Urban Air Mobility: Regulation and Control of Vertical Takeoff and Landing Vehicles

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Introduction & taxonomy

The number of Vertical Takeoff and Landing vehicle (VTOL) projects is rapidly growing in both commercial and recreational applications. This work reviews the most important safety and regulatory aspects of passenger VTOLs. Functional flying car prototypes and service portfolios appeared recently We highlight the most important training, certification and pilot-related human-factors, along with the challenges in physical and legal infrastructure development. VTOLs may become widely available and operational by 2030.

Unmanned Aerial Vehicle (UAV) or **Unmanned Aircraft (UA):**
- An aircraft without a human pilot on board

Drone:
- Any vehicle that can operate without a drive or pilot inside.

VTOL:
- A vehicle that can hover, take off and land vertically.

Flying car:
- Personal air vehicle or roadable aircraft

Autonomous ground vehicle:
- Surface vehicle equipped with a level

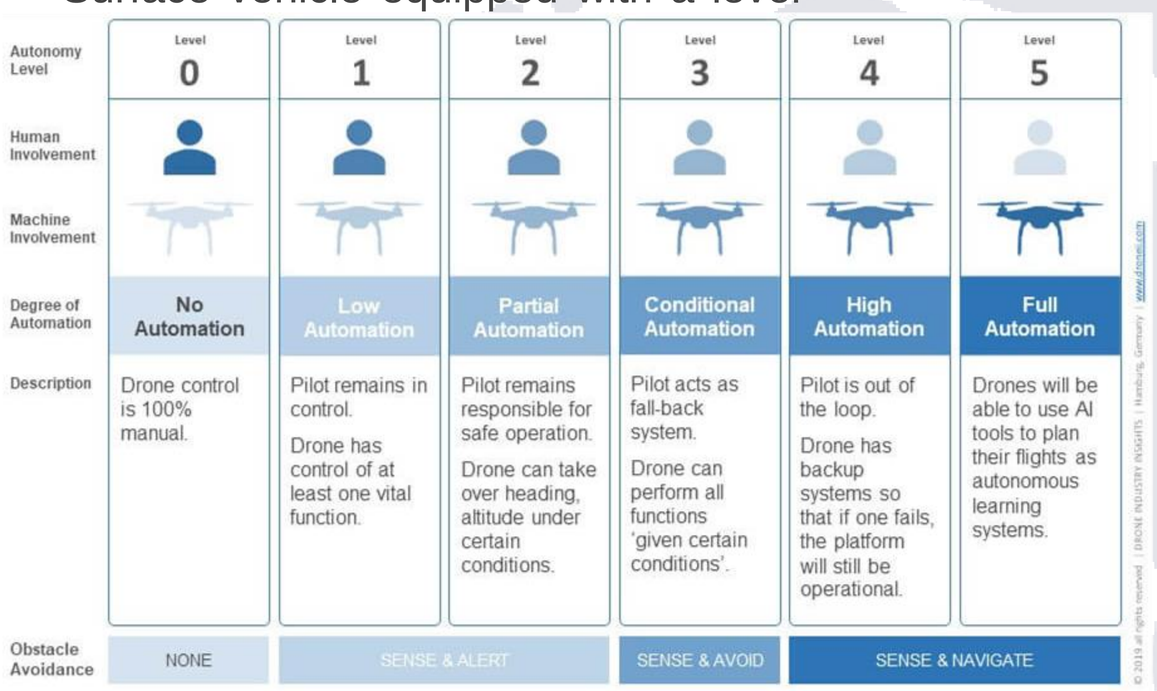

Fig. 1. Concept of Level of Autonomy for UAVs. (Dronell.com)

Regulatory

Lead by individual national bodies
- Aspects of operation
- Drone mass
- Population density
- Altitude
- Use case

National commercial drone regulation → **applicable for VTOLs**

National strategies

1. **Outright ban**
- Commercial use of drones is not allowed.

2. **Effective ban**
- Formal processes for commercial drone licensing
- Requirement for constant visual line of sight (VLOS)
- Experimental uses of beyond visual line of sight (BVLOS)

3. **Permissive**:
- A regulatory body exists giving operational guidelines

4. **Wait-and-see:**
- Little or none of the drone-related legislation

Safety measures

Semi-automated operation is foreseen
- AGV industry can serve as a guide
- Technology awareness and public social acceptance are key

Regulation of takeoffs and landings
- need of complex safety/risk analysis
- USA National Airspace System (NAS)

Aviation industry standards transferred
- System-wise redundancy
- Manned VTOLs are capable of LoA4

Training and certification
- Existing traffic control systems are expected to be overloaded
- VTOLs' human operators will require additional licence(s)
- Prototypes have various designs→ specific licences
- Certification, airworthiness and operation domains (ODD)
- Need to be defined for all designs and operation principles

Operation
- ODD should be defined for VTOLs
- Suitable landing sites are needed
- In-air journey divided to flight segments

Flight control support
- Additional licensing needed
- Suitable policies have not been established
- Initiatives exist to regulate ground-air and air-ground transition

Figure 2. Current VTOL prototypes. M400 Skycar, PAL-V and SkyDrive SD-03.

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CONCLUSION

Defining the levels of autonomy and educating future pilots about the capabilities of partly automated VTOLs is just as important as it is with ground autonomous vehicles.

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