UAV Communications: 5G and Beyond

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In the late 1990s, people in India started calling relatives abroad through the internet using voice over IP (VoIP) in internet cafes. It was just a matter of time before every household had an internet connection. Similarly, drones, also called unmanned aerial vehicles (UAVs) are now being used for shooting wedding videos in India. It is only a matter of time before drones become as ubiquitous as cell phones. Instead of kites, we may soon see youngsters flying drones on Makara Sankranti.

Currently, UAVs are manually controlled using radio signals on unlicensed bands like 2.4/5.8 GHz (Wi-Fi) and ISM (around 800-900 MHz). Like cell phones, UAV applications will keep evolving with time. Right now, all kinds of fancy ideas, e.g., using UAVs for delivering groceries and food are being discussed. However, just like the cell phone, it is difficult to foresee what UAVs are truly capable of at this stage.

Legacy UAV communication is simplistic, with a single channel line of sight (LoS) link, suitable for manual control. Myopic regulations have followed suit, mandating licenses for drones and operators. Drones are capable of intelligence and just like e-commerce applications borrowed artificial intelligence (AI) from robotics to the internet, commercial applications will ensure that such intelligent systems are mounted on UAVs as well. This will require drones to communicate with each other on high-speed links. Since drones are capable of flying, the communication modules have to be more sophisticated than those on cell phones.

Future drones are likely to have the following communication capabilities:

- High-speed Adhoc D2D (Drone to Drone)
- 5G cellular
- GPS
- SATCOM (Satellite Communication)

Thus, 5G communication is not limited to mobile telephony in cellular. UAV communication is also one of the focus areas of the evolving 5G standards.

The Drones Lab at IIT Hyderabad, supported by TiHAN, is currently working on technologies related to intelligent communication for ad-hoc networks for UAVs, supporting UAV swarms as shown in Fig. 6. We are in the process of replacing the onboard FS-iA6B Receiver Module available on most low-cost drones with our module using open-source software (e.g GNU Radio) and low-cost hardware. For this purpose, we are collaborating with OptimusLogic, a Hyderabad based startup, which has provided us with the indigenously developed Vaaman (वामन) boards (EOS S3 FPGA + ARM Cortex M4) for development as shown in Fig. 7. These boards can be programmed using the Raspberry Pi as well as Android-Termux.

The idea is to build indigenous low-cost/power communication systems for UAVs as a proof of concept and then extend these ideas to cellular and satellite communication as well. This will involve designing new communication standards at the physical layer and protocols in the higher layers. We look forward to the participation of the student community at IITH in this endeavor.

Fig. 6 Drone

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Fig. 7 Vaaman board

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