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Channel Estimation for Physical Layer Network Coding Systems

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Preface

Physical layer network coding (PLNC) system builds a simultaneous bi-directional transmission between two communicating terminals via the aid of a relay and is, sometimes, called as bi-directional relay network. Simultaneous transmission is allowed since any terminal can subtract the self-information from signals that are mixed at the relay. Hence the spectral efficiency is almost enhanced twice as compared to the unidirectional relaying. As any other system, PLNC requires channel state information (CSI) in order to realize the data detection as well as other optimal strategies, e.g., power allocation, node selection, beamforming, etc. To acquire accurate CSI, channel estimation via training sequences sent from both terminals serves as a nature choice. However, the bi-directional two-hop nature makes PLNC different not only from the traditional point-to-point system but also from unidirectional relaying system (URS). Hence, the existing channel estimation strategies designed for point-to-point system or URS, if applied to PLNC, would suffer from spectral inefficiency. It is then necessary to re-look into the channel estimation methodology and design the corresponding training sequences that are suitable for PLNC.

The objective of this Springer brief is to present the architectures of the PLNC system and examine recent advances in channel estimation for such a system. The motivations and concepts of PLNC are first explored. Then the challenges of channel estimation as well as other signal processing issues in PLNC are presented. The readers are exposed to the latest channel estimation and training sequence designs for PLNC system under three typical fading scenarios: frequency flat fading, frequency selective fading, and time selective fading. Via estimation theory and optimization theory, the new channel estimation mechanisms in PLNC system are devised to embrace the bi-directional two-hop nature, and the corresponding optimal training structures are also derived. Numerical results show the effectiveness of the new estimation strategies and the optimality of the training designs.

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Acronyms

PLNC	Physical layer network coding
CSI	Channel state information
URS	Uni-directional relaying system
SISO	Single-input single-output
MISO	Multiple-input single-output
MIMO	Multiple-input multiple-output
OFDM	Orthogonal frequency division multiplexing
STC	Space time coding
ML	Maximum likelihood
LS	Least square
MSE	Mean square error
MMSE	Minimum mean square error
LMMSE	Linear minimum mean square error
SNR	Signal-to-noise raio
LMSNR	Linear maximum signal-to-noise ratio
CRLB	Cramér-Rao lower bound
PDF	Probability density function
AF	Amplify-and-forward
AESNR	Average effective SNR
AMSE	Average MSE
SER	Symbol error rate
BER	Bit error rate
PT	Pilot-tone
TDD	Time-division-duplexing
DFT	Discrete Fourier transformation
IDFT	Inverse discrete Fourier transformation
SSA	Simultaneous sign ambiguity
CE-BEM	Complex exponential basis expansion model