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論　文　要　旨

・論文の構成

Chapter 1 Introduction
Chapter 2 System Model and Definitions
Chapter 3 Physical Layer Security under Asymptotic-Infinite Transmit Power
Chapter 4 Physical Layer Security under Limited Transmit Power
Chapter 5 Conclusion

・研究目的の妥当性，従来の手法との比較においての有意性，および理論・実験手法の新規性

In this thesis, the authors studied the performance of physical layer security under the correlated fading wire-tap channel. Compared with the traditional security methods, such as cryptography, the new physical layer security has been regarded as a promising technique to provide a strong form of security.

Available works related to physical layer security studies of wireless fading channel models are mainly based on the assumption that communication channels are independent from each other. In practice, however, the channels from a transmitter to different receivers are correlated with different levels. Different from these works, this thesis conducted the study for the correlated fading channels. The methods in our

theoretical analysis mainly combined the information theory, statistics, and integration techniques of special functions, such as Marcum Q function.

・得られた知見のシステム情報科学の分野における意義

The results of this thesis provide the following insights.

1. The theoretical models developed in this work will be helpful for the analysis of applying physical layer security to achieve information security in wireless networks.
2. Our results reveal that channel correlation is always harmful to secrecy capacity, but has both helpful and harmful effects on outage performance depending on secrecy rate adopted in the transmission and also the SNR conditions of both main and eavesdropper channels. These results are of great importance for network designers to design practical secure systems based on the physical layer security.

審査結果の要旨

This thesis provides a comprehensive study on the fundamental performance limits of physical layer security under correlated fading wire-tap channels. After providing system models and defining some information theoretic metrics, the thesis started the study from the scenario when transmission power is asymptotically infinite, where the asymptotic outage performances were analyzed by employing information theory and statistics. The thesis then extended the study to the limited transmission power scenario, where closed-form secrecy capacity and outage performances were derived based on information theory and integration techniques of Marcum Q function. Based on the theoretical results, the inherent performance tradeoffs under the concerned channel and also the potential impact of channel correlation on such tradeoffs were analyzed. It is expected that theoretical models we developed could provide guideline for efficient security systems design, and that the impacts of correlation on the security performances we revealed would be helpful for network engineers to design practical secure systems.