ISP ShinyNet connects customers to the Internet with a symmetric 40 Mbit/s link. The ISP gateway router/modem has a single buffer shared by all senders with a capacity of 1000 packets. You may assume all packets are of the same length and that packet-arrivals are not bursty.

A popular application uses three UDP flows each concurrently sharing the link. The three flows send at rates of 10 Mbit/s, 20 Mbit/s and 30 Mbit/s respectively.

(a) What is the data rate successfully traversing the buffer and the fraction of packets for each flow dropped by the buffer?  

ShinyNet upgrades the customer gateway router/modem. The upgraded device employs one queue per flow (three queues in total for this case); each queue can hold a maximum number of packets in proportion to the flow count (333 packets per flow), the queues are scheduled using simple per-flow fair queueing with an equal weight for each queue.

(b) What is the packet loss rate for each flow when using the upgraded gateway?

(c) Approximately how many packets does each flow have in its queue?

ShinyNet updates the gateway routers/switch to now use weighted-fair queueing. Using an unknown patented technology (or poor configuration); the following weights are assigned to the flows as follows: 0.2, 0.6, and 0.2 for each flow respectively.

(d) What is the packet loss rate for each flow when using this gateway with weighted fair-queueing?

(e) Approximately how many packets does each flow have in its queue?

(f) Throughout this question we have assumed packets are of equal length; this is not a valid assumption for the vast majority of Internet traffic. Presuming that over the long term we wish for the queue discipline to retain the desired weighted-fairness properties, discuss the issues variable length packets raise, and propose an approach to maintain the desired weighted-fairness outcome.