
Adaptive Channel Estimation for MB-OFDM Systems in Multi-access Interfering Environments

System Group's Seminar

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Reference

- **Paper Title: Adaptive Channel Estimation for MB-OFDM UWB Systems in Multi-access Interfering Environments**
- Authors: Y. Tasi, C. Wang, and X. Li
- Source: IEEE VTC Spring 2008

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Introduction


- For most OFDM systems, each data frame is generally led by some preamble symbols used for timing sync, CF recovery and CE.
- If there is an interference source present, the preambles may be corrupted.
- Multi-access in MB-OFDM by TFC
- Preambles have high possibility of being interfered by MAI
- In this paper, Authors apply time-domain redundancy (TR) into preamble symbols to cancel MAI

System and Channel Model: System Model

- MB-OFDM: piconet consists of PNC and DEVs
- Assumption of SOP (simultaneously operating piconets)
- TFC: TFI (1-4) and FFI (5-7)
- Transmission Phases: Preamble and Data
- If another Asynchronous SOP using same BG!!
- Overlapped by an interfering symbol
- Assume N is total num of sub-carriers in Tx band

$$s[n] = \frac{1}{N} \sum_{k=0}^{N-1} S[k] \times e^{j2\pi nk/N}, \quad n = 0, 1, \dots, N-1, \quad (1)$$

 ZPS for Tx

 Preamble sequence

System and Channel Model: CE and CM

$$\mathbf{y} = \mathbf{s} \otimes \mathbf{h} + \mathbf{w} + \mathbf{m} = \mathbf{s} \otimes \mathbf{h} + \mathbf{v}, \quad (2)$$

$$\mathbf{Y} = \mathbf{S} \times \mathbf{H} + \mathbf{W} + \mathbf{M} = \mathbf{S} \times \mathbf{H} + \mathbf{V}, \quad (3)$$

$$\hat{\mathbf{H}}^{LS} = (\mathbf{S}^H \times \mathbf{S})^{-1} \mathbf{S}^H \mathbf{Y}, \quad (4)$$

$$\hat{H}^{LS}[k] = Y[k]/S[k], \quad (5)$$

$$h(t) = \chi \sum_{l=0}^{\Gamma-1} \sum_{j=0}^{\Lambda-1} \varphi_{j,l} \times \delta(t - \Delta_l - \tau_{j,l}), \quad (6)$$

Adaptive CE: TR Property & LI

- Perform f-D decimation

$$s_{\text{even}}[n] = \frac{1}{2M} \sum_{k'=0}^{M-1} S[2k'] \times e^{j4\pi nk'/2M}, \quad n = 0, 1, \dots, N-1. \quad (7) \quad M = N/2.$$

- The last of $S_{\text{even}}[n]$ is the duplication of the first-half

$$\begin{aligned} s_{\text{even}}[n+M] &= \frac{1}{2M} \sum_{k'=0}^{M-1} S[2k'] \times e^{j2\pi(n+M)2k'/2M} \\ &= \frac{1}{2M} \sum_{k'=0}^{M-1} S[2k'] \times e^{j4\pi nk'/2M} \times e^{j2k'\pi} \\ &= s_{\text{even}}[n], \quad n = 0, 1, \dots, M-1. \end{aligned} \quad (8)$$

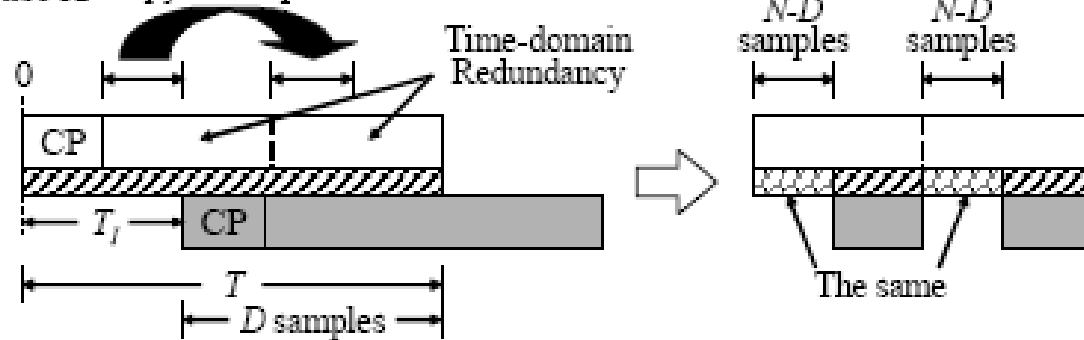
- TR-LI

$$\hat{H}^{LS}[k] = Y[k]/S[k], \quad k \in \text{even}; \quad (10a)$$
$$\hat{H}^{IP}[k] = \begin{cases} (\hat{H}^{LS}[k-1] + \hat{H}^{LS}[k+1])/2, & k \in \text{odd and } k \neq N-1; \\ \hat{H}^{LS}[N-2], & k = N-1. \end{cases} \quad (10b)$$

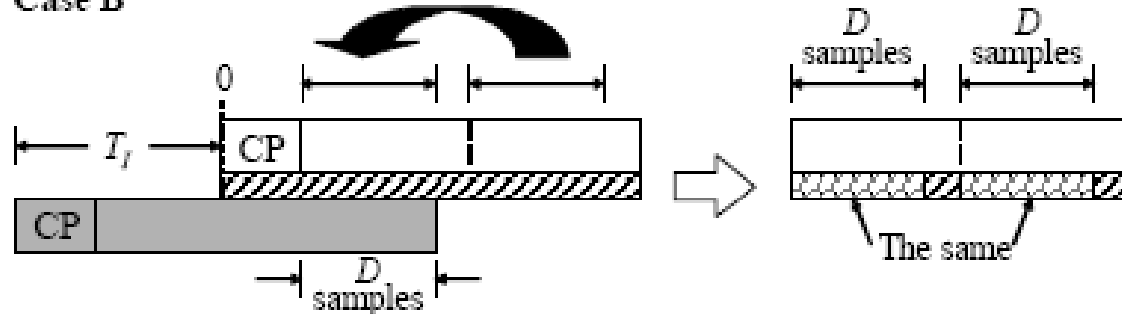
Adaptive CE: TR-LI with ASR

■ TR-LI with Adaptive Select and Replace (ASR)

Case A Copy and replace



Case B Copy and replace



Desired preamble: ; Channel noise: ; Repeated noise: ; Interference:

□ TR with Even/Odd Sub-carriers: Two Preambles

□ For highly frequency selective channels

Simulation Results(1)

$$\sum_{k=0}^{N-1} |H[k] - \hat{H}[k]|^2 / \sum_{k=0}^{N-1} |H[k]|^2$$

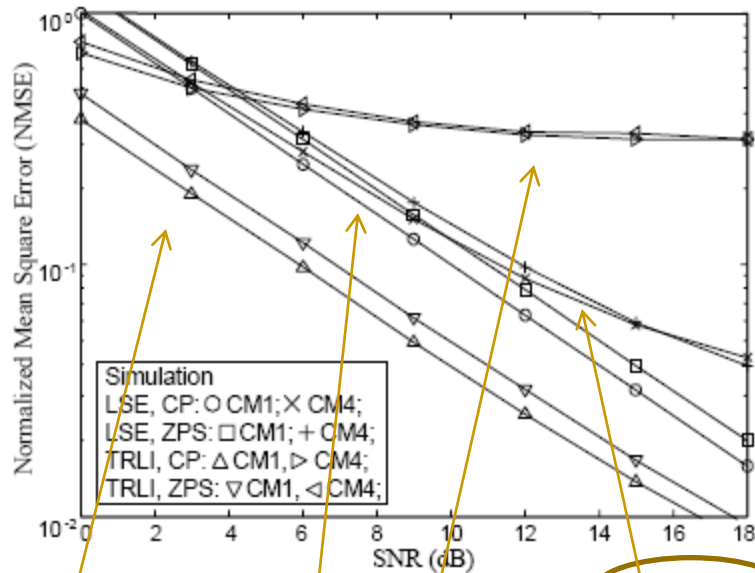


Fig. 2. NMSE of one symbol estimation versus SNR in an interference-free channel.

TRLI: CM1:LSE TRLI: CM4:LSE

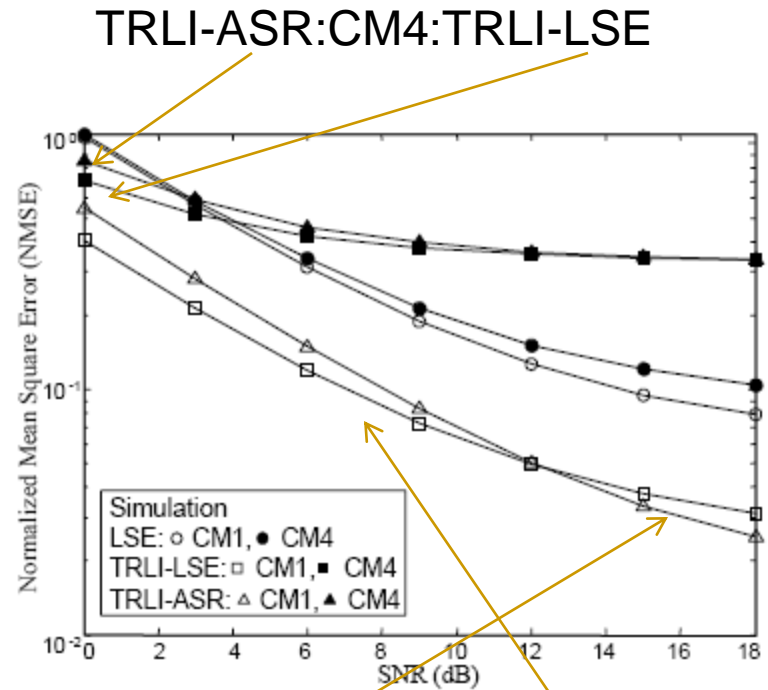


Fig. 3. NMSE of one symbol estimation with CP for SIR = 9 dB.

TRLI-ASR:CM1:TRLI-LSE

Simulation Results(2)

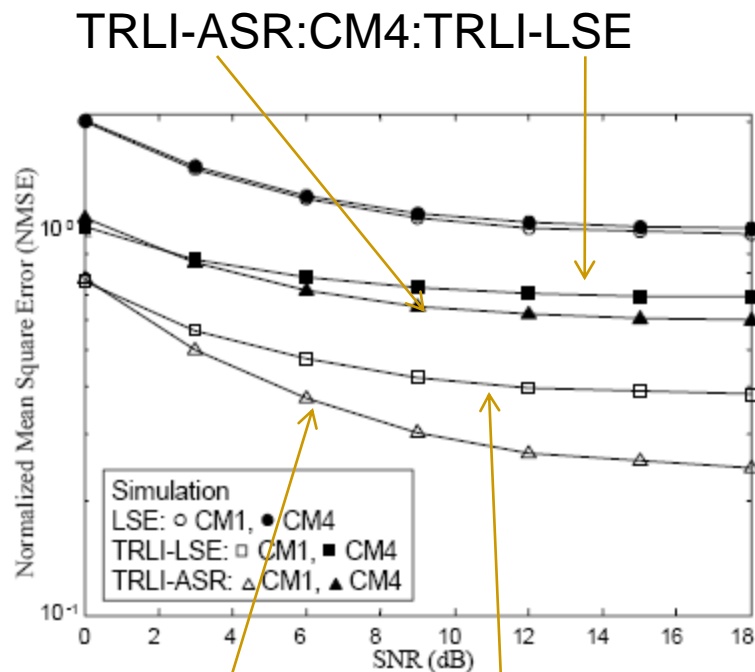


Fig. 4. NMSE of one symbol estimation with CP for SIR=-3 dB.

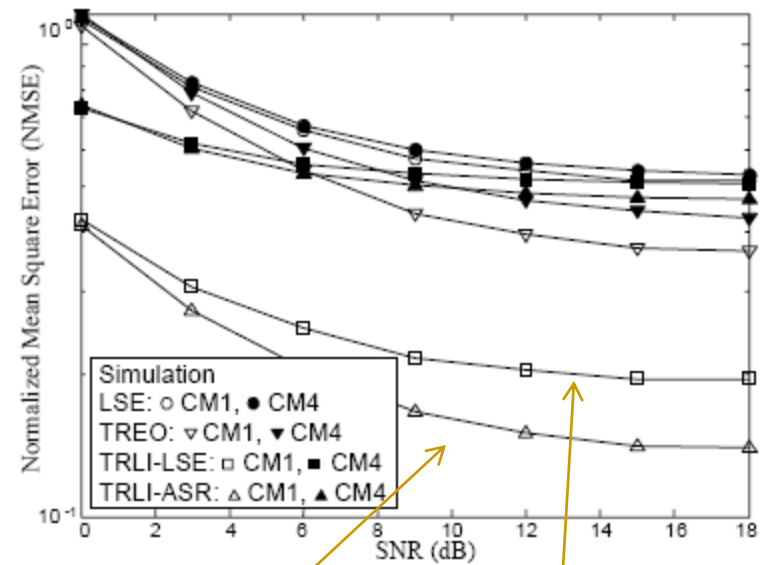


Fig. 6. NMSE of two symbol estimation with ZPS for SIR = -3 dB.

TRLI-ASR:CM1:TRLI-LSE

TRLI-ASR:CM1:TRLI-LSE

Conclusion

- TRLI-LSE, TRLI-ASR and TREO-ASR schemes for CE are proposed
- Significant performance improvement in presence of strong interference
- Even improved performance in case of CM1 (low frequency selective channel)
- Strong Interference: Apply TRLI-ASR
- No Interference: Apply TRLI-LSE (ASR is not active)

Thanks for Your Cooperation
Questions/Comments