Principles of Communications

Supervision Questions Set 4:
Optimisation, Scheduling and Switching

Marks are given for guidance only. The exam questions are intended to be optional and it is left up to your supervisor whether they will require you to do them or not.

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1. You are the head of operations for a hot air balloon company. Flights are losing money and your job is to make them profitable again. The number of flights is fixed but you can control which launch location to use and the duration of the flight (there is a minimum duration of 15 minutes). The cost of a flight depends on the duration (to cover fuel, pilot's wages and the cost of the chase vehicle), the launch location and how far the landing site is from a road (as you have to compensate any farmer whose fields you have to cross). You have 1 pilot and up to 9 passengers and are free to set the charge to whatever you want but the number of passengers decreases as the cost goes up.

    Construct this problem as an optimisation (e.g. construct plausible transfer and objective functions). What are the fixed parameters? What are the inputs and outputs? What are the control variables? How would you empirically estimate the transfer function[1]? *(10 Marks)*

2. Describe the operation of the following types of packet switch fabric, paying particular attention to the kinds of blocking which can occur *(5 Marks)*

    (a) CPU-driven

    (b) Shared Bus

    (c) Crossbar

    (d) Banyan

    (e) Batcher-Banyan

3. Optimisation-based congestion control aims to steer the network towards its optimal operating point, avoiding bottlenecks at any point, while maximising what economists call social welfare (the greatest number of end-users getting the best service they can). A new protocol called multi-path TCP (MPTCP) allows a multi-homed host to use two or more physical connections for a single TCP flow.

    (a) Discuss how a scheme like MPTCP might benefit the end-user. Consider throughput, reliability, etc. *(5 Marks)*

    (b) How might this improve the overall performance of the network, and how does this help achieve global optimisation? *(5 Marks)*

    (c) MPTCP is recommended to use a coupled congestion controller [RFC6356] to ensure fairness when competing with other traffic. What is meant by fairness in this respect? Describe the operation of the coupled congestion controller. *(5 Marks)*

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[1]from Keshav Ch.4 Ex.1

4. The max-min fair share criterion for allocation m_n of resources to a set of N flows, with respective demands x_n for a resource of capacity C, can be computed using the following equations:

$$m_n = min(x_n, M_n), \quad 1 \le n \le N$$

$$M_N = \frac{C - \sum_{i=0}^{n-1}(m_i)}{(N - n + 1)}$$

(a) Explain, perhaps with the use of an example, how this criterion operates to mitigate between over- and under-demands[2]. *(5 Marks)*

(b) Contrast max-min fairness with proportional fairness. Try to do this with reference to real-world examples. *(5 Marks)*

Exam Questions

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[2]From 2010 Paper 7 q.9