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	computer	cable	router
cell phone call	cell phone	free space	cell tower other person
YouTube Video	server	various	monitor or viewer

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

- amount of redundancy such as 2 channels that are similar (stereo)

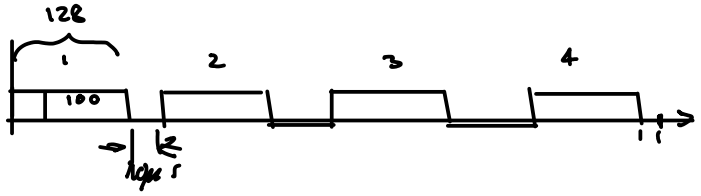
- variability in image or audio with respect to time or space

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.

	data rate variability (source)	tolerance to errors (sink)	tolerance to delay (sink)
phone call	CBR (VBR)	high (~%)	low (<<1s)
file download	? CBR (max rate of link)	none (0)	high
streaming video	server is ↑ codec is VBR	low if compressed high if uncompressed	?

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?

$$\text{throughput} = \frac{\text{good data bits}}{\text{time}}$$



1 Mb/s
128 bytes total
100 bytes data
4 users
10 μs between packets
10% lost

234 b/s.

bits delivered to user $= 100 \times 8 \times \frac{90}{100} = \approx 100 \times 10 \times 1 = 1000$

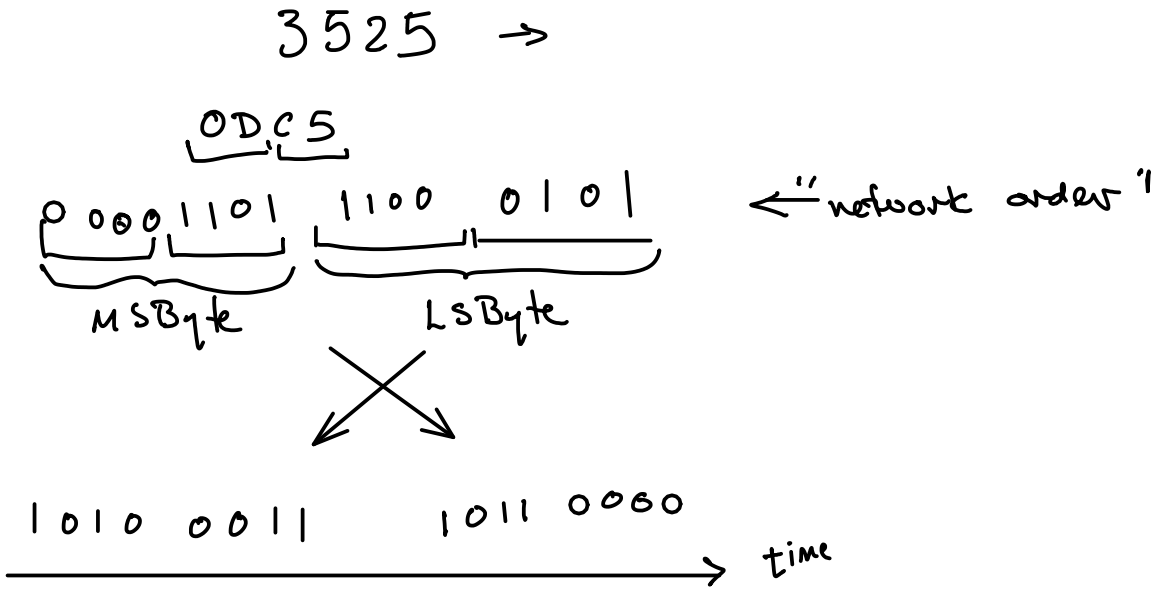
$\text{time} = 4 \times \left(\frac{128 \times 8}{10^6} + 10 \times 10^{-6}\right) \approx 4 \times \left(10^{-3} + 10^{-5}\right) \approx 4 \times 10^{-3}$

$\frac{b}{b/s} \rightarrow s$

$\text{throughput} = \frac{1000}{4 \times 10^{-3}} \approx 250 \text{ kb/s}$ (174 kb/s)

1 128
2 256
4 512
8 1024
16 2048
32
64

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".



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

0xdc5

$dc5

#dc5

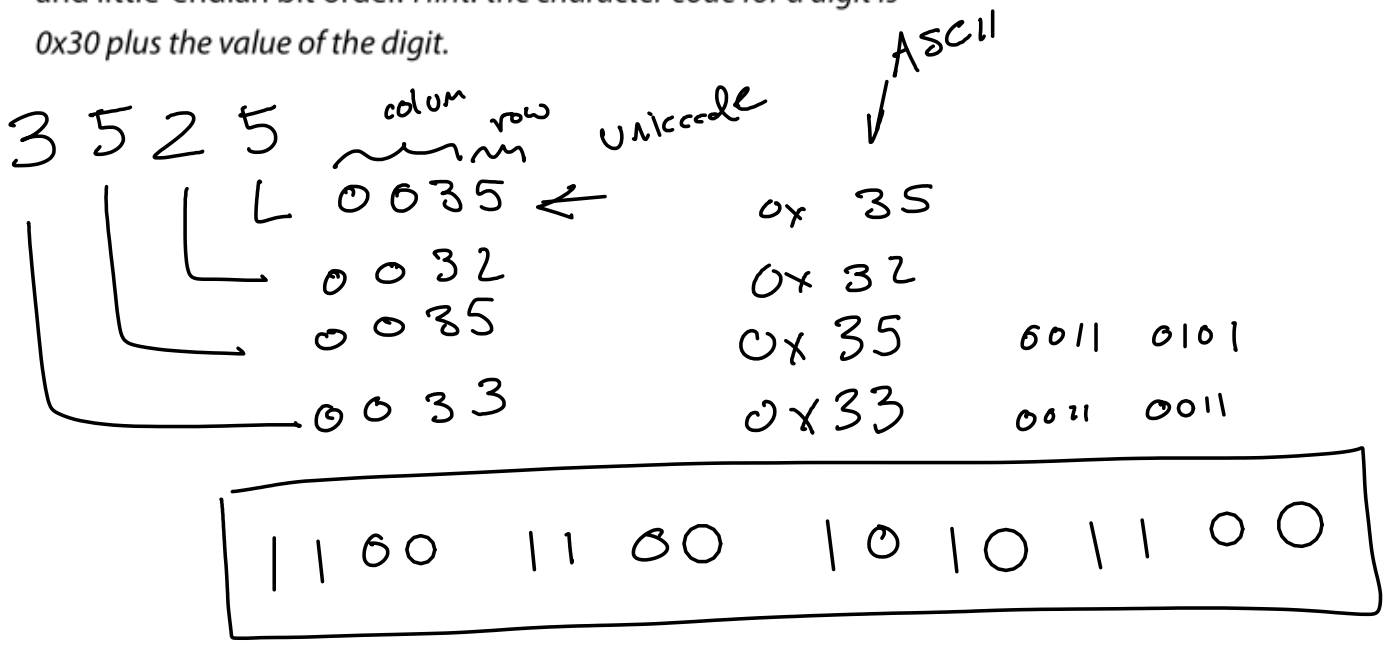
6Hdc5

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

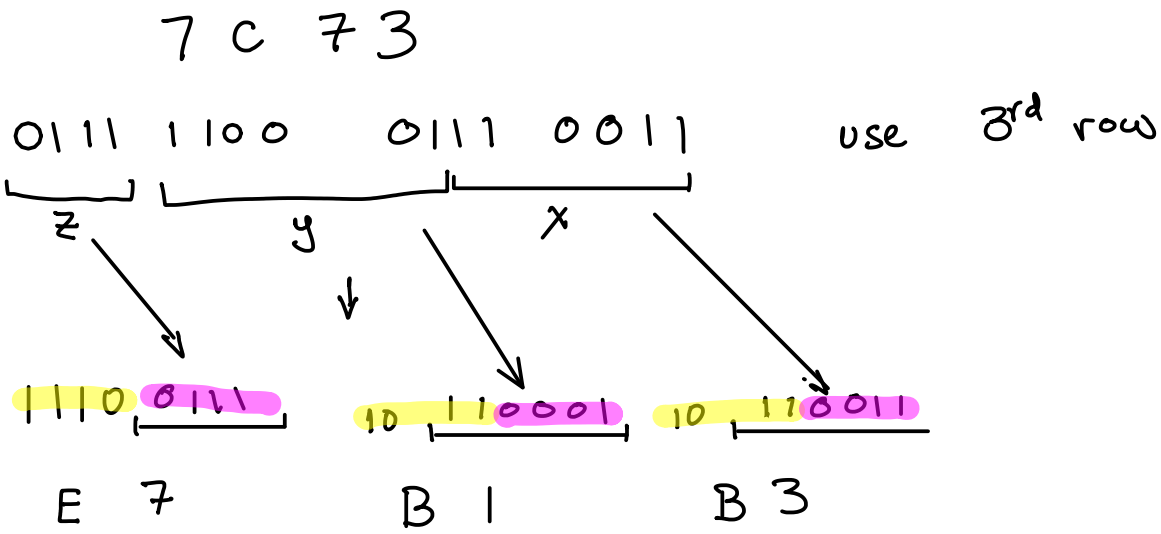
17 bits would be sufficient for 128k characters
but 16 would not (only allows for 64k characters)

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.*



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?



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