2010 Paper 8 Question 3

Digital Communication II

(*a*) Work conserving packet switches follow the law that for a given packet arrival rate λ_n, and packet service rate μ_n, the sum

$$\sum_{n=1}^{N} \rho_n q_n = C$$

where C is a constant and $\rho_n = \lambda_n \mu_n$.

(*i*) Explain what trade-off is represented in this equation, perhaps using a simple numerical example. [8 marks]

(*ii*) What is the key rationale for work conserving packet switches? [2 marks]

(*b*) The Transmission Control Protocol (TCP) uses a congestion control scheme which adjusts a congestion window in response to congestion feedback from the network. Explain how this can lead to a long-term steady-state rate of approximately:

$$\text{rate} \propto \text{MSS}/(\text{RTT} \times \sqrt{p})$$

where MSS is the Maximum Segment Size, and RTT is the Round Trip Time, and p is the mean packet loss rate. You may find it helpful to include a diagram of the evolution of the congestion window over time. [8 marks]

(*c*) Explicit Congestion Notification (ECN) can be used to replace *packet loss* as a signal of congestion. What is the key advantage of doing this? [2 marks]