Computer Networks WS12/13
Homework #10

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Final Exam

- Date: February 7th , 10:00am, duration 90 minutes
- Room: MN06
- If not done yet, register in FlexNow!

- Preparation: Slides, old exams, exercises
- Language: Questions are both in English and German, your answer can be in either of these languages

Quality of Service Building Blocks

- Q: Name three building blocks of Quality of Service?

- Classification: distinguish one flow/class from another
- Policing: ensure the traffic is in conformant to the contracted parameters
- Scheduling: ensure the QoS guarantees (e.g., bandwidth, delay)
- Admission control and resource reservation: check if resource requirements can be met and admit or deny flows accordingly

computer NETWORKS

Scheduling Policies

- Q: Name and characterize four scheduling policies that were introduced in the lecture.

- First In First Out (FIFO)
  - Packets are sent in order or arrival
  - If queue is full, discard either
    - Newly arriving packets
    - Packets based on priority
    - Random packets

Scheduling Policies (cont'd)

- Priority Scheduling
  - Packets are sent in order of priority
- Round Robin
  - Packets are sent alternating between different classes
- Weighted Fair Queuing
  - Combination of Priority Scheduling and Round Robin
  - Weighted amount of packets sent from each class every cycle

Policing

- Q: What are the criteria that policing mechanisms can use to control a data stream?

- (Long term) Average Rate
  - E.g. 6,000 packets per min (ppm)
- Peak Rate
  - E.g. 6,000 ppm on avg but limited to 1,500 packets per sec (pps) peak rate
- (Max.) Burst Size
  - E.g. 500 packets

Packet Scheduling

- Q: Illustrate in what sequence packets from three different queues (a, b, c) can be sent from a sending buffer that implements a WFQ scheduling policy. Suppose the weights for the queues are 0.25, 0.25, and 0.5. How could the sequence look like if there are no packets in queue 'c'?

- abcc abcc abcc -or- acbc acbc acbc
- abab abab abab

Token Bucket

- Q: Consider a token bucket that is filled with a rate of 1,000 tokens/min and has a size of 500 tokens. Each bit of data consumes one token. Does a flow of 20bps conform to this bucket?

- 20 bit per second = 1,200 bit per minute
  → excess of 200 bit per minute
- => The flow does not conform to this bucket
- However: If the bucket is full, flow has 2.5 min to adjust (500 tokens / 200 tokens/min)

Delay Guarantees

- Q: Assume a router maintains QoS garantees for two data flows. Flow A is policed by a token bucket with a capacity of 100 tokens and a fill rate of 20 token/sec. Flow B is policed by a token bucket with a capacity of 200 tokens and a fill rate of 12 token/sec. The router uses weighted fair queuing to schedule the packets with a weight of 3 for flow A and a weight of 2 for flow B. It's sending rate is 40 packets/sec. What is the upper bound delay that the router can guarantee for both flows?

Delay Guarantees (sol.)

- Flow A
  - 20 tokens/sec plus 100 tokens if filled
  - Worst case: 100 tokens worth of traffic instantaneously => Queue for A fills up with 100 packets
  - Outgoing rate is 40 packets/sec of which A is allocated at least 3/5 => 24 packets/sec
  - Worst case: A has average (incoming) flow rate of 20 packets/sec => only at least 4 packets/sec can be removed from the queue
  - Last packet in the queue will be delivered after 100/4 = 25 sec

Delay Guarantees (sol.)

- Flow B
  - 12 tokens/sec plus 200 tokens if filled
  - Worst case: 200 tokens worth of traffic instantaneously => Queue for B fills up with 200 packets
  - Outgoing rate is 40 packets/sec of which A is allocated at least 2/5 => 16 packets/sec
  - Worst case: B has average (incoming) flow rate of 12 packets/sec => only at least 4 packets/sec can be removed from the queue
  - Last packet in the queue will be delivered after 200/4 = 50 sec

IntServ and DiffServ

- Q: Briefly compare the IntServ to the DiffServ architecture.

Criteria	DiffServ	IntServ
Based on	Aggregated service classes	Single flow
Level of control	Coarse-grained	Fine-grained
Basic principle	Traffic classification	Resource reservation
States	Edge: per flow Core: none	Every node: per flow
Setup	Per class (long-term)	Per flow
Scalability	Average	Bad

Thank you

Any questions?