A Study on the Distributed Task Offloading and User Association in UAV-Assisted Mobile Edge Computing Systems

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UAV 지원 모바일 엣지 컴퓨팅 시스템의 분산 작업 오프로딩 및 사용자 연관에 관한 연구

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Abstract

Unmanned Aerial Vehicle (UAV)-assisted Mobile Edge Computing (MEC) systems are emerging solutions that reducing latency and improving the computational capacity for next-generation radio access networks. However, the limitation of energy capacity has constrainted UAVs in low performance. This is a significant challenge that needs to be solved effectively. This work formulates a joint optimization of computing resource allocation, computation offloading, and user association, so-called Computation Offloading and User Association (COUA) framework. We aim to minimize the consumed energy of both UAVs and user mobile devices that considers the limitations in computational resources of UAVs and the minimum requirements regarding the user offloading data rate. We demonstrate the formulated problem is a non-convex mixed-integer linear programming (MILP) problem that is difficult to solve straighforwardly. Therefore, we use game theory to transform the problem into a Potential Cooperation Game (PCG), which enables the distributed process. The transformed PCG framework is proved to converge and obtain a pure Nash Equilibrium (NE). We conduct extensive simulations to show the effectiveness of the proposed cooperation game framework. The achivable results demonstrate the significant enhancement in reducing the energy consumption compared to the benchmark schemes. Furthermore, our proposed framework provides valuable insights for designing the efficient offloading and user association for multi-UAV-assisted MEC systems.

Ⅰ. Introduction

Unmanned Aerial Vehicle (UAV)-assisted Mobile Edge Computing (MEC) systems are emerging solutions that reducing latency and improving the computational capacity for next-generation radio access networks. However, the limitation of energy capacity has constrainted UAVs in low performance [1]. This is a significant challenge that needs to be solved effectively [2].

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Ⅱ. Method

This work formulates a joint optimization of computing resource allocation, computation offloading, and user association, so-called Computation Offloading and User Association (COUA) framework. We aim to minimize the consumed energy of both UAVs and user mobile devices that considers the limitations in computational resources of UAVs and the minimum requirements regarding the user offloading data rate. We demonstrate the formulated problem is a non-convex mixed-integer linear programming (MILP) problem that is difficult to solve straighforwardly [3]. Therefore, we use game theory to transform the problem into a Potential Cooperation Game (PCG), which enables the distributed process. The transformed PCG framework is proved to converge and obtain a pure Nash Equilibrium (NE)..

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Ⅲ. Conclusion

We conduct extensive simulations to show the effectiveness of the proposed cooperation game framework. The achivable results demonstrate the

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significant enhancement in reducing the energy consumption compared to the benchmark schemes. Furthermore, our proposed framework provides valuable insights for designing the efficient offloading and user association for multi-UAV-assisted MEC systems.

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