Panel 1

Last Time:

H is low-pass filter (3KHz)

Nyquist Theorem:

V = # levels of signal

perfect channel

max data rate = $2H \log_2(V)$

Nyquist-Shannon Theorem

S/N is signal-noise ratio

noisy channel

max data rate = $H \log_2(1 + S/N)$

Transmission Media:

Tape

Twisted Pair

Coax Cable

Fiber Optics

Quiz on Monday !!!

1

Panel 2

Quiz Questions

(1) Assume perfect channel, 4-level signals, (6 MHz filter.)

max data rate:

$2 \cdot 6 \cdot 10^6 \log_2(4) = 24$ Mbps

(2) Suppose a signal-to-noise ratio is at 80 dB.

$S/N = 10^8 = 100,000,000$

$dB = 10 \log(S/N) = 80$

$\log(x) = 8 \Rightarrow x = 10^8$

(3) Assume channel with S/N ratio of 90 dB and 6 MHz filter.

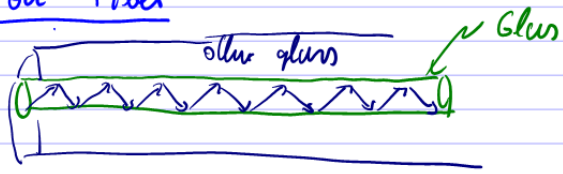
max data rate:

$6 \cdot 10^6 \cdot \log_2(1 + 10^9) = 6 \cdot 10^6 \cdot 29 = 179$ Mbps

2

Panel 3

More on Fiber



Fiber vs Copper

Copper needs repeater every 5 km, Fiber every 30 km

1000 twisted pairs / km = 8000 kg, 2 strands of fiber 100 kg

expensive — out of sand, cheap

easy to work with — Special + expensive tools and expertise

3

Panel 4

Wireless Transmission

frequency			
	10^0	Ocean waves	twisted pair, coax, wireless — undirected
	10^6	Radio	
	10^{10}	Micro waves	directed
	10^{12}	Infrared	
	10^{14}	Visible Light	Fiber optics
	10^{16}	UV	
	10^{20}	X-Ray	above 10^{10} waves are absorbed by water, such as rain
	10^{24}	Gamma Rays	

Teslas

4

Panel 5