6.5.3 Digital Communication I 2001 ML

a) ARQ - detect loss and request retransmission

FEC - Send enough information so that receiver can reconstruct information despite some errors.

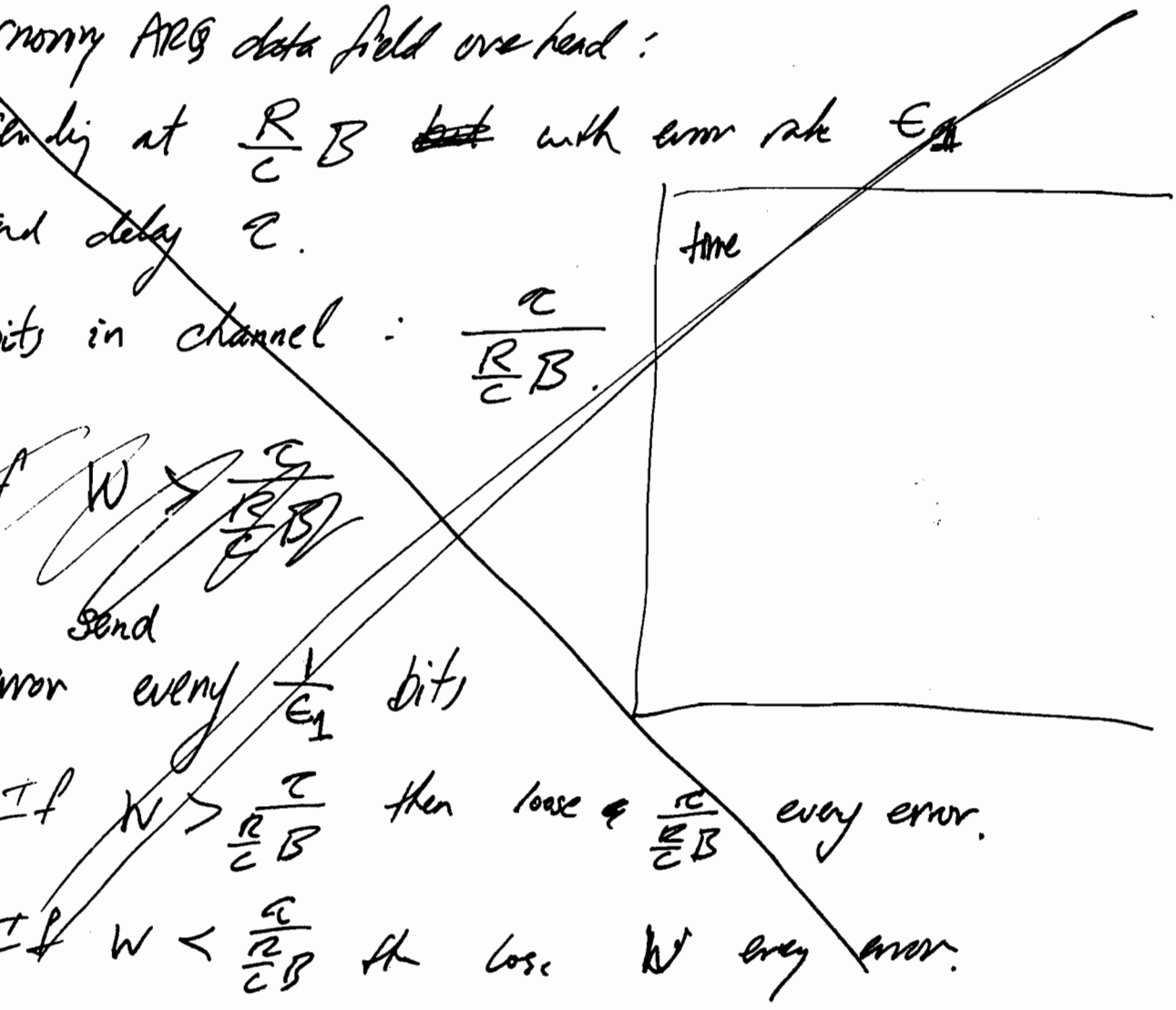
lossless compression - original info can be reconstructed exactly.

b) compression over ARQ over FEC

FEC only useful as lowest layer here, compressing FEC just steps of functioning. (ARQ could arguably be done over compression).

c) ignoring ARQ data field overhead:

- sending at $\frac{R}{C}B$ with error rate ϵ_1 and delay τ.
- bits in channel: $\frac{\tau}{\frac{R}{C}B}$.
- if $W > \frac{\tau}{\frac{R}{C}B}$



Send

- error every $\frac{1}{\epsilon_1}$ bits

If $W > \frac{\tau}{\frac{R}{C}B}$ then lose $\approx \frac{\tau}{\frac{R}{C}B}$ every error.

If $W < \frac{\tau}{\frac{R}{C}B}$ then lose W every error.

c) Work out throughput, delay, error rate of channels

underlying : B, τ, ϵ_0

FEC'd : BR, τ, ϵ_1

ARQ'd : two cases $W > 2\tau BR$, $W < 2\tau BR$.

note bit error on average every $\frac{1}{\epsilon_1}$ bits

Assume $\epsilon_1 << 1$.

Determine time to send $\frac{1}{\epsilon_1}$ bits, and add round trip for retransmission (selective) or throw away one channel-full of information (go back n).

$W > 2\tau BR$: Error free, $\frac{1}{\epsilon_1}$ bits takes $\frac{1}{\epsilon BR}$,

so with extra round trip, $\frac{1}{\epsilon BR} + 2\tau$

so rate is $\frac{1}{\frac{1}{BR} + 2\tau\epsilon} = \frac{BR}{1 + 2\tau\epsilon BR}$

$W < 2\tau BR$: Error free $\frac{1}{\epsilon}$ bits take $\frac{1}{\epsilon} \cdot \frac{2\tau}{W}$

so with extra round trip $2\tau\left[\frac{1}{\epsilon_1 W} + 1\right]$

so rate is $\frac{1}{2\tau\left[\frac{1}{W} + \epsilon\right]} = \frac{W}{2\tau[1 + W\epsilon_1]}$

so after compression, rates are

$\frac{1}{C} \frac{BR}{1 + 2\tau\epsilon_1 BR}$ for bits $W > 2\tau BR$

$\frac{1}{C} \frac{W}{2\tau[1 + W\epsilon_1]}$ else.