Components of a Digital Comm. System

Different functions in a digital Comm. System:

Source Encoder:

Rep. info in digital form up to arbitrary precision

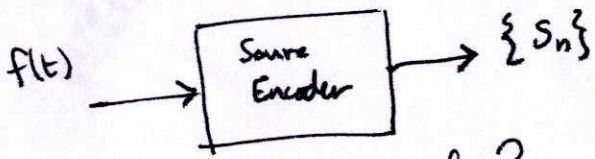
more rep. bits $\longleftrightarrow$ more fidelity

Source encoder does that in a practical manner

Remove redundancy from source data

~~Output of source~~

Output of source encoder is a seq. of symbols from a finite alphabet



Can S_n represent $f(t)$ exactly?

source symbols	Encoder output
inf. alphabet	finite alphabet
finite alphabet	finite alphabet

Distortion | Lossy comp.

Distortion does not occur if | Lossless comp.

Entropy of Source $\leq$ rate of Source Encoder

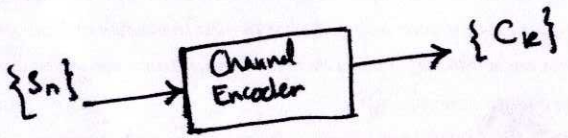
In reducing redundancy, we take into account end user requirement

Voice	64 k bits/sec.	wireline telephony
	4 k bits/sec	for server BW constraints
MP3 players	typical bit rate	128 k bits/s
High End Digital Audio	10 times	higher rates

Channel Encoder:

Introduces redundancy in a controlled manner (structured redundancy)

To combat errors that arise from
- channel imperfections
- noise



Channel encoder is designed specifically for
- anticipated ch. characteristic
- requirements dictated by higher net layers

Ex:

★ Delay insensitive applications:
code optimized for error detection → request for retransmission

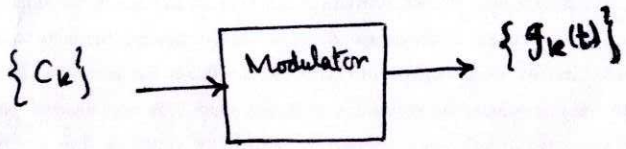
★ Real time applications:
code optimized for error correction (retrans. not possible)

Error Detection Capability

Code designed in between.

Error Correction Capability

Modulator:



Translates discrete symbols into an analog waveform that can be transmitted over channel

Ex: Physical ch. for WLAN 802.11b

Band of 20 MHz

Center freq. 2.4 GHz

Bit stream at rate of 1, 2, 5.5, 11 Mbits/sec

Mod. translates this bit stream into a waveform that fits into the 20 MHz BW.

Demodulator:

Channel produces a distorted & noisy version of the transmitted waveform

Demodulat processes the analog received waveform

Distorted & noisy version of transmitted waveform

Tasks

synchronization: compensate for

phase shit
frequency shift
time shift

} produced by channel

Clock at Tx & Rx are not synchronized a priori

Equalization:

Undo the channel effect
compensate for the intersymbol interference induced by the channel

Ultimate Task:

To produce tentative decisions on the transmitted symbols ~~to be fed to the channel~~

decision could be "hard" or "soft"

Channel Decoder:

Exploits redundancy in channel code to improve upon estimate from demod

To produce an est. of the seq. of symbols that was input to the channel encoder

Reverses operation of decoder

. Are decoder & demod ~~info~~ independent?

* In traditional receivers they are independent

* More advanced receivers

iterative info exchange bet. dec. & demod to reduce probability of error

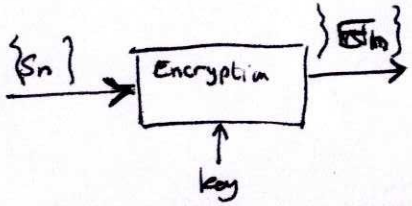
Source decoder:

Converts the estimated bits produced by the channel decoder back into its original format

Remarks:

1) Two more blocks

Encryption device



transforms S_n into E_n such recovering S_n from E_n without knowing the key is almost impossible

Decryption device

Reverses operation of the encryption device

2) Why digital when we humans consume analog info

Source-indep. design:

Once info is transformed into bits, it can Tx without interpritation

When we recover the bits, we recover the info

Comm. media is indep. of the source
Many info sources can share the same comm. media } Economies of scale

Encoding & decoding is done at the end points alone

Channel optimized design:

channel mod/demod
channel encoder / decoder
can be optimized for specific ch. characteristic

Bits ~~generated~~ transported are being regenerated at each link ⇒ no noise accumulation