

# Topology-Aware Offloading of DAG Tasks for Multi-UAV-Assisted Mobile Edge Computing

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## SUMMARY

The proliferation of Internet of Things (IoT) devices and advances in Artificial Intelligence (AI) have led to a surge in computation-intensive, delay-sensitive applications such as autonomous driving, real-time stream analysis, and facial recognition [1]. However, the limited computational capability of end user devices poses a major challenge to meet the stringent latency requirements of these applications. Although abundant computational resources are available in remote cloud data centers, accessing these resources often incurs significant communication latency and unpredictable network congestion, which makes them unsuitable for delay-critical services [2].

Mobile Edge Computing (MEC) emerges as a promising paradigm to address this challenge by offloading computational tasks to nearby UAVs [2], enabling task execution in close proximity to end users and thereby significantly reducing transmission delays. More recently, deploying multiple unmanned aerial vehicles (UAVs) equipped with onboard computing resources as mobile MEC servers has attracted increasing attention. Compared with fixed terrestrial UAVs, multi-UAV-assisted MEC can be rapidly deployed on demand, provides extended coverage in infrastructure-limited areas, and enhances system robustness through distributed aerial platforms [3], making it particularly suitable for dynamic, large-scale, and mission-critical scenarios.

Numerous task offloading strategies have been proposed to efficiently offload computational tasks generated by end users to UAVs in UAV-assisted MEC systems [4], many assuming independent tasks that can be parallelized. However, real-world applications such as face tracking and smart diagnosis often involve interdependent subtasks modeled as directed acyclic graphs (DAGs), where execution must follow dependency constraints. This limits parallelism and makes existing strategies for independent tasks unsuitable. Recent work has explored DAG-based offloading in MEC [5], primarily focusing on single-edge server scenarios, which face scalability limitations. Other studies consider three-tier architectures with local, edge, and cloud execution, but often assume direct connectivity between users and all servers, which is not always practical.

In this paper, we study DAG task offloading in multi-UAV-assisted MEC networks with arbitrary topology and

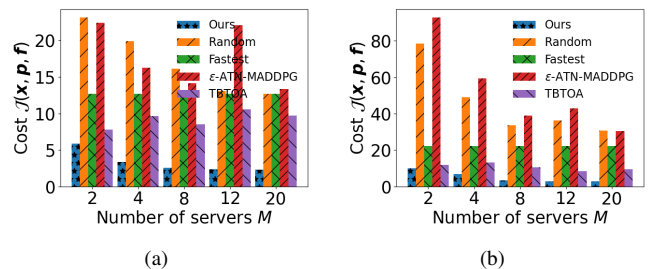


Figure 1. Performance comparison of different algorithms as the UAV network size increases for (a)  $N = 30$  and (b)  $N = 50$ .

formulate it as a new mixed-integer nonlinear optimization problem that jointly captures routing, transmission queuing delay, and resource allocation. To solve this challenging NP-hard problem, we propose a topology-aware algorithm that first orders subtasks to satisfy DAG precedence constraints and then iteratively optimizes offloading and resource allocation using a surrogate objective and a coordinate-descent strategy with guaranteed convergence. Comparative simulation studies (e.g., Fig. 1(b)) show that the proposed algorithm achieves near-optimal performance, consistently outperforms existing methods, and remains robust across a range of system settings.

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