**The University of Queensland**
**School of Information Technology and Electrical Engineering**

**Semester Two, 2009**

# 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.)

Probability of wastage = 1 – Probability of no wastage

= 1 – Probabability of successful transmission – Probability idle

$$= 1 - np(1-p)^{n-1} - (1-p)^n$$

**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 with 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**

If the number of hosts is doubling every 18 months, it will quadruple every 3 years. If in July 2000, the number of hosts is 85 million, in July 2003 it will be 340 million, in July 2006 it will be 1360 million (1.36 billion) and in July 2009 it will be 5.44 billion.

The number of hosts will pass 10 billion approximately 18 months later (i.e. double 5.44 billion), that is, in January 2011.

(Based on this model, it will be sometime in the 2009-2010 timeframe that the number of "hosts" on the Internet will pass the world population. Unfortunately, this won't mean that everyone has a computer. "Host" in this context means a device with an IP address and could be anything from a PC to a PDA to a coffee mug (e.g http://mediacup.teco.edu/frames/engl/index_engl.html). Given the current trend of putting any imaginable device or appliance on the Internet, it is likely that growth will exceed these expectations.)

**Question 5**

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 6**

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.