PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

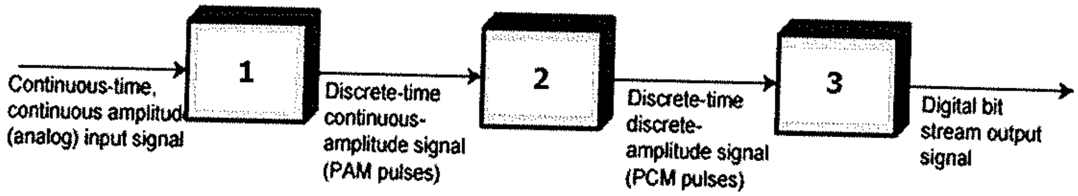
Mid-Term Examination: Semester I
Date: 12 October 2016
Subject: 242-460 Multimedia Networks

Academic Year: 2016
Time: 09.00-11.00 (2 hrs)
Room: S103

ทุจริตในการสอบ โทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

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

1. Below is the process how to digitise analog voice to digital voice. Each box receives its input and produces the output as described in the picture below. Please state what process is:



Answer

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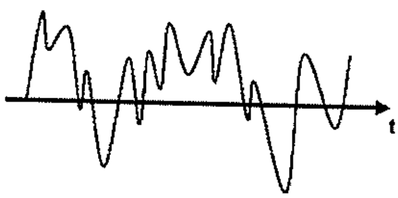
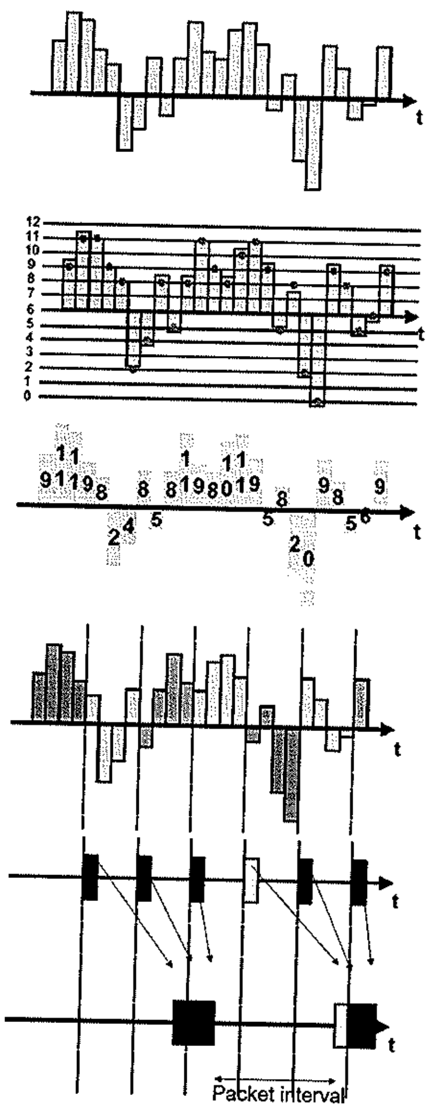
2. 2. Below is the process steps how to process analog voice input to voice packet. Please describe what the step names are.
3.



1) Analog input signal



2) ....

3) ....

4) ....

5) Voice Codec encoding

6) ....

4. VoIP performance

4.1 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 2%.

- End-to-end delay is 150 msec.
- Echo lose is 51 dB.

What is R value? (10 marks)

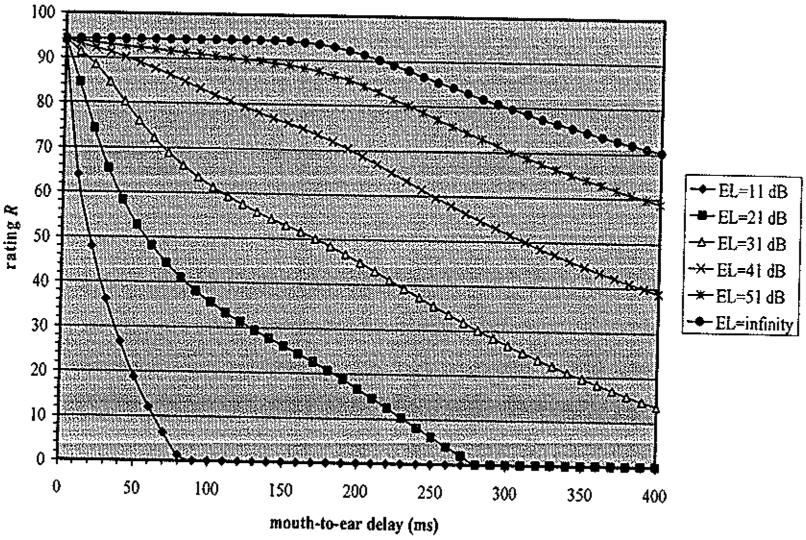


Figure 1 R rating vs mouth-to-ear delay

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	[illegible]
	G.726, G.727	ADPCM	16	50	[illegible]
			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

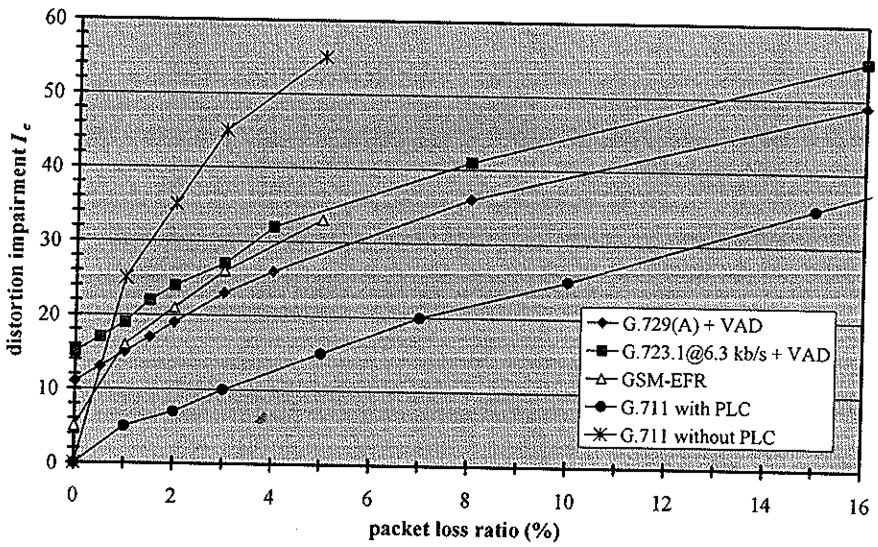


Figure 2 Distortion impairment vs packet loss ration

Answer:

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5. 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 question based on information in Figure **3**, Figure **4** and Table **2**.
   - 5.1.1 What does codec give the best performance in terms of R rating when % of packet loss is high (5 marks).
   - 5.1.2 What is codec giving good performance but when facing packet loss its performance drops significantly (getting worst) (5 marks).
   - 5.1.3 At 2 percent of packet lose, what codec gives 2nd better choice (5 marks).

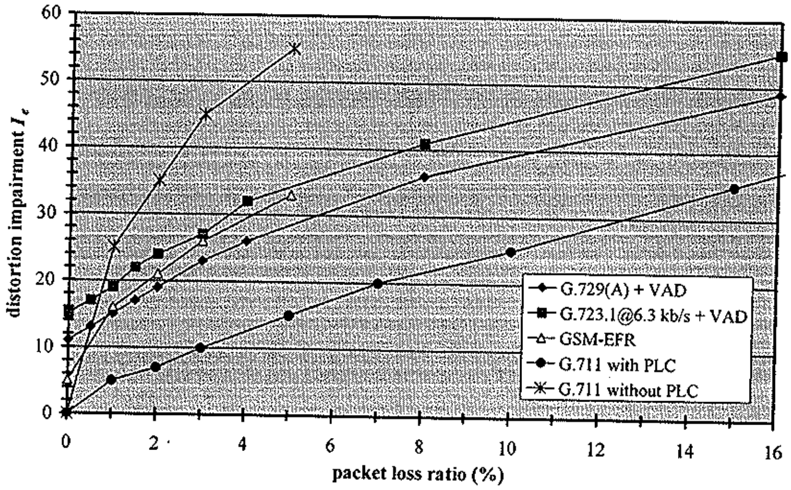

Figure 3 Distortion impairment *Ie* as a function of the packet loss

5.1.4 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).

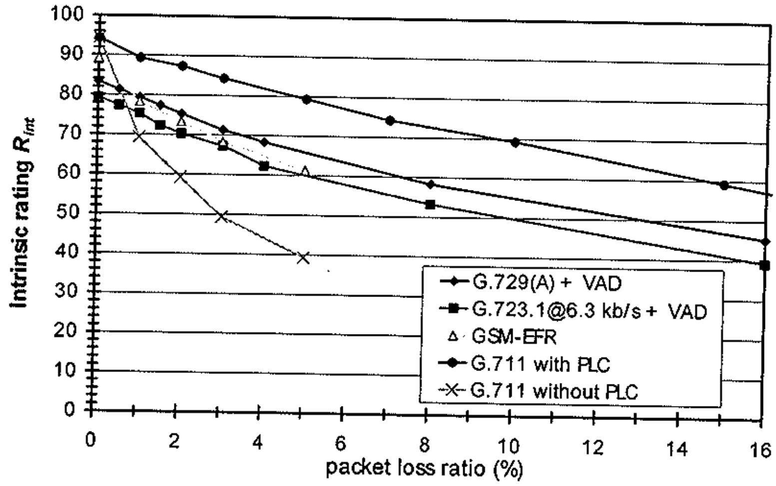

Figure 4 Influence of packet loss on distortion

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	[redacted]
	G.726, G.727	ADPCM	16	50	[redacted]
			24	25	69.3
			32	7	87.3
			40	2	[redacted]
	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:

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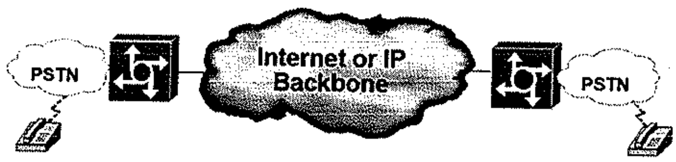
6. Below are **clarity** factors in PSTN: (5 marks)
   - Intelligibility (capability of being understood
   - Noise
   - Fading (to lose strength)
   - Crosstalk



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.

Answer

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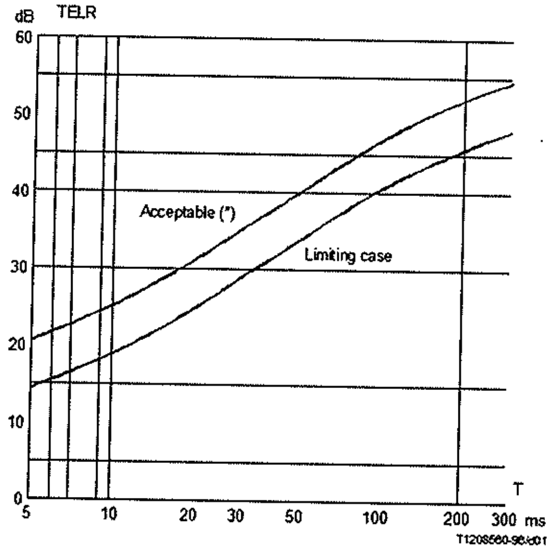
7. Please explain and interpret the effect of TELR (Talker Echo Loudness Rating) as shown in the graph below (e.g. what the relationship between delay time, echo, and loudness) (5 marks)



TELR Talker Echo Loudness Rating

Answer

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8. 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)

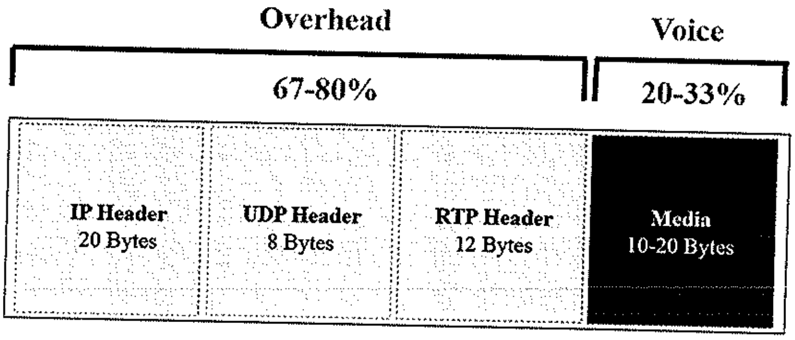

Figure 5 IP, UDP and RTP over heads

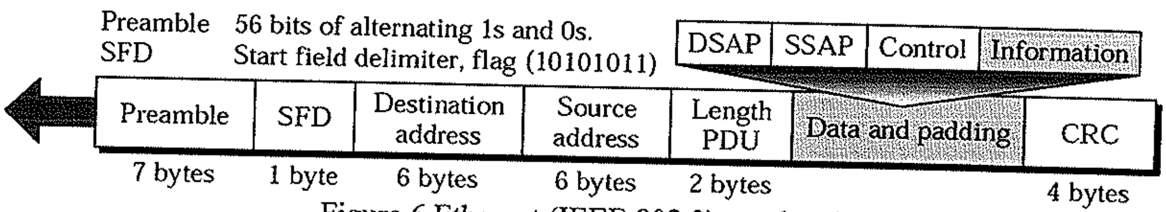

Figure 6 Ethernet (IEEE 802.3) overhead

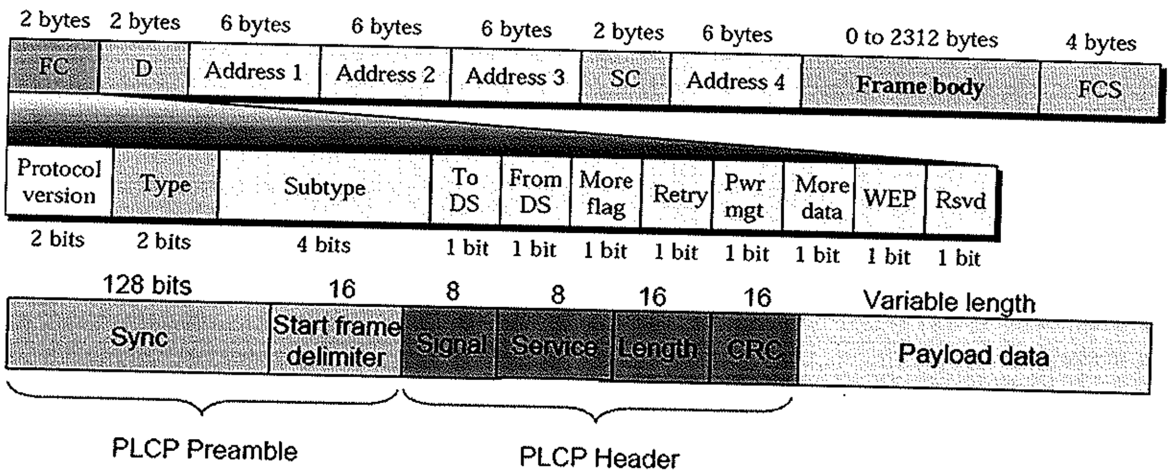

Figure 7 IEEE 802.11 MAC overhead

Answer

(Please show how to get each figure/value)

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9. 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

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10. 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 (10 marks).

Table 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
225	10.6
250	14.1
275	17.4
300	20.6
325	23.5
350	26.2
375	28.7
400	31

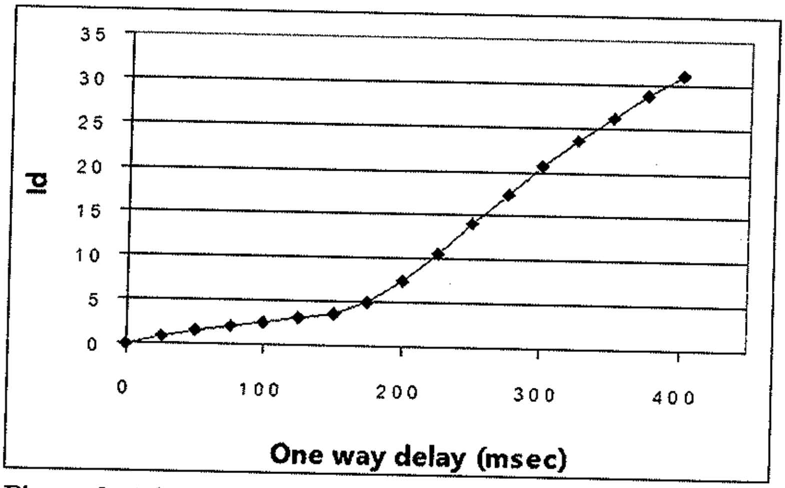

Figure 8 A knee in the curve occurs at a delay of 177.3 msec.

How to fine I_d

$$I_d = 0.024d + 0.11(d-177.3)H(d-177.3)$$

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 $x > 0$

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.

Answer

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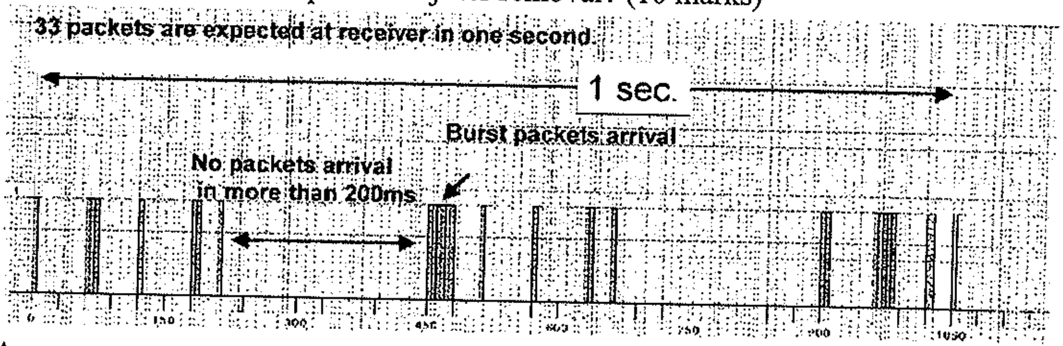
11. Delay is the main factor of VoIP's components that we need to consider when design and develop of VoIP system. There are 5 sources of delay of VoIP system. Please describe each of them what they are, how they affect VoIP performance (10 marks)

Answer

12. Below is the measuring of VoIP packet arrival at the destination node. The VoIP Codec used is G.723.1 encoded RTP voice packet stream. On the sending side, the packets were sent at rate 33 pk/sec. What is the percentage of packet lose? What is the minimum buffer size required for jitter removal? (10 marks)



Answer

13. Below is the Codec features comparison. Please use the information in the table, then answer the following questions:

Codec	Rate (kHz)	bitrate (kbps)	delay frame+lookahead (ms)	multi-rate	embedded	VBR	PLC	bit-robust	license
Speex	8, 16, 32	2.15-24.6 (NB) 4-44.2 (WB)	20+10 (NB) 20+14 (WB)	yes	yes	yes	yes		open-source/ free software
iLBC	8	15.2 or 13.3	20+5 or 30+10				yes		no charge, but not open-source
AMR-NB	8	4.75-12.2	20+5?	yes			yes	yes	proprietary
AMR-WB (G.722.2)	16	6.6-23.85	20+5?	yes			yes	yes	proprietary
G.722.1 (Siren7)	16	(16) 24, 32	20+20	yes			yes	yes	no charge, but not open-source
G.729	8	8	10+5				yes	yes	proprietary
GSM-FR	8	13	20+?				?	?	patented?
GSM-EFR	8	12.2	20+?				yes	yes	proprietary
G.723.1	8	5.3 6.3	37.5				yes	?	proprietary
G.728	8	16	0.625						proprietary
G.722	16	48 56 64	?		yes			?	?

13.1 If we would like to minimize the delay (e.g. no bandwidth constrain), which Codec is the best? (3 marks)

13.2 However, if we have wide band sound (e.g. stereo sound) which codec is the best? (3 marks)

13.3 If we are in noisy environment, which codec we should avoid? (3marks)

Answer

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