The Role of Regulation in Access to Civilian Airspace: Paths Forward for Unmanned Aerial Systems

Natasha Neogi, Jeff Maddalon, Kelly Hayhurst
NASA-LaRC

Harry Verstynen, Whirlwind Inc.

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Outline

- Motivation
- Regulatory Framework: Conventionally Piloted Aircraft
- Current UAS Regulation: Sample International Perspective
- Path Forward: Operations Oriented Approach
- Summary Thoughts

UAS Market Projections

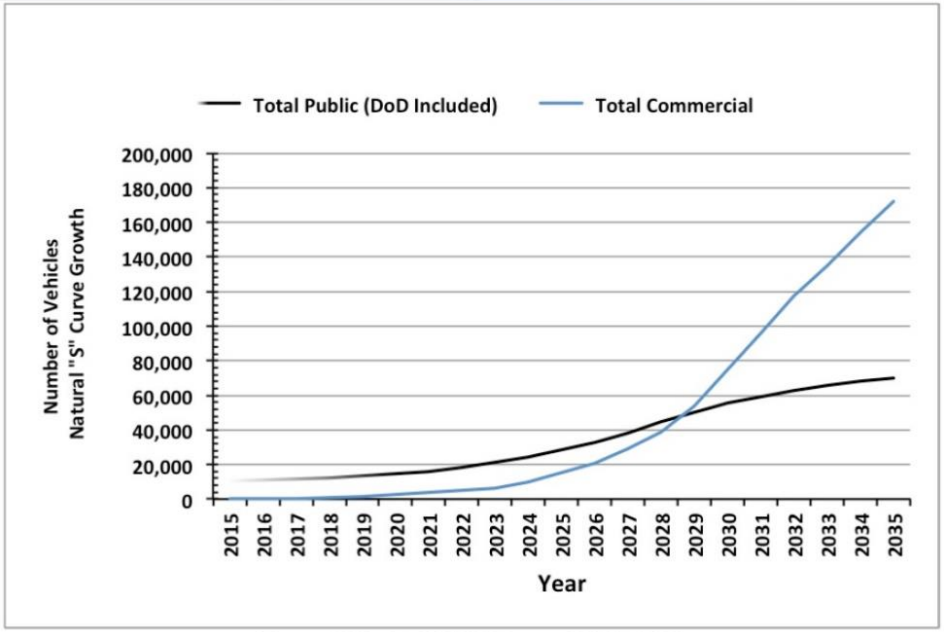
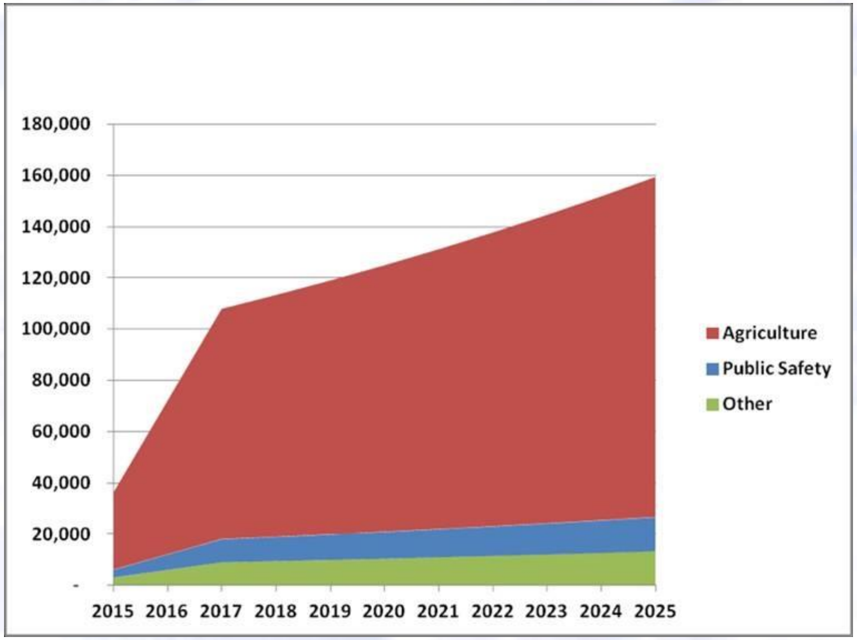


Figure ES-3 - Total UAS Forecast 2015 - 2035



Projected UAS growth in Commercial Market [1]

 # UAS Sales by Sector [2]

Barriers

- Lack of Assurance Arguments for Commercial Off The Shelf Components (COTS) in safety critical roles
- Lack of Component (e.g., sensors, actuators) Quality Assurance Data
- Lack of airspace/operator rules
  - Different mission (e.g., loiter)
  - Different performance envelope
  - Different equipment (see vs. sense)
- Lack of Operator/Ground Crew Standards
- Security and Privacy Issues
- **Lack of Explicit Consideration for UAS in Regulatory Framework**

REGULATORY FRAMEWORK: CONVENTIONALLY PILOTED AIRCRAFT

Regulatory Framework

- Regulation of aircraft in civilian airspace occurs through the application of (legally codified) rules
  - e.g.,1998 CASR,14CFR, EC No 216/2008, ICAO…
- Guidance for compliance is detailed in supplementary documentation (Soft Law)
  - Advisory Circulars (AC), Acceptable Means of Compliance and Guidance Materials (AMC-GM), etc.
- Standards Documents referenced in AC/AMC-GM provide detailed processes for showing acceptable means of compliance
  - e.g., DO-178C/ED-12C, DO-264/ED-78a etc.

Regulatory Framework: Certification

- We use the general concept of a CAA for this section to avoid restricting the discussion to any particular country's regulatory approach.
- A National Civil Aviation Authority (CAA) regulates access to civilian airspace (e.g., FAA, CASA, CAA etc.).
- One key aspect of regulation is certification:
  - Airworthiness Certification
  - Crew Certification
  - Instructions for Continuing Airworthiness
  - Air Operator Certification
- *Air Traffic Management (ATM), Air Navigation Service Provider(ANSP), Ground Infrastructure, and Aerodromes are regulated internally by the CAA.*

Airworthiness Certification

Airworthiness: Aircraft's fitness for flight operations, in all possible environments and foreseeable circumstances for which aircraft or device has been designed. [3]

- Type Certificate (TC)
  - Properly designed and meets required standards /regulations
- Production Certificate (PC)
  - Properly manufactured to type design
- Airworthiness Certificate
  - Required for each tail number to gain access to the airspace

Crew Certification

- Pilot Certification
  - Levels: student, sport, recreational, commercial etc.
  - Category Rating: airplane, rotorcraft, glider, etc.
  - Class and Type Rating: As required for category.
  - Ratings can also be obtained wrt equipment: instrument vs. visual, single vs. multi-engine etc.
- Aircrew: Supplementary Flight Crew, Cabin Crew etc.
- Ground Crew: Maintenance Technician, Flight Dispatcher, etc.

Continuing Airworthiness

- Applies to aircraft, engine, propeller or part
  - Complies with airworthiness requirements
  - Remains in condition for safe operation of aircraft
- Based on initial type certification, maintenance and operational regulatory approvals → Instructions for Continuing Airworthiness (ICA). For example:
  - Operator's approved maintenance data
  - Conformance to original Type Design
  - Record keeping and reporting…

Air Operator Certificate

- Air Operator Certificate establishes requirements and procedures for commercial operation of aircraft
  - Details type of equipment, where and when you will operate, crew training requirements etc.
  - Development of operations and maintenance manuals
  - Includes business plan, system safety process, and reporting procedures
- Directly influences continuing airworthiness

Perspectives (I)

- CPA Framework may not be suitable as-is for UAS:
  - Model of operation for UAS may differ from CPA(& cost)
  - Vehicle and ground infrastructure must be considered for airworthiness, including communications links
  - UAS Airframe manufacturers do not have airworthiness responsibility for fielded platform
  - UAS operators require different skills than conventional pilots
  - Air Operators/Service Providers may take larger role in gaining and maintaining airworthiness of platform based on services offered

CURRENT UAS REGULATION: SAMPLE INTERNATIONAL PERSPECTIVE

Australia [4]

- Civil Aviation Safety Regulation (CASR) Part 101 was first operational regulation for UAS released in 2002; deals with Remotely Piloted Aircraft Systems (RPAS)
  - Currently being updated with ACs, Notice of Proposed Rulemaking
- UAS in controlled airspace are treated as IFR flights, must be equipped with SSR and a collision avoidance or forward vision system, and have filed flight plan with contingencies
- Operation BVLOS, BRLOS requires abort/termination procedures to be filed with ATC authority
- RPAS operator must have ground training applicable for IFR rating

Canada [5]

- Establishes 2 classes: under 2 kg, between 2-35 kg with max airspeed <87kts
  - Requires VLOS, prohibits use of visual observers to extend LOS, and relay stations to extend RLOS
  - Operate below 300 ft in class G airspace, and 5 nmi from aerodome/urban area, minimum clearance of 500 ft with all obstacles/persons
  - Pilot must be 18, and completed pilot ground school
- All other UAS must certify as CPA do, though individual exemptions may be sought

European Union [6]

- EASA regulates UAS and RPAS ≥ 150 kg used for civil applications, all other UAS regulated by member nation CAAs
  - "Airworthiness Certification of Unmanned Aircraft Systems (UAS)"
- Concept of Operation for Drones
  - Three categories: Open, Specific and Certified
  - Open does not require authorization for flight, but must stay within defined boundaries
  - Specific requires risk assessment to gain Operations Authorization with specific limitations
  - Certified requires airworthiness certification

EU UAS under 150 kg

- UK [7] divides into two categories, ≤20 kg, and >20&<150.
  - Under 20kg, no airworthiness approval or registration for VLOS RPAS, below 400 ft, in class G airspace, or within 50 ft of people.
- Germany [8] prohibits operation of any UAS over 25 kg, or beyond LOS, or above 100 m
  - Commercial operation of a UAS or UAS over 5 kg requires license
  - UAS under 5 kg can receive limited permit for operations up to 100 m, within LOS for repeated use, but not over crowds
- France [9] has two decrees governing UAS use:
  - Aircraft Decree classifies UAS into 7 categories, C(mass, function)
  - Airspace Decree outlines 4 operational scenarios
  - (Category, Operational scenario) pairs determines level of oversight

Japan [10]

- Commercial use of unmanned helicopters for agriculture in Japan since 1980s
- Japan Agricultural Aviation Association sets standard (Ministry of Agriculture, Forestry and Fisheries)
  - Pilot Training
  - Aircraft Registration
- Operators must have valid Maintenance Operator License, and be registered, as well as meet structures, flight performance and maintenance standards
- Aviation Regulations only require that any UAS fly below 150 m and 9 km away from airports

US [11]

- 2 Part 21.25 Restricted category type certificates to Puma and ScanEagle for Arctic Operations
- Section 333 of FAA Modernization and Reform Act allows case-by-case exemption
  – FAA will grant COA for flights at or below 200ft to 333 exemption holders for weight <55 lbs, VFR, VLOS and stay fixed distance from airport→Can operate anywhere except over urban areas and restricted airspace
- Proposed small UAS rule for <55 lbs, max airspeed 100 mph, max altitude 500ft, VLOS, no overflight of persons
  – Allowed with permission in B,C,D,E airspace
  – Visual observers may be used, but not First Person Camera View

Perspectives (II)

- Other than in Australia, little formal regulation exists specifically to grant access to UAS larger than ‘small’ weight class
- Commercial UAS (even small) are often not granted access (except in Japan) and face regulatory burdens which may be disproportionate (enormous added cost)
- Beyond VLOS/RLOS operations are rarely enabled

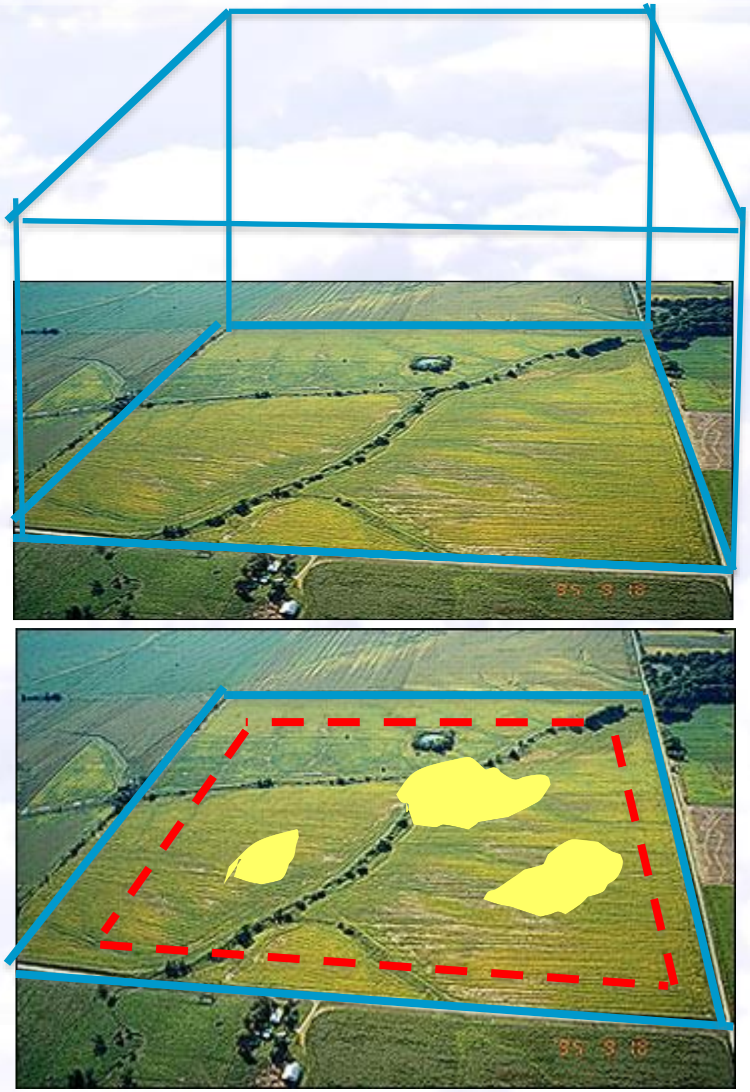
PATH FORWARD: OPERATIONS ORIENTED APPROACH

Motivation for Approach

- Wish to enable airspace access for class of commercial applications whose vehicle platform is not ‘small’, and/or who may wish to operate BVLOS
- Several commercial application domains have been identified:
  - Precision Agriculture, Inspection/Surveillance, Mapping/Surveying
- Each of these applications may present a restricted set of operational hazards whose mitigation may be sufficient to form a type certification basis
- This will enable a ‘starting’ certification basis for (Operational Concept, Platform) pair.

Define Concept of Operations [12]

- Clearly define:
  - Operational Scenarios
  - Operational Environment
  - Assumptions
  - Functional Performance
  - Anticipated Safety Considerations
- Also Relevant: economic considerations



Vehicle Selection [13]

- Relevant Vehicle characteristics
  - e.g., range, endurance, speed
- Relevant Safety Concerns
  - Autorotative capability, etc.
- Economic Considerations

Hazard Analysis

- For the clearly defined Conops, an Operational Hazard Assessment (in conjunction with the selected vehicle) will yield relevant hazards
  - Evaluate wrt severity
- Vehicle specific hazards (that are evinced in operational context) are then aggregated
  - Controllability, maneuverability, etc.
- In the context of operational and environmental assumptions, this forms the set of hazards to be mitigated (airworthiness, operational, training…)
  - Ground Station, Operator, Communication Links, etc.

Develop Type Certification Basis

- Can develop regulation for each hazard that will result in desired level of mitigation
  - Can use available regulation for conventional hazards
  - Can modify available regulation to fit similar hazards in new context
  - Develop regulation for aspects of vehicle/operation that is novel
    - e.g., Communications Link , Containment Area

Assured Containment Concept [14]

- Containment system independent of the UA autopilot and avionics
- Redundant means of enforcing the containment boundaries
  - Doesn't use vehicle's sensors, actuators or computational platform
- No single failure in UAS autopilot results in an automatic failure of the containment system
  - limit the UA's physical location in the presence of such failures.
- Extensible through:
  - Vehicle Types, Operational Environments, Application Domains

Perspectives (III)

- Enabling access to airspace for a wide class of vehicles and applications will require either:
  - Case by case evaluation or
  - Reuse of assurance concepts to form a common certification basis across vehicles and operational concepts or
- Cost outlay required to meet possibly unduly burdensome standards will act to drive which approach is taken

Summary Thoughts

- Enabling UAS access into the airspace must be done in an Efficient (time and cost), Safe and Secure, as well as Non-disruptive manner in order to ensure the economic benefit of this enabling technology is fully realized
- Regulatory impediments remain the largest barrier to UAS access of airspace
- Use of operationally driven type certification bases may provide relief while maintaining safety, and begin to build a foundation for certification over classes of operations and vehicles

Questions?

Natasha.A.Neogi@nasa.gov

Visit the DP-14 in the NASA Integrating UAS into the NAS Booth at AUVSI

References

[1] Teal Group, "World Unmanned Aerial Vehicle Systems, Market Profile and Forecast," 2013.

[2] "The Economic Impact of Unmanned Aircraft Systems Integration in the United States", AUVSI Report, March 2013, http://www.auvsi.org/econreport

[3] *Jane's Encyclopedia of Aviation*, Random House Value Publishing; Rev Ed, August 1993.

[4] Notice of proposed rulemaking: 1309OS-RPAS Terminology and Weight Categorization of RPA, http://www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_100374

[5] Transport Canada "Guidance Material for Operating Unmanned Air Vehicle Systems under an Exemption" https://www.tc.gc.ca/eng/civilaviation/opssvs/ac-600-004-2136.html

[6] EASA, UAS Policy Statement, http://easa.europa.eu/document-library/policy-statements/ey013-01

[7] CAP 722: Unmanned Aircraft System Operations in UK Airspace – Guidance, http://www.caa.co.uk/default.aspx?catid=1995

References

[8] Nutzung von unbemannten Luftfahrtsystemen, http://www.brd.nrw.de/verkehr/flugplaetze flugbetrieb/service/2014-12-04-BMVI-Kurzinformation.pdf

[9] DGAC, http://www.developpement-durable.gouv.fr/Drones-civils-loisir-aeromodelisme

[10] Akria Sato, "Civil UAV Applications in Japan and Related Safety & Certification, ADM001676, UAV 2002 Conference & Exhibition, http://www.juav.org/index.html

[11] https://www.faa.gov/uas/legislative_programs/section_333/

[12] Kelly J. Hayhurst, Jeffrey M. Maddalon, Natasha A. Neogi, and Harry A. Verstynen, "Concept of operations for UAS use in precision agriculture for targeted aerial application", unpublished.

[13] Dragonfly Pictures, Inc., (undated), "DP-14 Hawk", [Online], Available:

http://www.dragonflypictures.com/ products/unmanned- vehicles/dp-14-hawk/

[14] Kelly J. Hayhurst, Jeffrey M. Maddalon, Natasha A. Neogi, and Harry A. Verstynen, "A Case Study for Assured Containment", ICUAS 2015, to appear.