PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Mid-Term Examination: Semester I — Academic Year: 2015
Date: 07 October 2015 — Time: 09.00-11.00 (2 hrs)
Subject: 242-460 Multimedia Networks — Room: A200

ทุจริตในการสอบ โทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

- All type of calculators, dictionaries and electronic devices are not allowed.
- All notes and books are not allowed.

1. VoIP performance

1.1 E-Model is described in ITU G.107 as follows:

$$R = Ro - Is - Id - Ie + A$$

- *R Transmission rating factor*
- *Ro Basic signal-to-noise ratio (SNR)*
- *Is All simultaneous impairments to voice signal, e.g.* loudness, PCM quantization distortion
- *Id All delays (impairments after voice signal caused by delays), e.g.* echo, delay
- *Ie Distortion impairment caused by Equipment Impairment factor,* low bit rate codec, packet loss
- *A Expectation factor*

The following test conditions are used:
- Codec G.729A (+VAD)
- The packet loss is 1%.
- End-to-end delay is 200 msec.
- Echo lose is 51 dB.

What is R value? (10 marks)

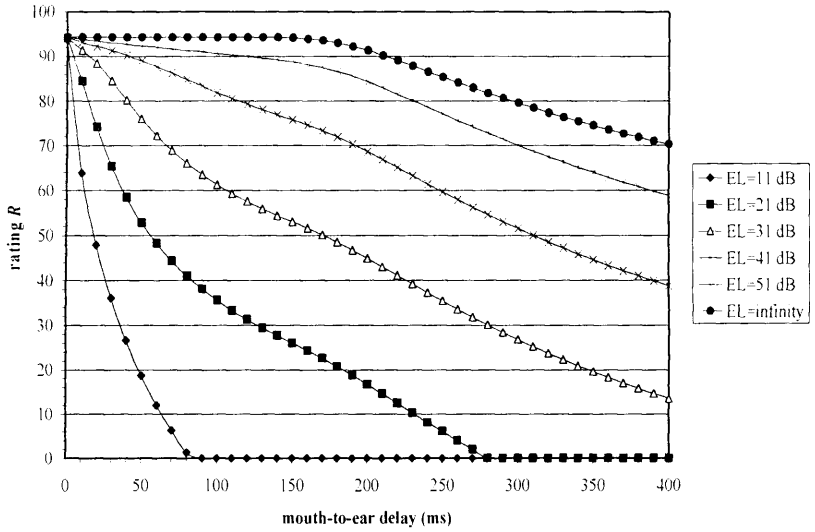

Figure 1 R rating vs mouth-to-ear delay

Table 1 Distortion impairment *Ie* for standardised low bit rate codecs in E-Model

origin	standard	type	codec bit rate (kb/s)	I_e	intrinsic quality R
ITU-T	G.711	PCM	64	0	93.2
	G.726, G.727	ADPCM	16	50	
			24	25	69.3
			32	7	87.3
			40	2	92.3
	G.728	LD-CELP	12.8	20	74.3
			16	7	87.3
	G.729(A)	CS-ACELP	8	10	84.3
	G.723.1	ACELP	5.3	19	75.3
		MP-MLQ	6.3	15	79.3
ETSI	GSM-FR	RPE-LTP	13	20	74.3
	GSM-HR	VSELP	5.6	23	71.3
	GSM-EFR	ACELP	12.2	5	89.3

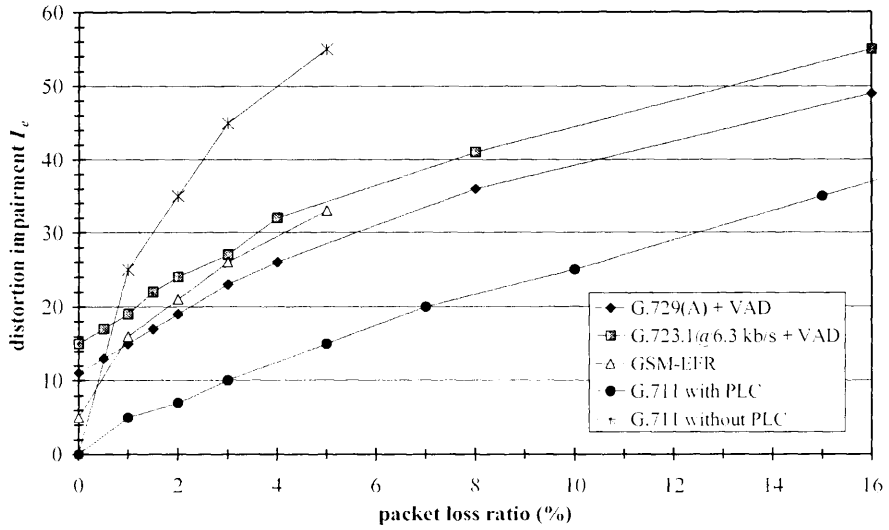

Figure 2 Distortion impairment vs packet loss ration

Answer:

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

2. Figure **3** shows distortion impairment Ie as a function of the packet loss. Figure **4** shows the influence of packet loss on distortion to R-factore. Table **2** shows distortion impairment Ie for standardised low bit rate codes in E-Model. Please answer the below questions based on information given in Figure **3**, Figure **4** and Table **2**.
   - 2.1.1 What does codec give the best performance in terms of R rating when % of packet loss is high (5 marks).
   - 2.1.2 What is codec giving good performance but when facing packet loss its performance drops significantly (getting worst) (5 marks).
   - 2.1.3 At 2 percent of packet lose, what codec gives 2nd better choice (5 marks).
   - 2.1.4 From Figure **4**, please indicate the maximum of packet loss of each codec (e.g. G.711, G.723, G.729) if the acceptable R-factor is 70 (5 marks).

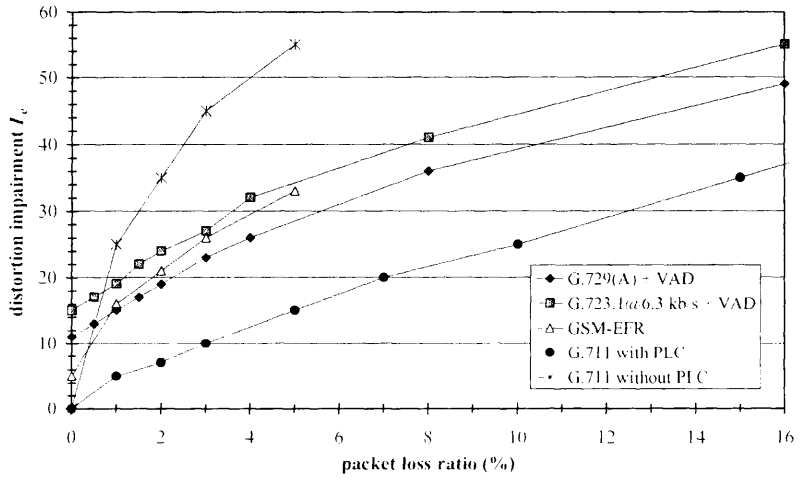

Figure 3 Distortion impairment *Ie* as a function of the packet loss

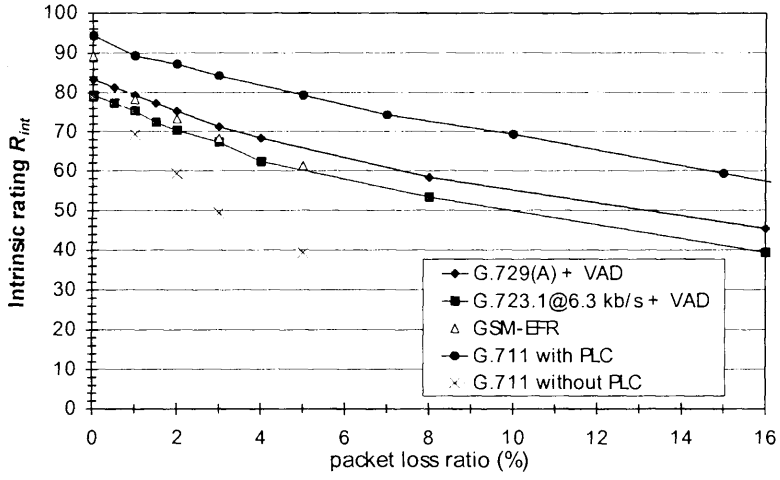

Figure 4 Influence of packet loss on distortion

Table 2 Distortion impairment *Ie* for standardised low bit rate codecs in E-Model

origin	standard	type	codec bit rate (kb/s)	I_e	intrinsic quality *R*
ITU-T	G.711	PCM	64	0	[illegible]
	G.726, G.727	ADPCM	16	50	
			24	25	69.3
			32	7	87.3
			40	2	[illegible]
	G.728	LD-CELP	12.8	20	74.3
			16	7	87.3
	G.729(A)	CS-ACELP	8	10	84.3
	G.723.1	ACELP	5.3	19	75.3
		MP-MLQ	6.3	15	79.3
ETSI	GSM-FR	RPE-LTP	13	20	74.3
	GSM-HR	VSELP	5.6	23	71.3
	GSM-EFR	ACELP	12.2	5	89.3

Answer:

3. Below are **clarity** factors in PSTN:
   - Intelligibility (capability of being understood
   - Noise
   - Fading (to lose strength)
   - Crosstalk

   The above factors appear in PSTN, however, there are other factors that only appear in VoIP (don't appear in PSTN). Please give such factors and their details, e.g. what each item is. (5 marks)

Answer

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

4. Please use the below information to calculate the voice utilisation as follows:
The VoIP uses G.729A CODEC with 20 msec packetized interval time. VoIP Clients are using 100 Mbps Ethernet (IEEE 802.3). Please find the following answers:
   a) What is the bandwidth needed for each VoIP client? (5 marks)
   b) If some clients are connected to WiFi, IEEE 802.11g, what is the minimum bandwidth needed for such VoIP clients? (5 marks)

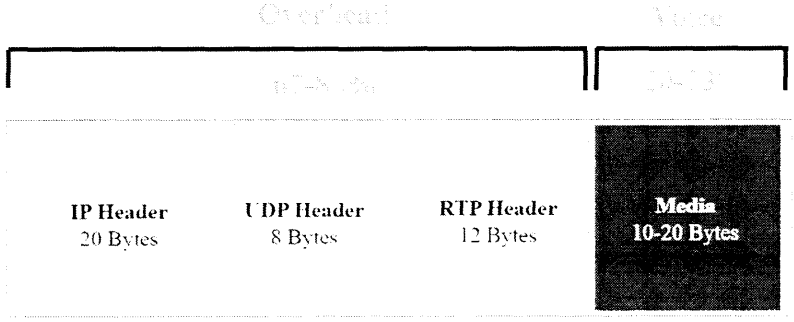

Figure 5 IP, UDP and RTP over heads

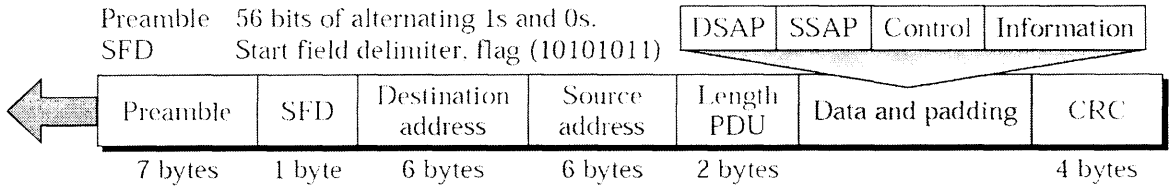

Figure 6 Ethernet (IEEE 802.3) overhead

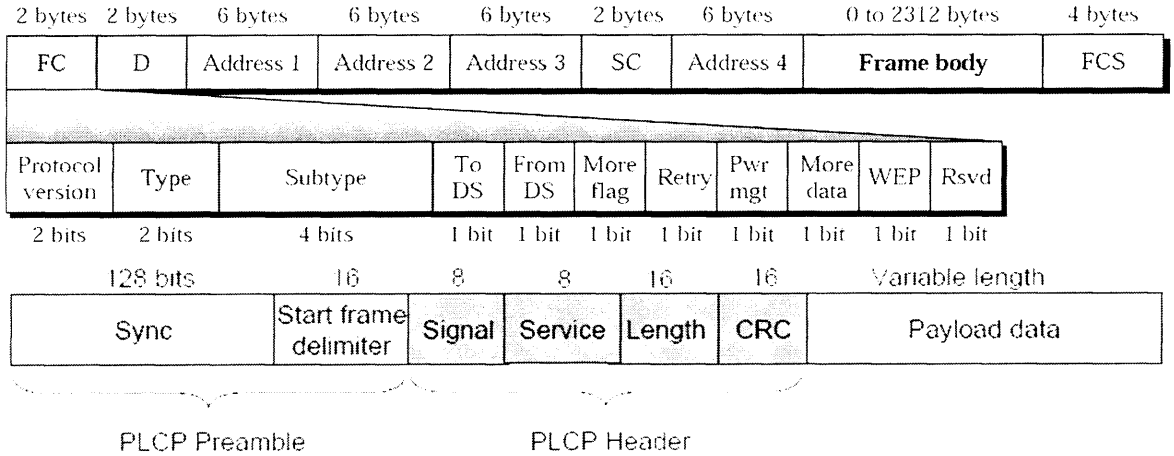

Figure 7 IEEE 802.11 MAC overhead

Answer

.....

.....

.....

.....

.....

.....

.....

5. Please use the table below to answer the following questions:

Table 3 Distortion impairment Ie, Transcoding matrix

CODEC	G.711 (64kb/s)	G.726 (40kb/s)	G.726 (32kb/s)	G.726 (24kb/s)	G.726 (16kb/s)	G.728 (16kb/s)	GSM-FR (13kb/s)	G.728 (12.8kb/s)	GSM-EFR (12.2kb/s)	G.729 (8kb/s)	G.723.1 (6.3kb/s)	GSM-HR (5.6kb/s)	G.723.1 (5.3kb/s)
G.711 (64kb/s)			87.3	69.3		87.3	74.3	74.3	89.3	84.3	79.3	71.3	75.3
G.726 (40kb/s)			85.3	67.3		85.3	72.3	72.3	87.3	82.3	77.3	69.3	71.3
G.726 (32kb/s)	87.3	85.3	80.3	62.3		80.3	67.3	67.3	82.3	77.3	72.3	64.3	68.3
G.726 (24kb/s)	69.3	67.3	62.3			62.3			64.3				
G.726 (16kb/s)													
G.728 (16kb/s)	87.3	85.3	80.3	62.3		80.3	67.3	67.3	82.3	77.3	72.3	64.3	68.3
GSM-FR (13kb/s)	74.3	72.3	67.3			67.3			69.3	64.3			
G.728 (12.8kb/s)	74.3	72.3	67.3			67.3			69.3	64.3			
GSM-EFR (12.2kb/s)	89.3	87.3	82.3	64.3		82.3	69.3	69.3	84.3	79.3	74.3	66.3	70.3
G.729 (8kb/s)	84.3	82.3	77.3			77.3	64.3	64.3	79.3	74.3	69.3	61.3	65.3
G.723.1 (6.3kb/s)	79.3	77.3	72.3			72.3			74.3	69.3	64.3		60.3
GSM-HR (5.6kb/s)	71.3	69.3	64.3			64.3			66.3	61.3			
G.723.1 (5.3kb/s)	75.3	73.3	68.3			68.3			70.3	65.3	60.3		

a) What is R value when G.711 is transcoded to G.729? (5 marks)
b) What is R value when G,729 is transcoded to G.723.1 (5.3 kbps)? (5 marks)

Answer

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

6. Below is the E-model at the Transport Layer. Please use all below information as well as other related information (from previous question) to answer:
VoIP terminal uses G.729 codec, 200 msec end-to-end delay is expected and 1% packet loss rate will be faced. Please find R value (10 marks).

Table 4 Id value

One-way delay (msec)	Id
0	0
25	0.9
50	1.5
75	2.1
100	2.6
125	3.1
150	3.7
175	5
200	7.4

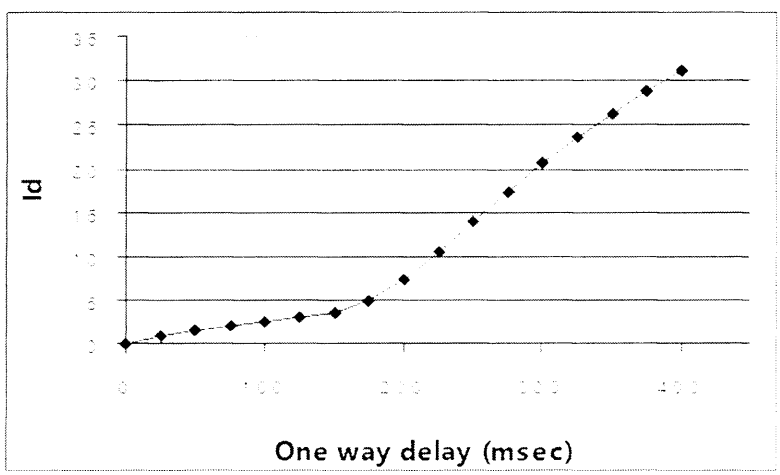

Figure 8 A knee in the curve occurs at a delay of 177.3 msec.

How to fine I_d

$$I_d = 0.024d + 0.11(d\text{-}177.3)H(d\text{-}177.3)$$

where

- d is mouth-to-ear delay (in msec)
- $H()$ is "Heavyside" or "Step" function:
  - $H(x) = 0$ if $x < 0$
  - $H(x) = 1$ if $x > 0$

Answer

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

7. Please describe what effect is caused by the below figure, why it happens. (5 marks).

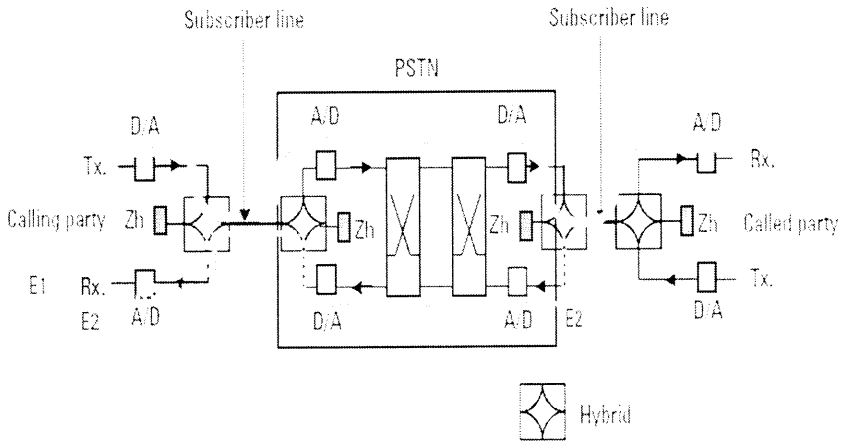

Figure 9 For question 7

Answer

8. There are 5 delay components in VoIP. Please give each delay component as well as its description, example, and explanation.

Answer