The University Of Sheffield.

Data Provided: None

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2006-2007 (2 hours)

Multimedia Systems 1

Soultions

1. a. A computer network must possess following:

General purpose, open standards,
Cost-effective,
Fair,
Robust
High Performance Connectivity **(3)**

b. Any three of the following.

- Needs to make explicit connections - establishment and teardown phases
- Cope with very variable RTTs
- Packets can get reordered across internet –delivery in the order sent
- Cope with very old packets that are received
- Variable amount of data in the "pipe" - need to establish resources at destination
- Cope with network congestion - packets sent faster than can be received Supports arbitrarily large messages
- Allows synchronisation of sender and receiver
- Supports multiple application processes on same host
- Permits receiver to use flow control

(3)

c.

- Flags – identifies a datagram as a complete packet or a fragment.
- Ident- The unique identification number given to each packet from the source host. This is used to identify the original packet to which the fragments belong.
- Offset – The fragment number. This is used to identify the order of the fragments appear in the original packet.
- Source address – To identify the host from which the packets/fragments came. **(6)**

d. Connectionless :

- Permits an application to send a message to any destination at anytime.
- No establishment of connection is required.
- Sending application must specify a destination (address) with each **(3)**

message

– (e.g., UDP)

e. Total time = propagation time + transmit time

= distance /velocity + datasize/bandwidth

$$= \frac{100 \times 10^3}{10^8} + \frac{200 \times 8}{200 \times 1024} = 8.8 \text{ milliseconds.}$$ **(5)**

2. a. (Any 3 of the following)

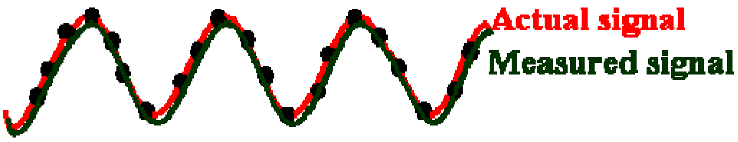
- Common format for all signal/data types
- Can use full capabilities of digital computers
- Common storage format (memory chips, hard discs, etc.)
- Possible to reconstruct perfectly if effected by noise
- Can include additional codes to detect and correct errors
- Can modify the time to transmit/playback signals
- Generally cheaper to transmit - can combine (**multiplex**) different channels **(3)**

b. (i) Two samples per period.

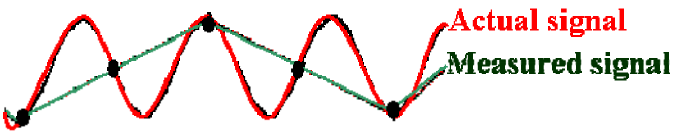
i.e., the sampling rate = 2 x Maximum frequency of the signal

(ii)

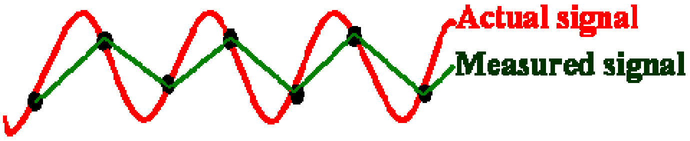
Higher than Nyquist Level



Less than Nyquist level

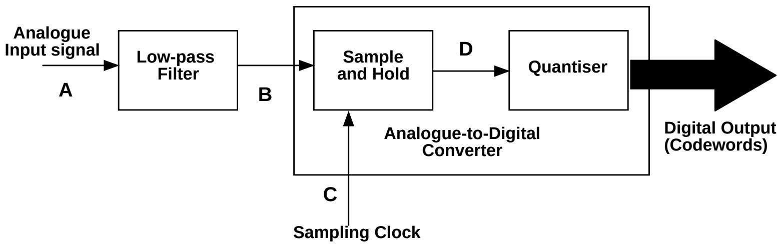


At Nyquist rate



(4)

c.



Low-pass Filter: passes low frequencies and attenuates high frequencies. Reduces noise and helps prevent aliasing. (Limits the signal to its maximum usable frequency component).

Sample and Hold: samples instantaneous amplitude of signal and holds this value until the ADC has converted value to digital representation.

Sampling Clock: sets sampling rate : minimum rate = Nyquist rate

Quantiser: converts analogue value to digital representation, sets resolution.

(5)

d. (i) the highest frequency = (sampling frequency)/2 = 16 kHz

(ii) Sampling freq = 32 kHz

Bit rate = 352 kbps

Therefore, Bits per sample = 352/32 = 11 bits

Quantisation interval: $Q = \frac{2V_{\max} + 1}{2^N} = \frac{2 \times 500 + 1}{2^{11}}$ = 0.49 mV. **(6)**

e. Signal to noise ratio is lower. Noise can be heard in sounds rather than in quiet passages. Less loud sounds are more distorted. **(2)**

3. a. State why data (such as music or video) compression is possible due to:

- Redundancy in source data (inter-pixel redundancy due to correlation and coding redundancy due to methods used in representation)
- Irrelevant data due to limitations of the human visual and hearing system

why is it often necessary?

- Uncompressed data consists of a lot of bits. But limited bandwidth in networks and limited space in storage devices. Therefore, compression is necessary **(3)**

b. Lossless image compression:

- Exact recovery of pixel values.
- Mostly DPCM and Entropy coding based compression. No quantisation.
- Only small compression ratios. 1.2:1 to 2:1.
- Example:- JPEG-LS, TIFF (LZW)
- Application:- Medical imaging, remote sensing imaging

Lossy image compression:

- Not exact recovery of pixel values.
- Quantisation (mostly based on HVS models) is used
- Large compression ratios. Up to 20:1(for acceptable visual quality)
- Example:- JPEG, JPEG 2000

Application:- web imaging, digital cameras

(4)

c.

A	0.4							0	1.00	0	
E	0.25					0	0.6	1		10	
D	0.12	1	0.21	1	0.35	1				1111	
F	0.09	0								1110	
C	0.08	1	0.14	0						1101	
B	0.06	0								1100	**(7)**

d. The average bits per symbol using Huffman codes

(1x0.4)+ (2 x 0.25)+ (4 x 0.35) = 2.30; Binary code requires 3 bits

The compression ratio 3/2.3 = 1.3:1. **(4)**

e. Short codes 0 and 10 do not appear as the prefix of any of the longer codes. **(2)**

4. a. In R-G-B format, each colour plane contains the same amount of data and would have the same data rate and bits per sample. But in Y Cb Cr, we can exploit the human eye's tolerance to reduced resolution in chrominance layers. Therefore they can de down sampled and the data rates can be reduced.

Y Cb Cr format also useful in transition from back and white tv transmissions to colour tv transmissions. **(3)**

b.

i. Specify the required resolution of the display in terms of number of pixels.

Vert. Angle subtended = arctan(1/12) = 4.76
Horiz. Angle subtended = arctan(4/3 x 1/12) = 6.34
Vert cycles = 4.76 x 150 = 714
Horiz cycles = 6.34 x 150 = 951
Nyquist criterion would require doubling of these figures to give 1428 x 1902 pixels on screen. Assume BW is limited and use Kell Factor so use 1020 x 1359 pixels **(4)**

ii. Can sense 38k hues – i.e, 15.2 bits – call it 16 bits.
In colour + luminance representation --- 200 luminance i.e., 8 bits for luminance
Memory per picture = 1020x 1359 x 3 bytes = 3.96 Mbytes **(4)**

iii. Can perceive flicker up to 80 Hz – so Nyquist would suggest 160 Hz frame rate but use interlacing.
Bit rate (bandwidth) = 3.96 x 80 = 316.8 Mbytes/s = 2.47 Gbps. **(3)**

iv. Currently use 4:4:4 sampling for Luminance and chrominance channels
Can reduce sampling of chrominance –
in 4:2:0 video – which gives H/2xW/2 resolution for chrominances.
In 4:4:4 total pixels = 3 HW
In 4:2:0 total pixels = (HxW) + (H/2xW/2) +(H/2xW/2) =1.5HW **(4)**

v. Any standard that can be useful for digital video broadcasting (DVB):
MPEG-2 or H.264 or AVC (Advanced Video Codedc) **(2)**