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Review of Unmanned Aerial Vehicle Assisted Communication in 5G-IoT Applications

[1]Ayush Saxena [2]Dr. Aparna Gupta
M.Tech Scholar, Associate Professor
Department of Electronics and Communication Engineering,
Lakshmi Narain College of Technology Excellence, Bhopal, India

Abstract : The Internet of things (IoT) has attracted increased attention due to its capability of connecting heterogeneous devices, technologies and applications through cellular and device to device (D2D) wireless communication. The major challenge of UAV path planning in the emergency communications is that the user distribution in the target area is unknown by the UAV. The UAV cannot pre-plan an optimal path that maximizes the number of served users. Also, due to the limited battery capacity of UAV, an energy efficient trajectory is critical for the UAV-assisted emergency communication. This paper reviews of unmanned aerial vehicle assisted communication in 5G-IoT applications.

IndexTerms **- IoT, UAV, D2D, IOT, 5G, Secure, Fast, Communication.**

I. Introduction

An unmanned aerial vehicle (UAV), commonly known as a drone, is an aircraft without any human pilot, crew or passengers on board. UAVs are a component of an unmanned aircraft system (UAS), which include additionally a ground-based controller and a system of communications with the UAV. The flight of UAVs may operate under remote control by a human operator, as remotely-piloted aircraft (RPA), or with various degrees of autonomy, such as autopilot assistance, up to fully autonomous aircraft that have no provision for human intervention. UAVs were originally developed through the twentieth century for military missions too "dull, dirty or dangerous" for humans and by the twenty-first they had become essential assets to most militaries. As control technologies improved and costs fell, their use expanded to many non-military applications. These include aerial photography, product deliveries, agriculture, policing and surveillance, infrastructure inspections, science, smuggling, and drone racing. Unmanned Aerial Vehicles (UAVs), commonly known as drones, are used in surveillance, monitoring, disaster relief, delivery, and other applications. The wireless connectivity among drones and with ground stations is crucial for control and data exchange. Cellular networks could potentially meet the stringent requirements of drone communication and networking.

The issue is that todays that are cellular networks are not designed for flying devices: various problems including but not limited to cell association, handover management, and interference mitigation need to be solved. This talk would shed lights on how connecting UAVs to cellular networks is dissimilar to connecting regular ground devices in order to capture the built-in technical challenges that drone-connected networks research has to deal with. At the same time, we will show motivating figures of connecting UAVs to and through cellular networks. The Internet of Things (IoT) has significant importance in the beyond fifth generation (B5G) communication systems.

In order to accommodate the communications of the surviving users and IoT devices efficiently, a multiobjective resource allocation (MORA) scheme is proposed for the UAV-assisted Het-IoT [1]. The 5G cellular network employs non-orthogonal multiple access (NOMA) to enhance network connectivity and capacity, and device-to-device (D2D) communications to improve spectrum efficiency. However, the underlay D2D communications may destroy the execution condition for the successive interference cancellation (SIC) decoding of NOMA cellular networks by introducing the extra interference, which degrades the cellular transmission reliability. Thus, we develop the interlay mode as a special D2D mode for NOMA system, which enables the power domain multiplexing of the D2D pair and cellular users to eliminate the strong interference between them by the SIC decoding [3].

II. Background

S. Lins et al.,[1] presents an open-source virtualized testbed that enables a concrete example of SI and EI roles in a SAR mission based on object detection with Deep Neural Networks (DNNs). In this proof-of-concept, the DNN layers are partitioned and the tradeoffs between communication and computational costs are highlighted. For instance, the results indicate that the latency can severely degrade the UAV trajectory and different DNN partitioning options can reduce the required bit rate to transmit DNN scores by more than three times.

C. Feng et al.,[2] approach employs multiple signatures based on threshold sharing to build an identity federation for collaborative domains. This allows us to support domain joining and exiting. Reliable communication between cross-domain devices is achieved by utilizing smart contract for authentication. The session keys are negotiated to secure subsequent communication between two parties. Our security and performance evaluations show that the proposed scheme is resistant to common attacks targeting Internet of Things (IoT) devices (including drones), as well as demonstrating its effectiveness and efficiency.

W. Y. B. Lim et al.,[3] Artificial Intelligence (AI) based models are increasingly deployed in the Internet of Things (IoT), paving the evolution of the IoT into the AI of things (AIoT). Currently, the predominant approach for AI model training is cloud-centric and involves the sharing of data with external parties. To preserve privacy while enabling collaborative model training across distributed IoT devices, the machine learning paradigm called Federated Learning (FL) has been proposed. The future FL network is envisioned to involve up to millions of distributed IoT devices involved in collaborative learning. However, communication failures and dropouts by nodes can lead to inefficient FL. Inspired by the UAV-assisted communications in 5G heterogeneous networks (HetNet), we propose the UAV-assisted FL in this article. The FL model owner may employ UAVs to provide the intermediate model aggregation in the sky and mobile relay of the updated model parameters from data owners to the model owner.

H. Yang et al.,[4] Unmanned aerial vehicles (UAVs) can be used as flying base stations (BSs) for providing wireless communications and coverage enhancement in fifth/sixth-generation (5G/6G) wireless networks. Operating multiple UAV-BSs to guarantee reliable device connectivity, intelligent control of UAV movements, and resource allocation plays an important role in dynamic UAV-assisted wireless networks. In this work, an asynchronous advantage actor-critic (A3C) based UAVs placement and resource allocation approach is proposed to maximize the network capacity while guaranteeing the wireless service requirements of ground devices.

Q. -V. Pham et al.,[5] Unmanned aerial vehicle (UAV) communication is a promising technology to yield great benefits for 5G wireless networks and beyond. In this work, we investigate the downlink transmission in wireless backhaul networks when a UAV is deployed as the flying base station. A joint optimization problem of UAV's placement, spectrum allocation, and power control is formulated, which is an NP-hard problem. To solve the above-mentioned problem efficiently, we propose decomposing the underlying problem into two subproblems, which are then solved alternatively in an iterative manner. Simulation results under various settings are provided to demonstrate the performance improvement of the proposed algorithm over baseline schemes.

N. Iradukunda et al.,[6] scrutinize the downlink transmission of UAV-enabled wireless backhaul networks in which non-orthogonal multiple access is incorporated to boost up the massive connectivity and high spectra efficiency. More precisely, our aim is to maximize the worst ground user's achievable rate by optimizing bandwidth allocation, UAV's power allocation and placement. The formulated problem is non-convex and not easy to solve optimally. Consequently, to deal with the complexity and non-convexity of our problem, we develop a path following procedure and generate a less-onerous algorithm that is iteratively run till convergence.

K. Yan et al.,[7] UAV technology is gradually developed and mature, and has a wide range of applications in various industries, which also puts forward higher requirements for UAV data link. The maturity and deployment of 5g technology provides a solution with high bandwidth and low latency for UAV data link. After analyzing the difficulties of traditional UAV data link, this work puts forward the UAV data link deployment scheme based on 5g technology, and analyzes the key issues such as network rate, network delay and network coverage. The use of 5g technology can make UAV use in a larger radius, and can flexibly network to realize system operation.

A. Mohammed et al.,[8] UAVs have been promising technology to quickly deploy and recover the system to provide efficient services to edge nodes. The offloading and resource allocation problems in current network technology are complex, and offloading task to edge server is vulnerable to security risks. Hence, we utilize a deep reinforcement learning method to handle a complex problem for computation offloading and resource allocations in a dynamic environment. And also, we explore a blockchain-based multi-UAV-assisted MEC architecture in securing and optimizing the offloading problems.

III. CHALLENGES

An incomplete list of several challenges involved in developing robust, high-capacity UAS communication systems focused primarily on the physical and data link layers includes the following:

- Integration of low-cost MIMO antenna systems.
- Development of secure (jam resistant, spoof resistant) physical and medium access layers and protocols.
- Development of high-reliability, high-capacity physicaland medium-access-control layers within the very limited available spectrum for UAS.
- Integration of UAS communication systems with satellite systems and (other) terrestrial communication systems.

- Development of resilient aeronautical networking schemes that enable coordination of fleets of UAS.

Despite the aim of standards bodies such as RTCA, ICAO, and ITU, and regulatory agencies such as the Federal Aviation Administration (FAA), UAS are being deployed by the general population, often indoors, sometimes in the form of model airplanes. Several trends can be cited:

- UAS will be used in an ever-widening range of environments for an ever-expanding list of applications; until (and if) regulated, these applications will often employ commercial communication links, e.g., the IEEE 802.11 technologies.

- The use of UAS will continue to incite debate and controversy over issues such as privacy and public safety.

- Smaller, more capable UAS will continue to be developed by numerous companies worldwide.

These challenges and trends provide opportunities for many, including regulators and policy makers, engineers, UAS manufacturers, and end users of UAS. The communications engineering challenges alone will require teams from industry, academia, and government. Some specific research opportunities for the communications engineering community include the following-

- Multiband and adaptive modulations: as with commercial systems, UAS will require a variety of data rates in a variety of channel conditions. A power control scheme, which can enable fractional frequency reuse for capacity increases, must be developed.

- Interference resilience: both intra- and inter-system interference will be present. This can be alleviated to some degree with MIMO/directional antennas, but as the number of UAS aloft grows, sophisticated signal processing techniques such as multi-user detection may be required to maintain link performance.

- Airframe shadowing: this AG “channel” effect has not been well-characterized, and the attenuations caused by shadowing in both frequency bands must be accounted for in link and protocol design.

- Incorporation of air-to-air links: air-to-air communication will be required in the future to increase range and optimize network operation. Any air-to-air communication must be complementary to, and compatible with, the AG communications.

- Networking: when both air-to-ground and air-to-air links are required, routing schemes must be designed to maintain efficiency and minimize latency.

IV. CONCLUSION

UAV have many challenges and application. The upcoming research on UAV communication brings many possibilities to enhance or change the communication scenario. In future the extensive simulations will performed to compare the performance of the proposed scheme with that of the NOMA system, the random UAV sub channel assignment-based scheme, and proposed schemes with different optimization targets. It will be show that the sum rate of the users and the access ratio of the devices in the proposed scheme outperform those of the other schemes, although there are performance tradeoffs between the individual users, the devices, and the entire IoT.

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