???

$$C = \arg P_x(X) \max I(X;Y) \tag{1}$$

$$I(X;Y) = \sum_{x,y} p(x,y) \log_2 \frac{p(x,y)}{p(x)p(y)} \tag{2}$$

$$I(X;Y)$$

$$C = B \log_2 \left(1 + \frac{S}{N_0 B}\right) = B \log_2(1+\gamma) \tag{3}$$

$$N_0 \gamma =$$
$$\frac{S}{N_0 B}$$
$$H(f) S(f) N_0 B / N f_i H(f_i)$$

$$C = \lim_{N \to \infty} \sum_{i=1}^{N} \Delta f \log_2 \left(1 + \frac{S(f)|H(f)|^2 \Delta f}{N_0 \Delta f}\right) = \int_B \log_2 \left(1 + \frac{S(f)|H(f)|^2}{N_0}\right) df \tag{4}$$

$$\int_B S(f) df = P \tag{5}$$

$$S(f) = \{ K - \frac{N_0}{|H(f)|^2}, |H(f)|^2 \geq \frac{N_0}{K} 0, |H(f)|^2 < \frac{N_0}{K} \tag{6}$$

??

$$??N_0 |H(f)|^2 / N_0$$

$$h_k =$$
$$|H(k)|^2 (k =$$
$$0, 1, \cdots, N-$$
$$1) \sigma^2 b_k p_k BER_{target} b_k p_k$$

$$b_k = \log_2(1 + \frac{h_k p_k}{\Gamma \sigma^2}) \tag{7}$$

$$p_k = \frac{\Gamma \sigma^2}{h_k}(2^{b_k} - 1) \tag{8}$$

$$\Gamma BER_{target}?$$

$$\Gamma = -\frac{\ln(5 \cdot BER_{target})}{1.5} \tag{9}$$

$$b_k \in$$
$$\mathbb{N} \mathbb{N}$$
$$?$$
$$b_k (k =$$
$$0, 1, \cdots, N-$$
$$1) P =$$
$$\sum_{i=0}^{N-1} p_k =$$
$$0 R =$$
$$\sum_{i=0}^{N-1} b_k =$$
$$0 P R$$

$$\Delta p_k = \frac{\Gamma \sigma^2}{h_k}(2^{b_k+1} - 1) - \frac{\Gamma \sigma^2}{h_k}(2^{b_k} - 1) = \frac{\Gamma \sigma^2}{h_k} 2^{b_k} \tag{10}$$

$$k^\star = \arg 0 \leq k \leq N - 1 \min \Delta p_k \tag{11}$$

$$P +$$
$$\Delta p_{k^\star} \geq$$
$$P_{total} b_{k^\star} =$$
$$b_{k^\star} +$$
$$1 P =$$
$$P +$$
$$\Delta p_{k^\star} \mathbf{2} P +$$
$$\Delta p_{k^\star} \geq$$
$$P_{total} R +$$
$$1 \geq$$
$$R_{target} b_{k^\star} =$$
$$b_{k^\star} +$$
$$1 P =$$
$$P +$$
$$\Delta p_{k^\star} R =$$