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School of Information Technology and Electrical Engineering

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COMS3200/COMS7201 – Tutorial 1 - Solutions

Question 1

The important thing to realize about this problem is that it is simply a graph edge labelling problem. First, make a complete graph on all the routers and calculate how many connections there are. This is a simple combination problem, that is, how many different pairs of routers can we select from a collection of 5 routers:

$$\begin{aligned} C_r^n &= \frac{n!}{r!(n-r)!} \\ \text{Number of links} &= \frac{5!}{2!(5-2)!} \\ &= \frac{120}{2 \times 6} \\ &= 10 \text{ links} \end{aligned}$$

On each of these link possibilities, we can place one of 4 different kinds of link: slow, medium, fast or none. Therefore, you have 10 links, each with 4 possible values, so the number of configurations possible is:

$$\begin{aligned} \text{Number of configurations} &= 4^{10} \\ &= 1048576 \text{ configurations} \end{aligned}$$

It takes 50ms of computer time to check each one, so the total amount of time required to check all configurations is:

$$\begin{aligned} \text{Total checking time} &= 1048576 \times 50 \\ &= 52428800 \text{ms} \\ &= 52428.8 \text{s} \\ &\approx 14.56 \text{ hours} \end{aligned}$$

Question 2

The key to this question is identifying the possible things that can happen at any transmission slot. Given n hosts using the medium, there are $n+2$ possible things that can happen.

Possibilities 1 through n are the successful transmission of a packet on the medium by each of the n hosts respectively. The probability of a successful transmission is the probability that one node transmits (p) while all the other nodes do not transmit ($1-p$). Since these events are independent we can just multiply them to find the probability of a successful transmission: $p(1-p)^{n-1}$.

Possibility $n+1$ is an idle media. The probability of an idle channel is $(1-p)^n$.

Possibility $n+2$ is a collision. This is what we want to find.

It is important to remember that these events are independent, so we can easily manipulate them without worrying about dependencies.

These $n+2$ events are exhaustive -- they cover all possibilities and must therefore sum to 1. Slots will be wasted if there is a collision (an idle channel is not wastage since no-one was attempting to

transmit anyway.)

$$\begin{aligned}\text{Probability of wastage} &= 1 - \text{Probability of no wastage} \\ &= 1 - \text{Probability of successful transmission} - \text{Probability idle} \\ &= 1 - np(1-p)^{n-1} - (1-p)^n\end{aligned}$$

Question 3

Applications generate messages of length M bytes. At each of the layers, an h -byte header is added. Therefore, in an n -layer protocol hierarchy, $n \times h$ bytes of header are added, and the total number of bytes transmitted will be $M + n \times h$. The fraction of the network bandwidth that is filled with headers is $\frac{n \times h}{M + n \times h}$.

Question 4

They are both layered, some of the layers are similar (network (called "IP" in the TCP/IP model), transport, application). There are many differences including the number of layers, number of protocols in layers (e.g. the TCP/IP model has only one protocol at the network layer - the connectionless IP protocol), and low level protocols (physical and data link layers) are not specified in the TCP/IP model - only the interface to them.

Question 5

Connection-oriented protocols require that a connection is explicitly open between the sender and the receiver before data is sent. Therefore two additional communication primitives are used: `open_connection` and `close_connection`. Each created connection is assigned a unique identifier which is used instead of message address. Connectionless protocols do not create connections and each message has to have full source and destination addresses in the message header.