Solutions to Assignment 2

Question 1

The datasheet for the Silvertel Ag1171 Ringing SLIC says it provides the following BORCHST functions:

B Battery Feed - this module provides up to 48V to the Tip/Ring pins.

O Over-voltage protection - the module does NOT provide over-voltage protection (section 4.2)

R Ringing - the module generates a ringing waveform controlled by the RM and FR pins

S Signaling - the module can detect on/off hook detection on the SHK pin

C Coding - this module does NOT provide PCM coding; this is typically done by an audio codec

H Hybrid - the audio signal at Tip/Ring is split into the two directions on pins Vout and Vin

T Test - the module does NOT have any built-in test features such as loop-back

Thus this SLIC module provides the BRSH functions but not the OCT functions.

Question 2

The purpose of this question was for students to learn about the various speech codecs available and the use of MOS (Mean Opinion Score) to quantify performance.

The question of which speech codec provides the best MOS at a rate of 8 kb/s is difficult to answer new codecs are constantly being developed and because the question does not specify the test conditions (e.g. delay, impairments, listener, type of speech).

The most popular popular speech codec that operates at 8 kb/s – which is not the same as a sampling rate of 8 kHz – is probably ITU-T G.729. It is typically rated to have a MOS of slightly less than 4.

However, there are other codecs such as AMR (used by cellular systems), SILK (used by Skype), Speex (a license-free codec), and Opus (a newer, license-free codec) that perform about the same as G.729 at 8 kbps. G.729 or a reference justifying the choice of one of these other codecs would be considered a correct answer.

Question 3

According to the Wikipedia VDSL and DOCSIS articles, G993.2 offers 100 Mb/s while DOCSIS 3.1 offers up to 10 Gb/s downstream data rates. Both are under ideal conditions.

Question 4

Telus provides the public the following pamphlet:
http://static.telus.com/common/cms/files/internet/PureFibre_Step_by_Step_and_FAQs.pdf
to answer questions about the deployment of their PON FTTH network.

(a) Some issues that customers appear to have with deployment of FTTH and how Telus is addressing these include:

- effect on the property - restoring the property to original condition
- markings for buried cables - using water-soluble paints and removing flags
- cutting driveways - repaired
- digging up the lawn - use of plows or drills

(b) Horizontal drilling allows running conduit under pavement and foundations and is more likely to be used in an urban underground deployments of fiber. Trenching with a plow might be more common in a rural areas since it is easier, these above-ground obstructions are less common and restoration of landscaping is often not necessary.

Question 5

(a) Each STS-1 frame contains 9 path overhead (POH) bytes.

(b) Each STS-3 frame contains $2 \times 9 = 27$ POH bytes.

(c) Each STS-3c frame contains 9 POH bytes.

Question 6

(a) Due to symmetry, the number of links traversed is the same regardless of the originating node.

In network (a), 2/3 of the traffic traverses one link and 1/3 traverses two links for an average of 4/3 links.

In network (b), 1/3 of the traffic traverses one link, 1/3 two links and 1/3 three links for an average of 6/3 or 2 links.

(b) Due to symmetry we can examine one link and the traffic on the other links will be the same. In this case we examine the link from node 1 to 2. Each node is generating traffic G/3 towards each other node.

For network (a) the link from 1 to 2 carries G/3 of traffic from 1 to 2, G/6 of traffic from 1 to 3 and G/6 of traffic from 4 to 2 for a total of 4G/6=0.66G.

For network (b), the link from 1 to 2 carries G/3 from 1 to 2, G/3 from 1 to 3, G/3 from 1 to 4, G/3 from 3 to 2, G/3 from 4 to 2 and G/3 from 4 to 3 for a total fof 6G/3 or 2G.

(c) Due to symmetry, each link is equally loaded. If each link is an OC-192 and is fully loaded then the total the total traffic received at one node for network (a) is twice the OC-192 rate or about 20 Gb/s. For network (b) it is the OC-192 rate or about 10 Gb/s.

Note that for network (a) a node transmits G=10/0.66 or 15 Gb/s while for network (b) G=10/2=5 Gb/s. Use of bi-directional links more than doubles the throughput due to the more efficient routing.