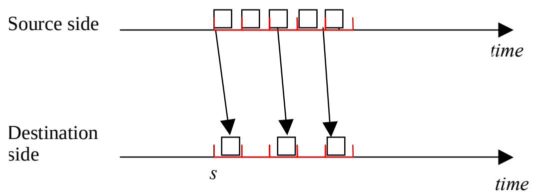
- Drop tail
- RED (Random Early Detection)



(m,k)-firm constraint

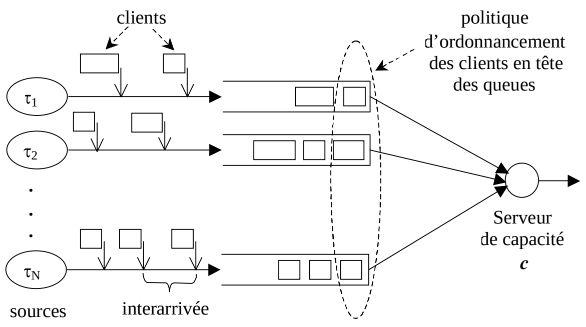
Definition: the deadlines of at least *m* out of any *k* consecutive packets must be guaranteed

- Providing non-long consecutive loss guarantee



System model

MIQSS (Multiple Input Queue Single Server)



Problem of (m,k)-firm constraint

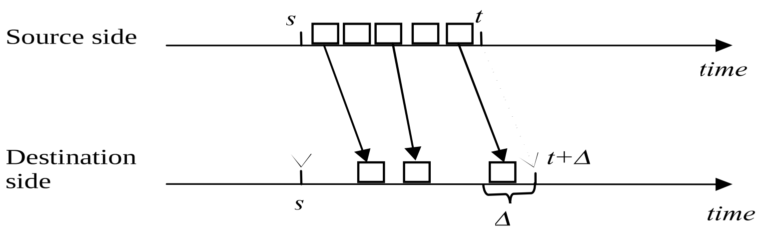
- deterministic (m,k)-firm guarantee can oblige resource reservation according to (k,k)-firm.
- (m,k)-firm could be violated in arbitrary low workload [Li03]
- It is a problem of NP-hard in strong sense [Quan00]

Contributions:

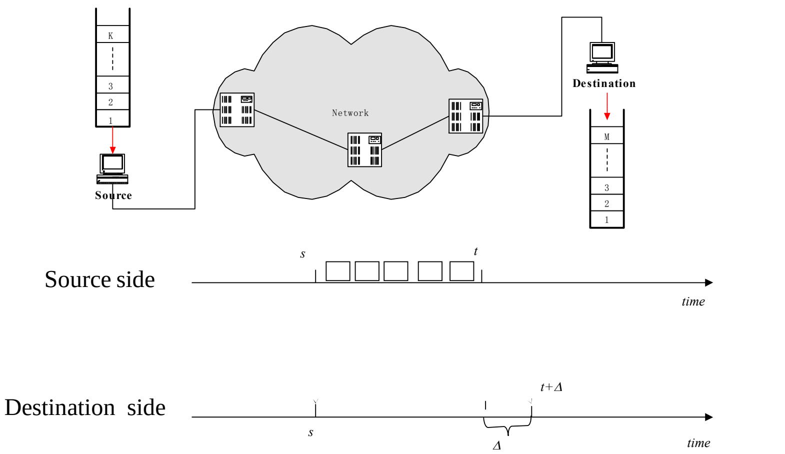
- ✓ Per-flow (m,k) constraint to improve resource utilization
- ✓ DLB (Double Leaks Bucket): one mechanism to deterministically guarantee PF-(m,k) constraint

PF-(m,k):

- PF-(m,k) is given faced on the integral flow instead of the per-deadline requirement as the conventional real-time constraint.



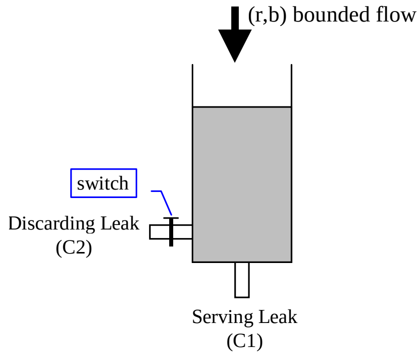
PF-(m,k) provides End-to-end QoS



Double Leaks Bucket

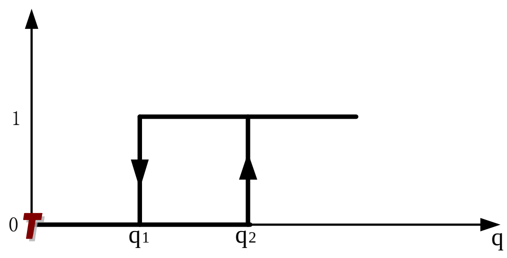
Liquid model of DLB

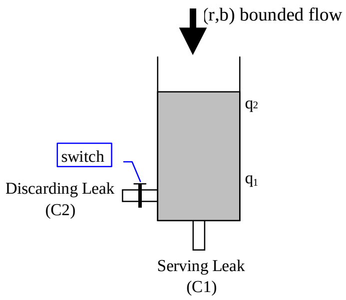
- The flow is bounded by (r,b)
- A bucket with Two leaks: discarding leak (DL), serving leak (SL)
- Discarding leak is controlled by a switch



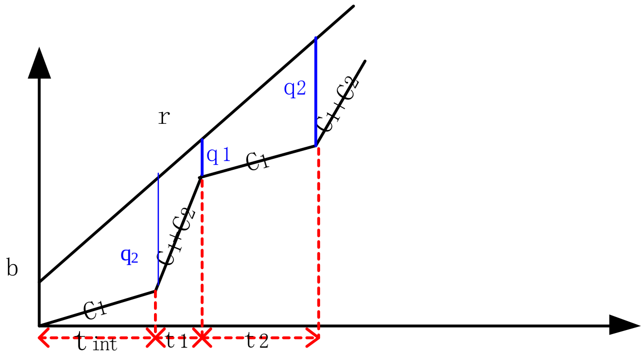
DLB:

- The switch is controlled by a function of *Double thresholds function*





DLB: Service curve

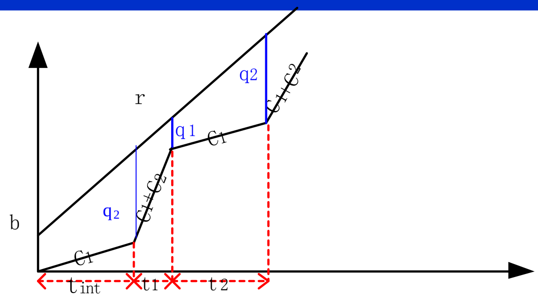


DLB Sufficient condition

- Condition (1) : *C1+C2>r*; ⇒; $\frac{C_1}{C_2} \ge \frac{m}{k-m}$
- Condition (2): if b>q2, then $\max\left(\frac{b-q_1}{C_1+C_2}+\frac{q_1}{C_1}, \frac{q_2}{C_1}\right) < \Delta$

  else $\max\left(\frac{q_2-q_1}{C_1+C_2}+\frac{q_1}{C_1}, \frac{q_2}{C_1}\right) < \Delta$

DLB: sufficient condition



- *Condition (1) ensures the (m,k) factor*:
- *Condition (2) ensures the transmission delay factor of PF-(m,k)*:

Numerical application:

- audio-CBR streams' parameters:

CD quality stereo audio stream

(r,b)=(1.4Mbps, 2kbit).

- PF-(3,5) constraint
- Δ=20ms

Configuration of DLB:

Condition (1) C1+C2=1.2r

$$\frac{C_1}{C_2} \geq \frac{m}{k-m}$$

Condition (2): b<q2

$$\max\left(\frac{q_2-q_1}{C_1+C_2}+\frac{q_1}{C_1}, \frac{q_2}{C_1}\right) < \Delta$$

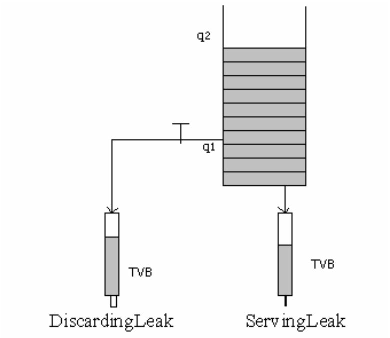
- C1=1.008Mbit/s
- C2=0.672Mbit/s
- q1=2kbit
- q2=5kbit

⇒ Delay $t_{delay} \leq 5ms \leq \Delta = 20ms$;

guarantee all packets within 20ms: 1.5Mbit/s

DLB: packet model

- Taking into account the granularity of the packets and the discrete time



Conclusion and future work:

- Per Flow (m,k) constraint, together with DLB provide graceful QoS degradation during network overload periods
  - E.g.: 1.008Mbps vs 1.5Mbps
- Future work

  Implementation of DLB in Click router

Modular *Router*

Thanks