The Era of the 5G Drone is Ahead, Are We Ready?

Chaturanga Basnayake, Kanchana Osanda Lakmal, Prof Dushantha Nalin K. Jayakody

Just a few years ago, seeing a drone in the Sri Lanka's skies was as scarce as hen's teeth; today, improved technology and rapid adoption have made it common for every eye.

Unmanned Aerial Vehicles (UAV) or drones, as they are often called are aircraft that can fly without pilots or remote control. In the early 1900s, military researchers started UAV innovations, which originally focused on providing practice targets for training military personnel. With the influence of world wars, these researches expanded, and were used both for military trainings, as well as for arial attack missions in military campaigns. However, after 1980s, drones were not limited just for military purposes and they made their role prominent in surveillance and reconnaissance operations and in other civil applications, such as aerial crop surveys, fire detection and monitoring, urban management, large-accident investigation and coordinating humanitarian aids. For example, UAV has been seen as an active service in humanitarian operations undertaken by the government of Sri Lanka in 2009.

On the other hand, 5G use cases such as drone network. It has also come up with new challenges in order to coordinate drones, to ensure that they can fly safely in the air. The fifth-generation (5G) cellular network technology, with its low latency and greater capacity, has already proven its usefulness in the communication field, since all drone operators can operate their drones beyond line of sight distance with the help of 5G.

Diverse applications of UAVs such as weather forecasting, emergency response etc. are illustrated in figure 01. UAVs have now become highly helpful in times of distress due to the fact that now it is able to mount cameras on them. UAVs can be very useful in surveillance of disaster-affected areas, locate affected people and deliver aid and assess damage inflicted upon property. Furthermore, they have proven to be a feasible solution to provide emergency supplies and relief to stranded people in hard to reach areas during times of severe weather conditions. The application of UAV is not limited to disaster management, but also military activities. Furthermore, the use in defense marked the inception of the UAV and it is the most important area of application even today. The technology has evolved massively over time and portable UAVs being used by ground forces is a common sight at present. Military use UAVs mostly for surveillance and offensive operations. UAVs can help farmers in gathering data an automating some practices which could dramatically increase the efficiency which in turn would deliver better yields, which is a prime goal in the modern economy. Some of the applications of UAVs in agriculture include spray pesticides and other fertilizers to the fields, Seeding the fields of air at very high efficiency and speed, pollinate flowers which can well compensate for the declining bee population, etc.

Applications of UAV

In a smart city, the city will interconnect all public services using advanced and robust communications technologies. The cost and resource consumption within the city can be greatly reduced as a result of the interconnection between all the

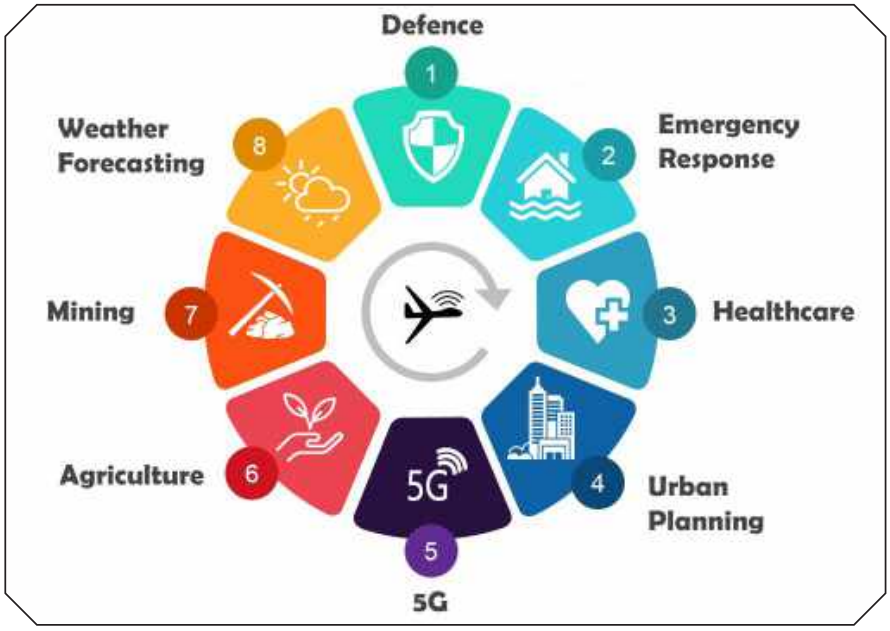

Fig 1 : Applications of UAV

services. UAVs can play a huge role in this whole interconnection process. For example, in a smart city, a call to the emergency services would immediately dispatch a well-equipped UAV to the location of the caller using the GPS (Global Positioning System)coordinates. Uninterrupted by traffic and the street lights UAVs can get to the scene in record time which can be crucial. With real-time video link to security forces vehicle, ambulance and other emergency vehicles attached, first responders would get an accurate scene assessment before they even arrive which could expedite the process and save that valuable second of the response time and save officers' lives when responding to a dangerous situation such as a riot or a shooting incident. This increases not only the response time of the emergency service personnel, but their own safety as well.

Since planes cannot remain airborne for long periods, and satellites are too far above the Earth's surface, aerial photographers cannot continue to rely on conventional aircraft, and consequently UAV act as an equivalent of satellites in the atmosphere. Nowadays, aerial photography and videography with UAV are ideal for the Sri Lankan

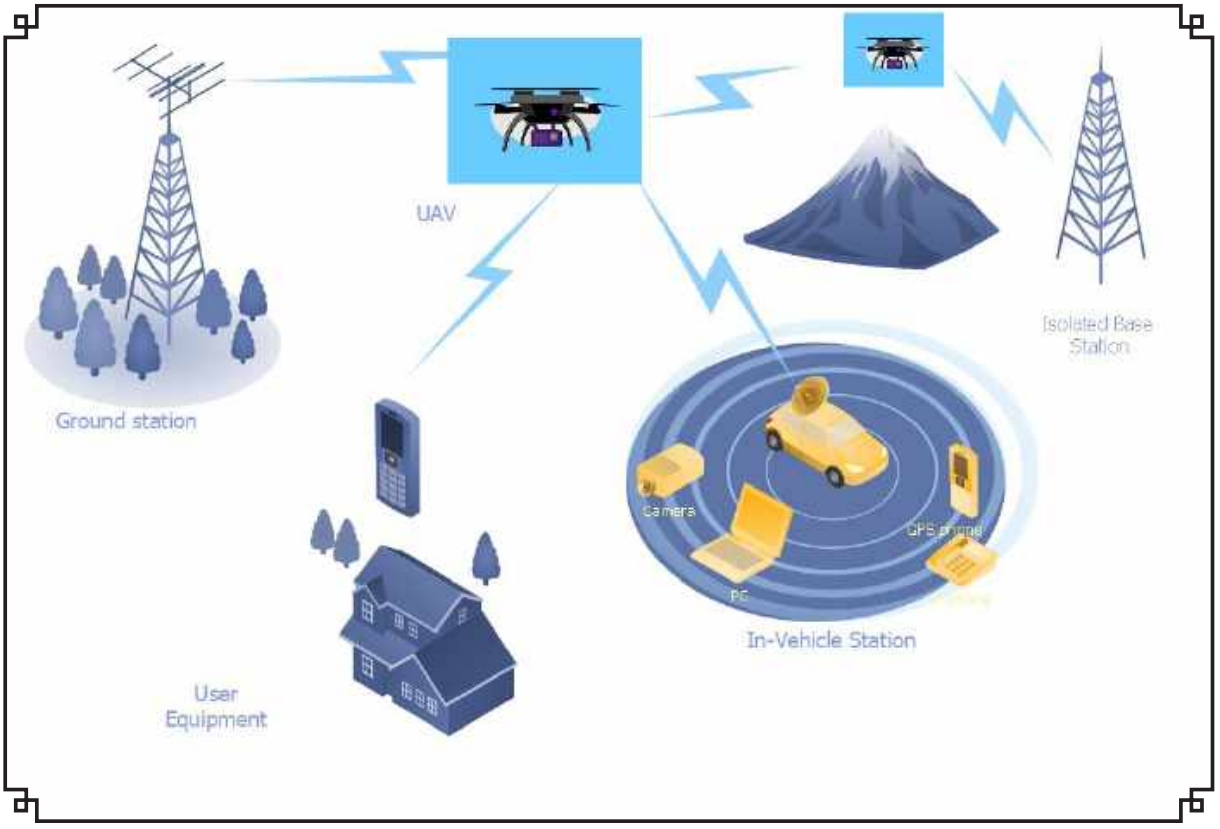

Fig 2 : Cellular connected UAV Communication Network

travel and tourism industries, and some of these types of videos made by vloggers increased foreign tourist attraction to Sri Lanka. However, unfortunately, drones were very recently introduced for these kinds of work in Sri Lanka, and is also growing fast. One of the main reasons for this is that the Sri Lanka's national aviation authority, the Civil Aviation Authority of Sri Lanka (CAASL) has been convinced that commercial drones were safe to be allowed in Sri Lankan air.

Cellular Connected UAV

Imagine a sky with flying vehicles and drones at different attitudes from the ground for which they need wireless connectivity with the ground for different purposes, for controlling the vehicle itself, and for sending mission critical information. In the past few years, many research projects address both high capacity and secure air-to ground connectivity service to the UAV. While telecommunication organizations are currently exploring possibilities for serving UAVs with further cellular network. Because of that drone will be envisioned as one of the key use cases in the future 5G arena. Most researchers in UAV communication field have a dream to use UAV as base stations in future mobile network such as 5G, operating at millimeter wave frequencies, alongside wireless energy transfer. This dream can only come through successful integration of the UAV communication system and the cellular networks. Accordingly, researchers at both academia and industry are currently investigating accurate models for a cellular-connected UAV network using different techniques. Such a proposed model is as shown in figure 2 which depicts a cellular connected UAV communication network.

The use of artificial intelligence techniques in UAV's communication systems will be expanded during the next decade and researchers will more concern about artificial neural networks, deep learning and machine learning techniques to optimize the UAV communication network, as these techniques have shown its predominant advantages in many applications. As an example, researchers at the CTR (Center for Telecommunication Research, Sri Lanka) presented an efficient approach which utilizes the properties of the neural model and the concept of matrix-coloring in order to maximize the UAVs positioning likelihood for optimized throughput coverage and maximum User Equipment (UE) to UAV mapping. Other than that, we have proposed blockchain-based network model to ensure connectivity, availability, and survivability, which are fundamental in achieving ultra-reliable and low-latent communication in UAV communication network. In this research project researcher have evaluated the performance of network model and the proposed approach, in terms of flyby time, probability of connectivity, energy consumption, failure rate, survivability, reliability, and area spectral efficiency. In the other hand, securing UAV communication network is not an easy task because of the difference in communication standards and range of applicability. Aerial nodes are prone to various types of attack in a network such as sybil attack, wormhole attack, sinkhole attack, or impersonation attack. These attacks lead to a large number of vulnerabilities causing fatal incidents. Currently, we are working on introducing novel networking and security architecture for UAV communication system.

To date, researchers in the UAV communication field explored many user cases of cellular connected UAV and has achieved some results. Also, they have been two-sided facing both opportunities and challenges, since both the 5G and UAV fields are still in young age. However, researchers will continue to explore through trial and error, and solve these challenges until the 5G drone become a reality.

Prof. Dush Nalin K. Jayakody, Ph. D. (Dublin), IEEE Senior Member
School of Postgraduate Studies & Research
Sri Lanka Technological Campus, Padukka.

Chaturanga Basnayake
B.Sc (Hons, Eng., Ruhuna), AMIESL
Ph.D. Scholar (Tomsk Polytechnic University, Russia)
Research Assistant (SLTC, Sri Lanka).

Kanchana Osanda Lakmal
Research Assistant
(SLTC, Sri Lanka)