

Using UAVs for Aerial Mapping, Surveying and Photography

Prepared for:

Central Florida GIS Workshop

18 September 2013

Kevin Shortelle
System Dynamics International, Inc
kevinshortelle@bellsouth.net



Presentation Contents

- **Federal Government Policy Update**
- **National Air Space & UAS Legislation**
- **Certificate of Waiver or Authorization (COA)**
- **UAS Mapping & Surveying Applications**
- **System Dynamics' Firebird & Quadrotor UAS**



Congressional Directive

- **February 2012: Congress directed Federal Aviation Administration (FAA) to accelerate integration of small, civil Unmanned Aircraft Systems (UAS) into National Airspace (NAS) by September 2015 ***

- Small UAS: < 55 lbs



- **Impediments to implementing directive (GAO-12-889T; 7/2012)**

- No sense-and-avoid capability to detect other airborne platforms
- Command and Control (C²) vulnerability
- Lack of technical operational standards
- Lack of regulation to ensure safe integration into NAS
- Privacy
- GPS spoofing and jamming

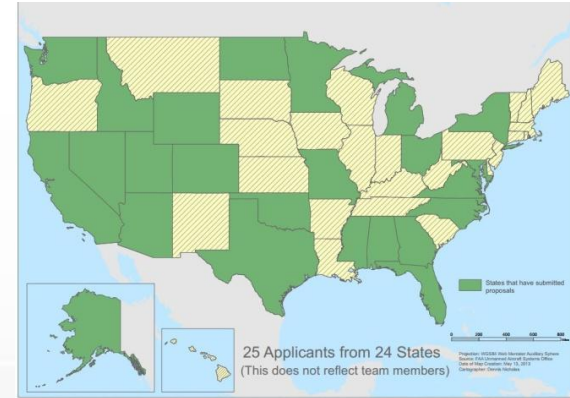


* **FAA Modernization and Reform Act 2012**

FAA's Implementation Plan

- Designate **six** sites to test UAS technologies

- Screening Information Request (aka, RFP) issued on 14 Feb 2013
- 25 responses received from 24 states
- Expected award date: December 2013



- Mandate for UAS test sites:

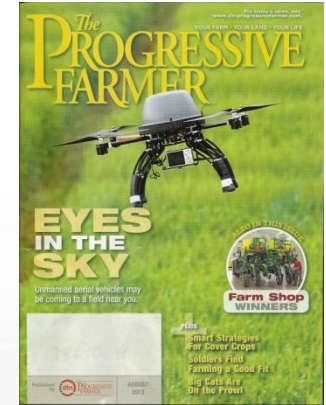
- Ensure safe airspace for integrated manned/unmanned flight operations
- Develop certification standards of UAS air traffic requirement
- Leverage NASA and DoD resources
- Ensure Coordination with Next Generation Air Transportation System
- Address both civil and public UAS use in National Airspace



Economic Ramifications*

- AUVSI projects **\$82 billion** infusion into US economy over 10 years following FAA authorization

- \$75.6 billion for agricultural applications
- \$3.2 billion for public safety
- \$3.2 billion for natural resource management



- Over 100,000 jobs projected to be created

- Many involve manufacturing positions paying >\$40,000 annually



*National Defense Magazine, May 2013

2013 Florida UAS Legislation

- “Freedom from Unwanted Surveillance Act”

- SB 92, Sen. Joe Negron, R-Stuart
- **PASSED** in 2013 legislative session

- Limits use of UAS for **law enforcement only** – three exemptions include:

- Terrorist situation
- Probable cause that includes a search warrant
- Special circumstances (e.g., missing child, hostage situation ...)

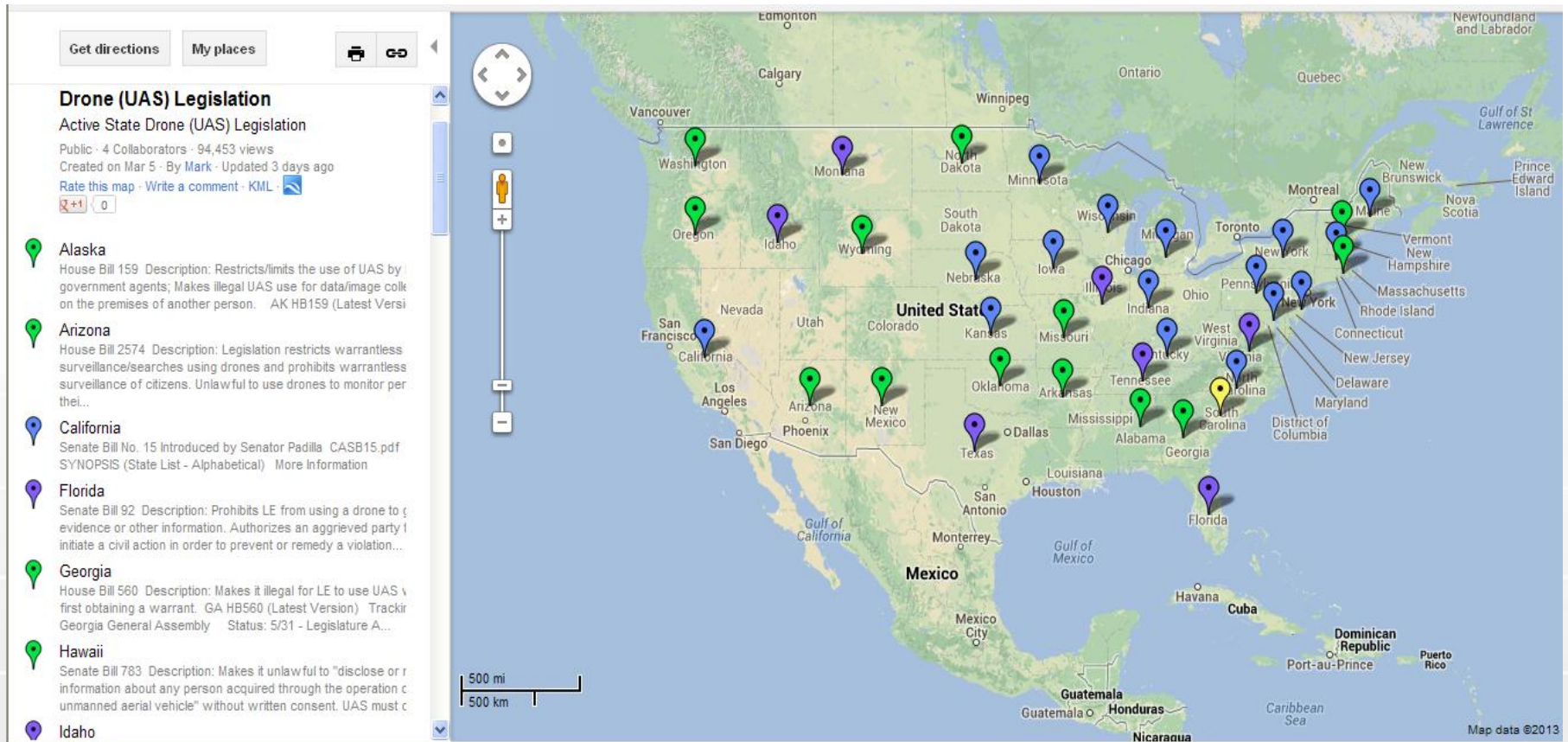


- Does not extend to commercial, private, or federal use



Nationwide UAS Legislation

Interactive Map: <http://amablog.modelaircraft.org/amagov/drone-legislation/>



BLUE: Bill introduced, **Yellow:** Bill progressing, **Green:** Bill failed or stalled, **Red:** Bill progressing with negative implications for model aircraft, **Purple:** Bill passed



Proposed Federal UAS Legislation

- **“Preserving Freedom from Unwanted Surveillance Act”**
 - S. 1016, Sen. Rand Paul, R-Ky
 - Aimed at protecting individual privacy against unwarranted governmental intrusion through the use of UAS

- **“Safeguarding Privacy and Fostering Aerospace Innovation Act”**
 - S. 1057, Sen. Mark Udall, D-Colo
 - Aimed at regulating individuals or businesses from conducting surveillance on another person using UAS



National Airspace (NAS)

Airspace at-a-Glance



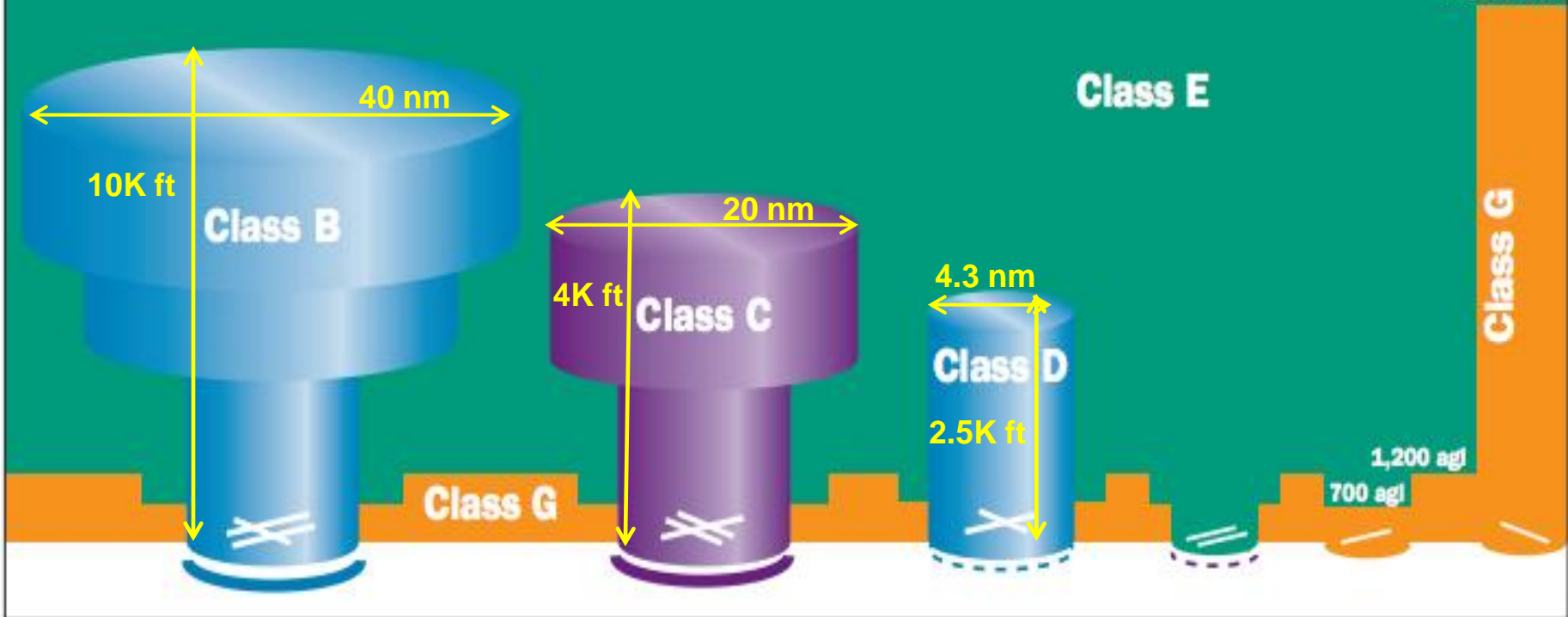
FL600

Class A

18,000 msl

AOPA Air Safety Foundation • 800-USA-AOPA • www.asf.org

14,500 msl



- Classes A, B, C, D, and E are **controlled** airspaces
- Class G is **uncontrolled**



How do we currently fly UAS in NAS?

- **Hobbyists permitted to fly UAS at remote locations -- below 400 ft, >3 miles from airport, and within visual flight rules (AC91-57)**
- **For all others, FAA authorizes flight for military & non-military UAS based on case-by-case safety review**
- **FAA issues two types of authorizations -- both specify times, locations, and permissible flight operations**
 1. **Certificate of Waiver or Authorization (COA)**
 - Issued to Federal, State, and local Government agencies
 - From 1/1/12 to 7/12/12, 201 COA's issued to 106 applicants (including 12 state and local law enforcement agencies)
 2. **Special Airworthiness Certificate – Experimental Category**
 - Issued to commercial companies operating UAS as part of business
 - From 1/1/12 to 7/12/12, 8 certificates issued to 4 UAS manufacturers



Certificate of Authorization (COA)

- SDI flying under COA for existing Air Force contract, authorized solely for our fully-autonomous SiteSeer UAS



- Our key COA requirements are:

- Class G airspace, UAV remains in visual range below 400 ft (AGL)
- Three personnel present:
 - Observer, Pilot-in-Command, Ground station operator
- Pilot must pass knowledge test for private pilot certificate
- Pilot and Observer must have 2nd Class Airman medical certificates



UAS Mapping & Surveying Applications

- Ecology of coastal salt marsh and mangroves



- Conservation easements



- Wildlife and invasive plant & animal species monitoring



- Agriculture and farmland



- Ranch land



SDI's Firebird UAS

- In-house program to develop UAS for aerial mapping, surveying, and photography
- Sensor payload includes:
 - Gimbaled video camera for oblique, geo-tagged full motion video (FMV)
 - High resolution DSLR camera for geo-tagged nadir views of ground surface
- Payload easily changed (e.g., IR or multi-spectral camera)



PARAMETER	VALUE
Fuselage	5.5 ft
Wingspan	8 ft
Takeoff Weight	10 lbs
Cruise Speed	15 - 25 m/sec
Altitude (AGL)	< 400 ft (typical)
Power	Electric
Endurance	~ 45 Minutes



Firebird Imagery

Geo-Tagged FMV Frames



- Video overlaid with telemetry data (aka, metadata) that includes Firebird's location, altitude (AGL), and airspeed when image is captured
- Video viewed on ground station in real-time during mission

Firebird Imagery

Hi-Res Geo-Tagged Photograph (Vehicles and personnel)



- Camera shutter initially activated from ground station; operates automatically thereafter at pre-set rate (e.g., every 2-sec)
- Photos stored on-board and downloaded following mission
- Photos watermarked with Firebird location (post-test)



Firebird Imagery

Hi-Res Geo-Tagged Photograph
(Cattle Herd)



Firebird Imagery

Hi-Res Geo-Tagged Photograph
(Cattle Herd at lower altitude)



Spatially Displaying Aerial Photographs

ArcGIS Firebird Mission 26 March 2013

Details Add Basemap Save Share Print Measure Bookmarks

Contents

- Firebird 26 March 2013
- Imagery

PICTURE 03268376_tag.JPG

Lat	29.5177
Lon	-82.5550
Ele	235.00
Dir	290.60
FOV	42.00

Zoom to

Esri.com . Terms of Use . Privacy . Contact Us . Report Abuse

POWERED BY esri

- Aerial photos taken by Firebird uploaded to ArcGIS Online
- Point features in map are selected to display photo and attribute data
- Photo coordinates correspond to aircraft position



Firebird Imagery Products

Within 24-hr of mission completion, upload data to “cloud”

25 April 2013 Mission

Georeferenced Photographs: <http://bit.ly/11OXU54>

Full Motion Video with GPS-Overly: http://youtu.be/0y9kA5lpJ_M

Firebird Flight Path: <http://youtu.be/mVjUuZTjYOo>

26 June 2013 Mission

Georeferenced Photographs: <http://bit.ly/18QeKVO>

Full Motion Video with GPS-Overly: <http://youtu.be/mo5XnURBdAM>

Firebird Flight Path: <http://youtu.be/Uafzz5E8skg>



Quadrotor UAS

- 26 Mpixel Sony NEX-7 camera:
 - High-resolution photographs
 - Full Motion Video
- Camera mounted on 2-axis gimbal to enhance image stabilization
- GPS-Equipped
- RC or autopilot controlled



<http://youtu.be/2OTFKV99OXQ>

Questions?



Supplemental Slides



Certificates and Authorizations

Civil Operation – Private Industry

For civil operation, applicants may obtain a [Special Airworthiness Certificate, Experimental Category](#) by demonstrating that their unmanned aircraft system can operate safely within an assigned flight test area and cause no harm to the public. Applicants must be able to describe how their system is designed, constructed and manufactured; including engineering processes, software development and control, configuration management, and quality assurance procedures used, along with how and where they intend to fly. If the FAA determines the project does not present an unreasonable safety risk, the local FAA Manufacturing Inspection District Office will issue a Special Airworthiness Certificate in the Experimental Category with operating limitations applicable to the particular UAS.

Public Operation – U.S. Government Organizations

For public operation, the FAA issues a [Certificate of Authorization or Waiver \(COA\)](#) that permits public agencies and organizations to operate a particular UA, for a particular purpose, in a particular area. The FAA works with these organizations to develop conditions and limitations for UA operations to ensure they do not jeopardize the safety of other aviation operations. The objective is to issue a COA with terms that ensure an equivalent level of safety as manned aircraft. Usually, this entails making sure that the UA does not operate in a populated area and that the aircraft is observed, either by someone in a manned aircraft or someone on the ground



COA Recipients (2006 through June 2011)

U.S. Air Force
Arlington, Texas Police Department
U.S. Army
CAL FIRE (California Department of Forestry and Fire Protection)
City of Herington, Kansas
City of Houston, Texas Police Department
City of North Little Rock, Arkansas Police Department
Cornell University (Ithaca, New York)
DARPA (Defense Advanced Research Projects Agency)
DHS (Department of Homeland Security) / CBP (Customs and Border Protection)
DHS (Department of Homeland Security) / Science and Technology
DOE (Department of Energy) - Idaho National Laboratory
DOE (Department of Energy) - National Energy Technology Laboratory
Department of Agriculture - US Forest Service
Department of Agriculture - US Forest Service
Department of Agriculture - Agricultural Research Service
Department of Agriculture - Agricultural Research Service
Department of the Interior - National Business Center/Aviation Management Directorate (NBC/AMD)
DOJ (Department of Justice) - Queen Anne's County, Maryland Office of the Sheriff
Eastern Gateway Community College (Steubenville, Ohio)
FBI (Federal Bureau of Investigation)
Gadsden, Alabama Police Department
Georgia Tech Police Department, Office of Emergency Preparedness (Atlanta, Georgia)
Georgia Tech Research Institute (Smyrna, Georgia)
Hays County, Texas Emergency Service Office
Kansas State University (Manhattan, Kansas)
Mesa County, Colorado Sheriff's Office
Miami-Dade Police Department
Middle Tennessee State University (Murfreesboro, Tennessee)
Mississippi Department of Marine Resources (Biloxi, Mississippi)
Mississippi State University
Montgomery County, Texas Sheriff's Office
NASA (National Aeronautics and Space Administration)
U.S. Navy
New Mexico Tech (Socorro, New Mexico)
New Mexico State University Physical Sciences Laboratory (NMSU-PSL) (Las Cruces, New Mexico)
Nicholls State University (Thibodaux, Louisiana)
NOAA (National Oceanic and Atmospheric Administration)
Ogden, Utah Police Department
Ohio University (Athens, Ohio)
Orange County, Florida Sheriff's Office
Otter Tail County, Minnesota
Polk County, Florida Sheriff's Office
Seattle, Washington Police Department
Texas A&M University Corpus Christi

Texas A&M University - TEES (Texas Engineering Experiment Station) (College Station, Texas)
Texas Department of Public Safety (Austin, Texas)
Texas State University (San Marcos, Texas)
University of Alaska Fairbanks
University of Arizona (Tucson, Arizona)
University of Colorado (Boulder, Colorado)
University of Connecticut (Storrs, Connecticut)
University of Florida (Gainesville, Florida)
University of Michigan (Ann Arbor, Michigan)
University of North Dakota (Grand Forks, North Dakota)
University of Wisconsin (Madison, Wisconsin)
USMC (United States Marine Corps)
Utah State University (Logan, Utah)
Virginia Commonwealth University (Richmond, Virginia)
Virginia Polytechnic Institute and State University (Blacksburg, Virginia)
Washington State Department of Transportation (Lacey, Washington)



Advisory Circular AC91-57

DATE June 9, 1981

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Washington, D.C.

Subject: MODEL AIRCRAFT OPERATING STANDARDS

1. **PURPOSE.** This advisory circular outlines, and encourages voluntary compliance with, safety standards for model aircraft operators.
2. **BACKGROUND.** Modelers, generally, are concerned about safety and do exercise good judgment when flying model aircraft. However, model aircraft can at times pose a hazard to full-scale aircraft in flight and to persons and property on the surface. Compliance with the following standards will help reduce the potential for that hazard and create a good neighbor environment with affected communities and airspace users.
3. **OPERATING STANDARDS.**
 - a. Select an operating site that is of sufficient distance from populated areas. The selected site should be away from noise sensitive areas such as parks, schools, hospitals, churches, etc.
 - b. Do not operate model aircraft in the presence of spectators until the aircraft is successfully flight tested and proven airworthy.
 - c. Do not fly model aircraft higher than 400 feet above the surface. When flying aircraft within 3 miles of an airport, notify the airport operator, or when an air traffic facility is located at the airport, notify the control tower, or flight service station.
 - d. Give right of way to, and avoid flying in the proximity of, full-scale aircraft. Use observers to help if possible.
 - e. Do not hesitate to ask for assistance from any airport traffic control tower or flight service station concerning compliance with these standards.

