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論　文　要　旨

Unmanned aerial vehicle (UAV)- enabled wireless communication is emerging as a promising technology widely employed in modern wireless communication systems. However, the broadcast nature of wireless communications and the high-quality line-of-sight (LoS) air-to-ground links make UAV communications more vulnerable to security threats than traditional terrestrial wireless communications. Covert communication serves as a good solution to achieve secure communication in UAV-enabled wireless communication systems. This dissertation focuses on the protocol design and related performance analysis for covert communications in UAV-enabled wireless communication systems. We first focus on the single-receiver scenario, in which the transmitter UAV, ground receiver Bob and ground warden Willie are all equipped with antennas capable of operating in both omnidirectional microwave (OM) and directional mmWave (DM) transmission modes. We propose a covert transmission protocol based on hybrid OM/DM transmission mode selection, and develop related theoretical models to depict the system performance in terms of detection error probability (DEP), transmission outage probability (TOP), and effective covert rate. We then consider a simple multi-receiver scenario, in which a UAV would like to disseminate common covert information (CI) to multiple ground users (GUs) within its coverage area while simultaneously evading the detection by a ground warden Willie outside the covered area. We design both one-hop and two-hop multicast transmission protocols for the concerned

system, and develop related theoretical models to show the system performance in terms of detection error probability (DEP) and overall transmission time. We further consider a general multi-receiver scenario, in which a UAV would like to disseminate a common CI to multiple GUs diversely distributed within a circular area while simultaneously evading the detection by a ground warden Willie located in the center of the area. We propose two effective multicast group (MG) construction algorithms, develop a theoretical framework for the performance modeling of each MG, and explore the transmission time minimization in each MG. By integrating these components, we thus devise a complete and time-efficient covert multicast transmission protocol for the concerned system. Extensive numerical results are provided in this dissertation to illustrate the efficiency of the new transmission protocols for covert communications in UAV-enabled wireless communication systems. It is expected that the work in this dissertation can serve as a promising solution and also shed light on the protocol design for future UAV-enabled covert wireless communication systems.

審査結果の要旨

This thesis focuses on the protocol design and performance analysis for covert communications in UAV-enabled wireless systems. Firstly, we consider the single-receiver scenario, propose a covert transmission protocol based on the optimal selection between omnidirectional microwave and directional mmWave transmission modes and develop related theoretical models for performance evaluation. Then, we consider a simple multi-receiver scenario where a UAV disseminates covert information to multiple ground users (GUs) subject to the detection by a ground outside warden, design both one-hop and two-hop multicast transmission protocols, and develop related theoretical models for performance evaluation. Finally, we consider a general multi-receiver scenario with multiple GUs distributed within a circular area and a warden located at the center. By proposing the multicast group (MG) construction algorithms, developing models for modeling MG performance, and conducting transmission time minimization within each MG, we devise an efficient covert multicast transmission protocol for this general multi-receiver scenario.