

HW4

1. TCP/IP inherently doesn't care about how to deliver data rather than give "best-effort" service whenever possible to clients. It is hard to change tcp and ip to support QoS since all other protocols must be compatible with it, transparent of service quality, and inelastic rather than elastic for guarantees. This is not only to mention that we can only have so many bits allocated for QoS of which there are a limited number of service levels possible.

Integrated Services try to set aside resources based on explicit or implicit service levels to broadcast to clients' information about requested and assigned service levels of networks. Process of providing service in this way requires many flows' information.

Differentiated Services try to assign resources based on priority that is given to packets by the router. Processing of providing services this way requires only information locally available at the router.

2.
 - a. Flat addresses without hierarchical structure means no more subnetworks, each address has to be unique for every computer ever made.
 - b. You could use BGP to route through several devices until you reach the destination since devices would still be linked but some devices may not route to the destination.
3.
 - a. This drop policy would ensure high-cost packets would get dropped and flows would be punished for having big chunks of the queue. The disadvantage is that we will need to recompute the cost every time the queue updates.
 - b. This can happen with 3 packets where the sizes and order are 3, 7, 2. Since we calculate the size x sum of sizes of previous packets, the last packet of size 2 has a cost of 22 while the middle larger packet of 7 has a cost of 21.
 - c. If we say a packet of size 3 and, right after, a packet of size 2 arrive in the queue, then assume that the packet of size 4 will be sent at $T=5$, we can make the following schedule:

T=0	$3 * 5 = 12$	$2 * 6 = 12$
T=1	$3 * 4 = 12$	$2 * 5 = 10$
T=2	$3 * 3 = 9$	$2 * 4 = 8$
T=3	$3 * 2 = 6$	$2 * 3 = 6$
T=4	$3 * 1 = 3$	$2 * 2 = 4$

At $T=4$ the packets switch costs.

4.
 - a. By calculating the area under the curve we can get the delay of each packet. With packet 2, the delay is $4 * 2 = 8$ time steps. Packet 3, the delay is 8.

- b. At $t=8$, only the first packet has arrived. Packets 2 through 8 will not be played and the video will have to wait to receive these packets.
 - c.
 - d.
 - e. Losses are not the problem for streaming, you just lose some frames. The issue is jitter and wide variations of jitter which result in extreme delays. If a video streaming service doesn't use a playback buffer and has negligible losses but the jitter (variability in delay) is not negligible, then the video would stop/start constantly and you'd only get to see 2 seconds of video before receiving frames.
- 5.
- a. For max-min fairness, we give evenly give each user a small portion of resources that they demand for and any increase to a user will decrease another user that has equal number of resources.
 - b.
 - $9 \text{ units} / 5 \text{ demands} = 1.8$ w/ $.8$ excess for A
 - $.8 / 4 \text{ demands} = .2 \Rightarrow [1, 1.2, 1.2, 1.2, 1.2]$ allocated, B has excess of $.2$
 - $.2 / 2 = .1 \Rightarrow [1, 1, 1.4, 1.4, 1.4]$ is the final allocated values to A,B, C, D, and E.
6. Fair queueing is the act of dropping packets from different flows equally in network-congested scenarios. With FIFO, if a certain flow wants to gain bandwidth they can just flood the switch to occupy the buffer all the time. That way all other flows' packets will be dropped. Fair Queueing identifies misbehaving flows and implicitly punishes them for trying to get more than their fair share.
- 7.
- a. If tokens arrive at 2 packets per second, and at $t=0$ there were 7 buckets sent, that means with x as the bucket depth: $x-7+2=x-5$. We then use this answer to do the same at $t=1$ where 4 packets were sent with $x-5-4+2=x-7$. We then do this recursively for every time step. At $t=2$, $x-7-2+2=x-7$. At $t=3$, $x-7-0+2=x-5$. At $t=4$, $x-5-7+2=x-10$. At $t=5$, $x-10-2+2=x-10$. By solving an inequality $x-10 \leq 0$ we can see $x=10$ so the bucket depth should be 10.
 - b.

T=0	7	$x-7+4=x-3$
T=1	4	$x-3-4+4=x-3$
T=2	2	$x-3-2+4=x-1$
T=3	0	$x-1-0+4=x$ (excess dropped)
T=4	7	$x-7+4=x-3$
T=5	2	$x-3-2+4=x-1$

At least bucket depth of 4.