

channel Estimation (hest)

$$y_p = R_{hp} + \text{noise}$$

$$R_{hp} = x_p * h$$

To make y_p as circular convolution of $(x_p + h + \text{noise})$

$$z_p = \text{flip}(y_p)$$

$$y_p(1:L-1) = y_p(1:L-1) + \text{flip}(z_p(1:L-1))$$

$$y = y_p(1:\text{end}-L+1)$$

$$X = \text{fft}(x_p), Y = \text{fft}(y)$$

$$H = X/Y$$

$$h_{\text{est}} = \text{ifft}(H)$$

$$h_{\text{est}} = h(1:L)$$

MMSE

$$H = \text{Toeplitz}(h_{\text{est}})$$

$$W = \left(H^* H + \frac{1}{\text{SNR}} \right)^{-1} H^* \longrightarrow \text{MMSE filter (Least Squares Algorithm)}$$

$$\hat{x} = Wy$$

where, $y = x * h + \text{noise}$