1 Information Content

$$I(A) = \log_2 \frac{1}{A}$$
$$H = I(0) \cdot P(A)$$
$$H_{\text{max}} = \log_2 m$$
$$R = H_{\text{max}} - H$$

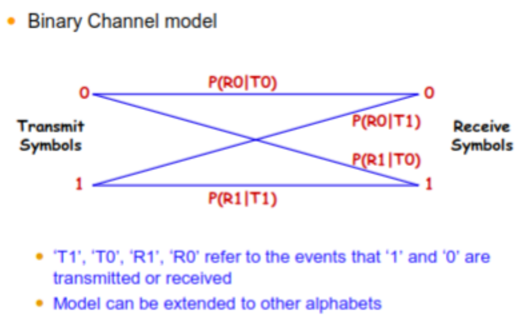
H_{max} is true when all symbols are equiprobable.

2 Source Coding

$$\text{CR} = \frac{L_{\text{input}}}{L_{\text{output}}}$$
$$\eta = \frac{H}{H_{\text{max}}}$$
$$\eta = \frac{H}{L}$$

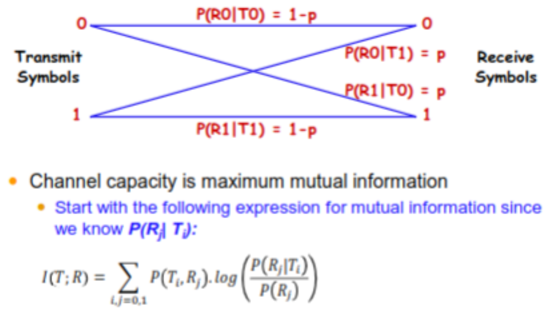
For Huffman Coding, order probabilities from highest to lowest. Then pair two lowest probabilities together and sum. '1' for higher of the two, '0' for lower. Repeat until root node equals 1.0.

3 Information Transfer



$$P(T|R) = \frac{P(R|T)\,P(T)}{P(R)}$$
$$I_{\text{priori}}(Tx) = log_2 \frac{1}{P(Tx)}$$
$$I_{\text{posteriori}}(Tx|Ry) = log_2 \frac{1}{P(Tx|Ry)}$$
$$I(T;R) = H(T) - H(T|R)$$
$$I(T;R) = H(R) - H(R|T)$$

4 Capacity



$$\text{Max}(I(T;R)) = (1-p)\log_2(2(1-p))$$
$$+p\log_2(2p)$$
$$C = \frac{1}{p} log_2 \left(1 + \frac{S}{N}\right)$$

5 Link Budget

$$PFD_{\text{isotropic}} = \frac{P_T}{4\pi d^2}$$
$$PFD_{\text{real}} = \frac{P_T G_T}{4\pi d^2}$$
$$P_r = PFD_{\text{real}} A_e$$
$$A_e = \eta A_{\text{actual}}$$
$$\text{Directivity} = \frac{\text{Max power density}}{\text{Average Power Density}}$$
$$\text{Gain} = \text{Directivity} * \text{Efficiency}$$
$$\text{SIR} = \frac{S}{S_I + N}$$
$$\frac{C}{N_0} = P_T + G_T - dB\left[\frac{4\pi d}{\lambda}\right]$$
$$\frac{C}{N_0} = R_b * \frac{E_b}{N_0}$$

6 Baseband Coding Schemes

Ideally, a baseband coding scheme will be chosen to: be simple so it is cheaper to design and test, have as small as possible bit error rates, easily decodeable by keeping symbol transitions clear, and to not use high-frequency content in case cheap channel mediums are used.

Baseband coding schemes:

- NRZ - 1 is +ve, 0 is 0 (or -ve if polar)
- RZ - Same as NRZ but with a duty cycle
- NRZI - alternate from +ve and -ve on bit with highest amount, do not alternate on bit with lowest amount
- AMI - 1 alternates btwn +ve and -ve, 0 is 0
- HBD3 - AMI with modifications. First four 0's in a row are 000V0, next B00V
- Manchester - 1 is hi-lo, 0 is lo-hi
- Diff Manchester - 1 is transition in middle, 0 is transition at start
- MLT-3 - 1 transitions in pattern (+ve, 0, -ve, 0), 0 stays same level

7 Optimum SNR for Matched Filters

$$E_s = \int_{-\infty}^{\infty} h^2(t)\, dt$$
$$E_s = \frac{P_{\text{transmitter}}}{\text{baud rate}}$$
$$E_s = \frac{V_{\text{signal}}}{R_{\text{line}}} * \mathrm{T}_{\text{pulse}}$$
$$E_{sR_x} = \frac{E_s}{\text{attenuation} * \text{distance}}$$

$$\text{SNR} = \frac{2E_s}{N_0}$$
$$\text{BER}_{\text{polar}} = Q\left(\sqrt{\frac{2E_s}{N_0}}\right)$$
$$\text{BER}_{\text{uni}} = Q\left(\sqrt{\frac{E_s}{N_0}}\right)$$

8 Linear Passband Conversion

$$N_E = 2\sigma^2$$
$$S_E = \frac{S_0 + S_1 + \ldots + S_n}{n}$$
$$P_e = Q\left(\sqrt{\frac{1/2\text{closest point dist}}{\sigma}} \sin\Theta\right)$$

$$P_s = 2Q\left(\sqrt{\frac{2S_E}{N_E}} \sin\Theta\right) = 2Q\left(\sqrt{\frac{2E_s}{N_0}} \sin\Theta\right)$$