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Relation of Optimal Pilot Offsets in the Shifted Constellation-Based Method for the Detection of Pilot Contamination Attacks

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Abstract : One possible approach for maintaining the security of communication systems relies on Physical Layer Security mechanisms. However, in wireless time division duplex systems, where uplink and downlink channels are reciprocal, the channel estimate procedure is exposed to attacks known as pilot contamination, with the aim of having an enhanced data signal sent to the malicious user. The Shifted 2-N-PSK method involves two random legitimate pilots in the training phase, each of which belongs to a constellation, shifted from the original N-PSK symbols by certain degrees. In this paper, legitimate pilots’ offset values and their influence on the detection capabilities of the Shifted 2-N-PSK method are investigated. As the implementation of the technique depends on the relation between the shift angles rather than their specific values, the optimal interconnection between the two legitimate constellations is investigated. The results show that no regularity exists in the relation between the pilot contamination attacks (PCA) detection probability and the choice of offset values. Therefore, an adversary who aims to obtain the exact offset values can only employ a brute-force attack but the large number of possible combinations for the shifted constellations makes such a type of attack difficult to successfully mount. For this reason, the number of optimal shift value pairs is also studied for both 100% and 98% probabilities of detecting pilot contamination attacks. Although the Shifted 2-N-PSK method has been broadly studied in different signal-to-noise ratio scenarios, in multi-cell systems the interference from the signals in other cells should be also taken into account. Therefore, the inter-cell interference impact on the performance of the method is investigated by means of a large number of simulations. The results show that the detection probability of the Shifted 2-N-PSK decreases inversely to the signal-to-interference-plus-noise ratio.

Keywords : channel estimation, inter-cell interference, pilot contamination attacks, wireless communications
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