UAS Symposium
Key Research Challenges and Opportunities

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Date: April 20, 2016
UAS Symposium
Research & Development Panel

• Dr. Ed Waggoner, Director, NASA Integrated Aviation Systems Program, Aeronautics Research Mission Directorate

• Dallas Brooks, Director, Raspet Flight Research Lab, Mississippi State University

• Dr. R. John Hansman, Director of the MIT International Center of Air Transportation and Professor of Aeronautics & Astronautics
UAS Regulatory Framework

- Standards & Certification
- Regulations, Policies, & Procedures
  - Airspace
  - Airports
  - International
- Dependencies
- Enables
- Identifies
- Informs

VLOS, Operations Over People, EVLOS, BVLOS
UAS R&D Portfolio

**UAS R&D Portfolio Management**

- **UAS Partnerships**
  - AVS/AFS, ARP, ATO/AJV/AJM/OAV
  - NASA (NAS Integration, UTM RTT)
  - DoD, DHS, DOI
  - Industry (UAS ARC, RTCA SC-228)
  - FFRDC (MITRE CAASD, MIT/LL), CAMI, VOLPE
  - Industry CRDAs
  - Pathfinder Program

- **UAS AVS**
  - Technical Community Representatives Group (TCRG) Core R&D
  - Detect & Avoid (DAA)
    - Certification Obstacles
    - Data Fusion Strategy
    - System Safety Criteria
    - Standards Evaluation
    - Collision Avoidance
    - Small UAS DAA for BVLOS
    - Surveillance Criticality
  - Control & Communication
    - Control Performance
    - Communication Security, Cyber Security
    - Control Non-Payload Communications
  - Operations and Approvals
    - Simulating UAS in the NAS Certification Test Case to Validate Industry Consensus Standards
  - Maintenance & Repair
    - Data Collection Elements and Standards
  - Human Factors
    - Analyses and Recommendations on UAS Control Stations
  - Congressional Test Sites
    - Data Collection & Analysis

- **UAS Concept, Plans Mapping**
  - FAA Concept of Operations
  - FAA Research Mapping
  - NAS Enterprise Architecture
  - National Aviation Research Plan (NARP)

- **UAS Demonstrations**
  - FAA/NASA ACAS-X Demo
  - TBO-UAS Demo
  - sUAS Command & non-Payload Communication (CNPC)
  - SWaP Demo
  - UAS NextGen Demos Demos 1-6

- **UAS Center of Excellence Academia**
  - ASSURE COE 5/8/2015

**Weather Impacts on UAS**

**Wake Separation Stds for UAS**
FAA UAS R&D Timeline

2004
✓ FAA/NASA/DoD/DHS/Industry Access 5 for High Altitude Long Endurance
✓ Establishment of initial WJHTC UAS Modeling and Simulation Capability
✓ RQ-7B Shadow, MQ-9 Predator B Performance Model Verifications/Demo
✓ RQ-7B Shadow UAS Operational Assessment: Cherry Point, NC
✓ Multi-UAS Operational Assessment: Class D Airspace
✓ Initial NAS Integration Simulation-1
✓ UAS NAS Integration: RQ-7B Shadow with FMS Simulation
✓ UAS NextGen Demonstrations – NASA, DHS/CBP, USAF, ERAU
✓ ScanEagle Performance Model Verification – Boeing/Insitu

2008

2010
✓ NASA UAS in the NAS Project (In progress)
✓ UAS R&D organized within a Portfolio

2012
✓ FAA UAS Integration Concept of Operations V2.0 (Maturation underway)
✓ DoD UAS Airspace Integration Joint Test (2012-2015)
✓ UAS Test Sites (AK, NV, NY, ND, TX, VA)
✓ Integration of UAS into the FAA NAS Enterprise Architecture
✓ NASA UAS Traffic Management Research Transition Team

2013
✓ UAS Center of Excellence (MSU - ASSURE)

2015
✓ UAS FY15 - FY16 R&D Initiatives in Progress

Present

Present FAA Sponsored Research

- DAA System Certification Obstacles
- Integration of ACAS-Xu into DAA
- UAS C2 Link Compatibility
- UAS Human Factors Considerations
- UAS Enroute Contingency Operations (pilot & ATC procedures)
- Analysis of Test Site Safety Data
- sUAS Well Clear Definition
- sUAS DAA required for BVLOS (Limited portions of NAS)
- sUAS Control & Non-Payload Communications (SWaP)
- Validation of sUAS Industry Consensus Standards for airworthiness
- UAS Airborne Collision Severity Thresholds
- UAS Ground Collision Severity Thresholds
- UAS Noise Certification
Emerging Commercial UAS Operational Environments (OE)

I. “Manned like” IFR
UAS will be expected to meet certification standards and operate safely with traditional air traffic and ATM services. (DRM: Internet Provider)

II. Tweeners
Flights at altitudes below critical NAS infrastructure, and transitioning low altitude and traditional aircraft operations. (DRM: Inspection)

III. Low Altitude Populated
Must interface with dense controlled air traffic environments as well as operate safely amongst the traffic in uncontrolled airspace. (DRM: Package Delivery)

IV. Low Altitude Unpopulated
Low risk BVLOS rural operations without aviation services. (DRM: Agriculture)

MINIMUM ENROUTE ALTITUDE

18K’ AGL

10K’ AGL

500’ AGL

Federal Aviation Administration

FAA UAS SYMPOSIUM
R&D Concerns for UAS Integration

- Lack of Clear Research Questions to Support Policy Decisions
- Ambiguity of Architecture, Technology Levels and Con-Ops
  - CNS, Level of Automation, Vehicle Performance, Data Structures
  - Dynamic Environment
  - Need for Reference Placeholders (Architecture, Con-Ops)
- Diversity of UAS Operating Environments and Platforms
  - Segregated (Low Altitude, High Altitude)
  - Integrated (Mid Altitudes)
- Urgency Driving Piecemeal Approach
- Need to Leverage Initial Efforts
  - Operating Statistics and Pathfinder Efforts
- Role of NASA, DOD, International
  - NAS Integration
  - Vehicle Technologies
Simplified Set of States Required to Achieve Operational Capability

Avionics Spec.
- Designed Avionics
  - Certified Avionics
    - Installed Equipment
      - Certified Installation
        - Operational Approval
          - Airborne Operational Capability

Operations/ Applications Spec
- Designed Procedures (Airborne)
  - Operating Spec.
    - Trained Pilot
      - Operational Approval
        - Procedural Operational Capability
          - System Operational Capability

Shared Procedures
- Designed Procedures (Control)
  - Published Procedures
    - Operational Approval
      - In-Service Decision
        - System Operational Capability
          - Airborne Operational Capability

Infrastruct. Spec.
- Designed Equipment
  - Approved Equipment
    - Acquired Equipment
      - Verified Equipment
        - In-Service Decision
          - Ground Infrastructure Capability

Ground/ATC Elements
- Designed Infrastructure
  - Approved Infrastruct.
    - Deployed Infrastruct.
      - In-Service Decision
        - System Operational Capability
          - Airborne Operational Capability

Certification Process

Acquisition Process

Weibel & Hansman
Breakout Discussion
Application of Research

• What are the key and emerging challenges to:
  • Enabling
  • Enhancing
  • Reducing restrictions on your current and desired public & commercial UAS operations?

• What research is required to address these challenges?