# ELEX 3525 - Lecture 1

Exercise 1: For each of the following digital communication services identify the source, sink and the channel(s) involved: the Ethernet connection between a computer and a router; a cell phone call ; watching a YouTube video at home.

	source	channel	sink
Ethernet	laptop	cable	router
cell phone	person	free space	person? cell site?
video	server	mutiple "Internet"	monitor ? user ?

Exercise 2: What features of speech and video waveforms might result in variable bit rates when these sources are compressed?

- when signal is not changing, not much information has to be sent (e.g inter-frame video compression)

bursty

CBR :

VBR :

phone call :
intermittent CBR →

speech burst

intermittent VBR →
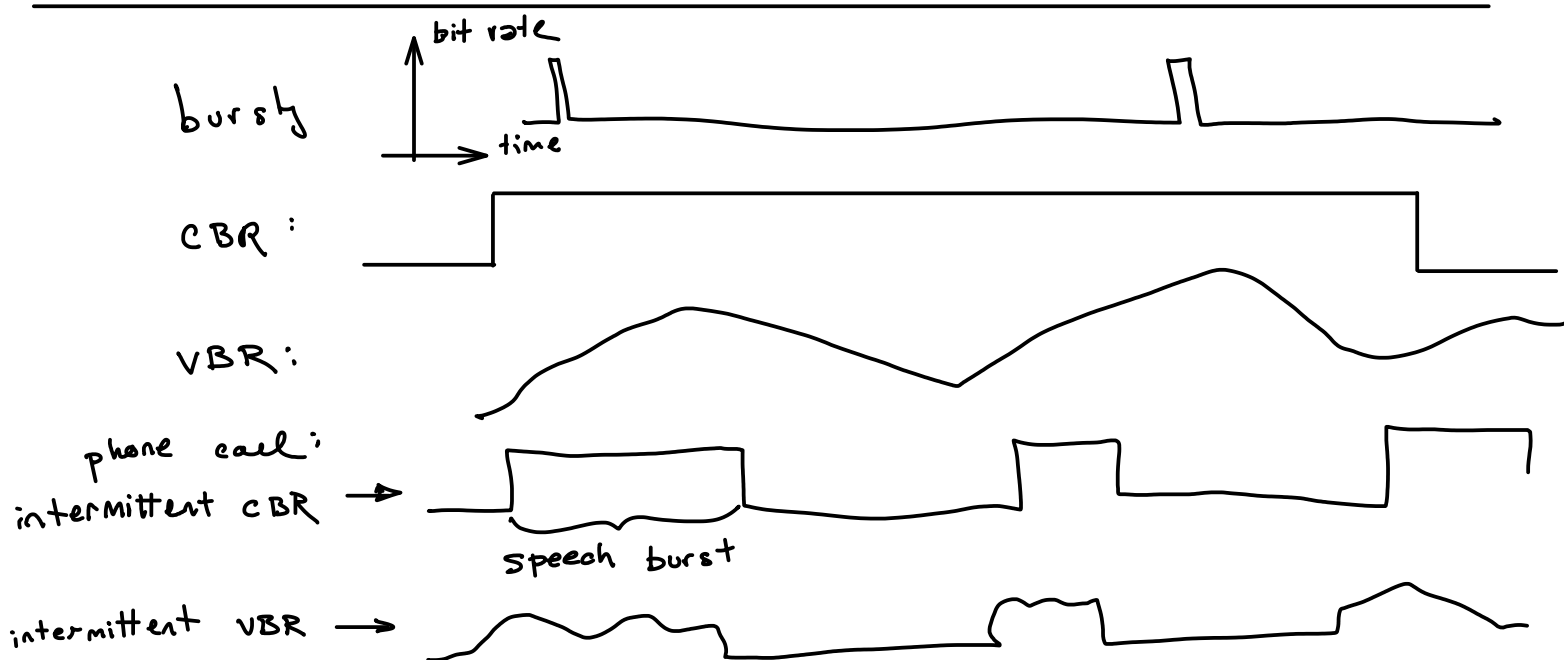
Exercise 3: What units would be used to specify error rate, delay, and delay variability? For each of the following data sources/sinks identify the relative data rate variability and the tolerance it is likely to have to errors, to the absolute delay and to the ~~delay variability:~~ a phone call between two people, downloading a computer program, streaming a video over a computer network. Try to guess typical values.

BER = bit error rate
PER = packet " "
FER = frame " "

per unit
per cent
fraction

e.g 10^{-6}

delay : time (e.g. ms)

variability : variance, standard deviation ($time^2$, time)

	variability	tolerance to error	tolerance to delay
phone call	CBR, VBR	high (a few% → 50%)	≪ 1s (s005 good)
download computer program	?	UEP ≈ 0 (100's → 1000s of years)	depends, ≫ 1s
streaming video	VBR.	in between	in between.

$$\frac{1 \text{ Mb/s}}{\mu s} \quad @ \ 10 \text{ b/symbol} \implies \frac{100k \text{ symbols/second}}{2^{6} = 1024 \text{ different symbols.}}$$

baud rate = 100 k baud

10μs

Exercise 4: A system transmits data at a rate of 1 Mb/s in "packets" of 128 bytes. 100 of these are bytes data and the rest are overhead. The channel is shared between four users. There is a 10 μs gap between each packet. 10% of the frames are lost due to errors. What throughput does each user see?
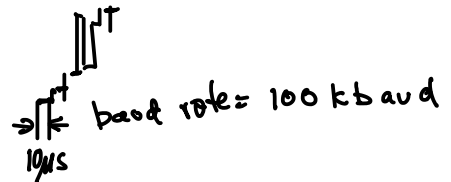
1 Mb/s
128 bytes = 1024 bits
100 data
4 users
10μs gap
10% lost → 90% of packets received.

128

10μs
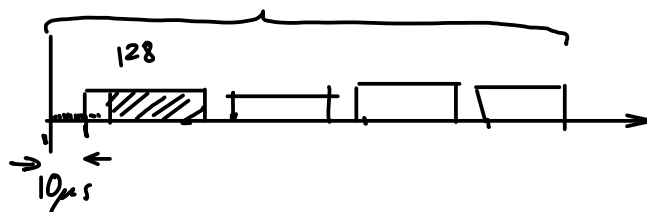
$$throughput = \frac{data\ delivered}{time\ taken}$$

$$\text{data} = 70\% \times 100 \text{ bytes} \times 8 \text{ bits/byte} = 720 \text{ bits.}$$

$$\text{time} = 4 \text{ users} \times \left(10 \mu s + \frac{1024 \text{ bits}}{1 \times 10^6 \text{ bits/s}}\right) = 4 ms$$

$$\text{throughput} = 180 \text{ kb/s}$$

Exercise 5: Convert the decimal number 3525 to a 16-bit (two-byte) binary number. Write the sequence of bits that would be transmitted if both the bytes and bits were transmitted in little-endian order. Write the sequence of bits that would be transmitted in "network order".

$$3525 = DC5$$

$$= 0000\ 1101\ \underbrace{1100\ 0101}$$

LS bit & byte order: $1010\ 0011\quad 1011\ 0000$

Network order : $0000\ 1101\quad 1100\ 0101$

$\$dc5$

$oh\ dc5$

$\#dc5$

$int\ x = 035:$

$\uparrow$

octal

Exercise 6: Write the 16-bit number above in hexadecimal notation.

$$3525_{10} = DC5_{16}$$

Exercise 7: How many bits would be required to uniquely identify 100,000 different characters? (Hint: $2^{16} = 65536$).

$$16 = 65355$$

$$17 \text{ bits} = 128 \text{ kiB}$$

Exercise 8: Find the ASCII codes for the *characters '3525'.* Write out the first 16 bits of the sequence that would be transmitted assuming each character is encoded using 8 bits per character and little-endian bit order. *Hint: the character code for a digit is 0x30 plus the value of the digit.*

as

'3' = 0x33 ← first 16 bits

0011 0011 big endian
0011 0101

'5' = 0x35

'2' = 0x32

'5' = 0x35

little endian bit order

$\underbrace{1100 1100}$ $\underbrace{1010 1100}$

⟶ t

Exercise 9: The Chinese character for "Rice" (the grain) is "米" with Unicode value (code point) U+7C73. What is the UTF-8 encoding for this character?

0111 1100 0111 0011

$\underbrace{\quad}$ $\underbrace{\quad}$ $\underbrace{\quad}$

z   y   x

↓   ↓   ↓

1110 $\overbrace{0111}$ $\overbrace{10}$ 10 0001 $\overbrace{10}$ 11 0011

$\underbrace{\quad}$

E   7   B   1   B 3

Exercise 10: Highlight or underline each term where it is defined in these lecture notes.

Exercise 11: Draw a diagram showing the flow of of goods and services between these various entities. Classify the following: Intel, Xilinx, Analog Devices, Belden, Avnet, DigiKey, Samsung, Apple, Cisco, Ericsson, Telus, Netflix, Walmart, Amazon, IEEE-SA, IETF, Industry Canada, CRTC, FCC. Look these up if you're not familiar with them.

Walmart

retailers

customers

component manuf

Intel
Xilinx
AD
Belden

distributors

DigiKey

equip. manof

Apple

service providers

Telus
Netflix

stds org.

IEEE-SA
IETF

regulators

CRTC
Industry Canada
FCC