SPECTRUM POLICY CHALLENGES OF UAV/DRONES

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There is growing interest around the world in unmanned aerial vehicles (UAVs), often called "drones," for both military and civil use. In International Civil Aviation Organization (ICAO) jargon they are called remotely piloted aircraft (RPA), while in the International Telecommunication Union (ITU) they are called unmanned aeronautical systems (UAS). The civil use includes both commercial use as well as noncommercial use (e.g., a new platform for photography). Indeed, a major U.S. newspaper reported recently, "The next time you go to a wedding, be sure your hair is done, your lipstick is on, and your underwear isn't sticking out of your pants. You never know if a drone is lurking in the sky about to zoom in and take your picture [1].

UAVs range in size from military units with mass of over 1000 kg to much smaller consumer units with mass of up to a few kilograms. Similarly, the range and endurance time of these units vary significantly from minutes to hours. While autonomous UAVs without radio links are theoretically possible, for a variety of reasons radio links are generally used for vehicle control and often used to downlink information such as imagery or video in real time.

The spectrum needs of UAVs have been under consideration in ITU deliberations for more than a decade. A 2009 ITU-R report [2] found that "Communications are key in UAS systems due to the remote nature of human presence. Safety-of-flight is the driving factor when the seamless flight of UAS within civilian air traffic is at stake. In the end, safe operation of UAS relies on communications which represents a critical step in enabling UAS operations in non-segregated airspaces."

The report listed a wide variety of applications for UAVs, including:

- Movie making, sports games, popular events like concerts
- Cargo planes with reduced man power (one-man cockpit)
- Inspections for industries such as oil fields, oil platforms, oil pipelines, power line, and rail lines
- Provision of airborne relays for cell phones in the future
- Commercial agricultural services like crop dusting
- Earth science and geographic missions (e.g., mapping and surveying, aerial photography), biological and environmental missions (e.g., animal monitoring, crop spraying, volcano monitoring, biomass surveys, livestock monitoring, tree fertilization)
- Coastline inspection, preventive border surveillance, drug control, anti-terrorism operations, strike events, search and rescue of people in distress, and national security
- Public interest missions like remote weather monitoring, avalanche prediction and control, hurricane monitoring, forest fire prevention surveillance, insurance claims during disasters, and traffic surveillance
- Famine relief, medical support, aid delivery; search and rescue activities

Note that this long 2009 list from ITU-R includes neither the military use of UAVs, which has become a regular news item, nor wedding photography.

The same report estimated the spectrum needs for UAVs to be "34 MHz for terrestrial systems (and) 56 MHz for satellite systems." However, in view of the rapid recent changes in UAV technology, it is not clear if these 2009 estimates are still adequate.

Next year, ITU WRC-15 Agenda Item 1.5 will consider "the use of frequency bands allocated to the fixed-satellite service … for the control and non-payload communications of unmanned aircraft systems (UAS) in non-segregated airspaces, in accordance with Resolution 1533 (WRC-12)" [3, 4].

But while formal reallocations are being considered, the "marketplace" is making way for rapidly expanding private sector UAVs use, utilizing existing spectrum in ways that might cause long-range pragmatic problems. In particular, unlicensed ("licence exempt" in European jargon) spectrum and cellular land mobile spectrum are both readily, if not formally legally, used for modest UAV applications such as photography for weddings, and marketing houses and land for sale. Already one U.S. cellular carrier has announced the marketing of a UAV controlled from smartphones via a Bluetooth link [5]. Whether this is a brilliant marketing decision or an event that "opens Pandora's box" remains to be seen. Why? Illegal jamming of both cellular spectrum and GPS spectrum is an unfortunate growing trend in industrialized countries. While the sociology of this jamming is complex, a key motivator appears to be perceptions in society that some of today's wireless technology of which we are so proud is seen by others in our communities as invading personal privacy. (Jamming motivated by direct personal gain, on the other hand, appears to be rare.)

"Peeping drones" are a growing concern about UAVs that provide imagery from locations previously thought private such as bedroom windows and backyards [6]. Public perception of UAV use as privacy invasion could escalate interest in illegal, but hard to suppress, jamming of the spectrum supporting the imagery.

While ITU and national spectrum allocations provide for the Aeronautical Mobile Service that is planned for communications to/from airborne systems, cellular and unlicensed bands are not similarly planned for transmitters well off the ground. Thus, transmitters in UAVs at more than 50–100 m altitude can impact the band used much more than terrestrial users since height has a great impact on propagation loss and effective signal range. Widespread use of imagery transmission from UAVs in cellular or unlicensed spectrum may congest that spectrum much more than the expected terrestrial use for which the systems in

those bands were designed. For example, in a cellular system in an area with dense base stations, a drone using cellular spectrum at several hundred meters could cause significant power flux density at a large number of base stations and decrease system capacity much more than terrestrial users anticipated in system planning.

Thus, poorly planned use of cellular and unlicensed spectrum for UAV imagery might have adverse impacts on both cellular and unlicensed/"license exempt" spectrum hosting the transmission. WRC-15 deliberations on UAV/UAS use will be a forum to approach this issue in a deliberate way, but might not be timely enough for the rapid growth of this sector. National regulators will probably have to deal with UAV spectrum issues for private sector users independent of the pending WRC-15 agenda item since UAV use is growing on a faster timescale than ITU deliberations.

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BIOGRAPHY

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