ROADMAP TO NEAR-TERM DEPLOYMENT OF UNMANNED AERIAL VEHICLES (UAV) FOR TRANSPORTATION APPLICATIONS

CHARGE TO PARTICIPANTS

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UAV2003 WORKSHOP OBJECTIVES

- Utilize geospatial RS products and tools, developed over past 5 years by DOT/NASA RS multimodal transportation applications program (4 university consortia, >12 technology application projects, including UAV utility demonstrations)
- Capture the benefits of partnerships developed with states, local agencies, share knowledge and resources
- Identify transportation needs for RS imaging or digital data communications, cost-effectively met by UAV's. Match UAV type to mission need, performance envelope and cost
- UAV's Competitive Edge? When, why and how can UAV's complement or replace competing (manned or near-ground sensor) data sources
- Market pull or technology push? Show when, where, which and how UAV's can be used for transportation and/or homeland security
- Identify barriers to UAV's near-term deployment
- Identify promising options to overcome barriers: synergy with other efforts (NASA ERAST Alliance, Access 5, TAAC, AUVSI, UAV Forum)
- Develop UAV roadmap for near-term transportation users

REMOTE SENSING APPLICATIONS TO TRANSPORTATION SECURITY

- RS imagery for geospatial information for:
  - Inventory and simulations of regional infrastructure systems
  - Scenario planning and analysis
  - Contingency planning
  - Disaster visualization and monitoring
  - Emergency response management
- Tailor choice of remote platforms and sensors to need (UAV/MAV, helicopters, aircraft, tethered balloons, satellites)
- Recognize limitations:
  - Obfuscation (smoke, dust, night, weather, debris plumes)
  - Ground swath, spatial, spectral, temporal resolution
  - Intermittency ( revisit time, deploy on demand)
  - Cost, availability, reliability, user-friendly?
UPSIDE OF UAV PLATFORM

- Commercially available, now proven for multiple military and civilian applications
- Many commercial providers, wide range of cost, attributes
- Flexibility in mission profile, tasking, long dwell time
- Ability to operate in hostile, toxic environments
- UAV's have a niche performing dull, dirty and dangerous missions
- UAV's niche market to assess, manage and reduce natural and terrorism disaster losses:
  - Quick response time
  - Imagery
  - In-situ measurements
  - Emergency communications relay platform

DOT MODAL MISSIONS IN TRANSPORTATION SECURITY

- FAA (with DHS/TSAS): Safety certification of design for airports, aircraft, airway facilities, NAS C3
- FHWA: Maintains strategic highway network (STRANET, 61,000 mi) and connectors (1,700 mi) to military bases, ports and airports for defense and emergency mobility; border crossings and NAFTA priority freight corridors
- FMCSA: Documents and clears foreign motor carriers for freight (HAZMAT)
- FRA: Rail system security program, shared use track and row (passenger and freight trains)
- FTA: Transit security and emergency preparedness, lead for bio/chem terrorism
- RSPA: Office of emergency transportation (OET) CMC (24/7), Office of pipeline safety (OPS), hazardous materials (HAZMAT), civil reserve air fleet (CRAF) mobilization
- MARAD: Ready reserve fleet mobilization (RRF), Work W. DHS/CG and US Navy on port security grants and upgrades

HOT 2002 STRATEGIC PLAN:

HOMELAND AND NATIONAL SECURITY OBJECTIVE

- "Ensure the security of the transportation system for the movement of people and goods, and support the national security strategy:
  - Reduce the vulnerability of the transportation system and its users to crime and terrorism.
  - Increase the capability of the transportation system to meet national defense needs.
  - In cooperation with the new Department of Homeland Security (DHS), ensure that the nation's transportation system is able to function effectively while under attack or after natural disasters strike.
  - Make essential contributions to the defense department's strategic mobility through management and operation of the nation's strategic sealift reserve - the ready reserve force."
TRANSPORTATION AND HOMELAND SECURITY: WHERE, WHEN, HOW CAN UAV’S HELP?

- Heightened awareness of vulnerability of infrastructure, operations and communications
- Urgency to prioritize needs and protect most critical facilities and nodes; emergency response preparedness
- Improved interagency coordination: federal, state, local and first responders
- Limited knowledge and resources—need for public-private partnerships (P3) to cost-share
- But: Federalization of security, restrictions on information access (including GIS and RS databases).
- DOT and DHS (TSA, USCG, TSWG) invite new ideas, promising technologies, cost-effective solutions
- Can UAV’s be rapidly deployed on-demand for transportation and other homeland security needs?

UAV REMOTE SENSING TECHNOLOGIES AND PRODUCTS FOR TRANSPORTATION SECURITY

- Stand-alone, or as complement to ‘ground truth’ information on hotspot (IR, chemical or nuclear signature)
- Provides baseline (normal) transportation infrastructure locations, conditions and operations from RS surveillance and monitoring
- Allows modeling “what if” scenarios of attack delivery and location, damage and response evacuation plans
- Must detect, recognize event signature for damage assessment and recovery planning
- Non-intrusive source of synoptic, contextual information on damage footprint, propagation
- Tailor to need types of UAV platform and sensors (helicopters or other rotorcraft, aircraft, gliders, balloons, satellites)

SURVEILLANCE: HIGHWAYS, PORTS AND CARGO TERMINALS

Route 1 Pacific Coast
Port of Galveston, Texas
WHY USE UAV AIRBORNE SENSORS?

- READELY AVAILABLE TECHNOLOGY - OVER 200 COMMERCIAL VENDORS
- ABILITY TO OPERATE IN HOSTILE ENVIRONMENTS FOR D3 (DIRTY, DULL OR DANGEROUS) MISSIONS
- CAN DEPLOY ON DEMAND
- FLEXIBILITY IN TASKING: SURVEILLANCE OR DISASTERS, ETC.
- PLUG AND PLAY PAYLOAD (TAILORED SENSORS) POSSIBLE
- HIGH-RESOLUTION VIDEO OR DIGITAL IMAGERY AND SENSORS
- REQUIRES REMOTE CONTROL, TRACKING AND TELEMETRY LINKS
- LARGE AREA COVERAGE
- WAYPOINT TRACKING: PROGRAMMED LINEAR OR AREAL SCANS
- REMOTE AREA COVERAGE (E.G., ALASKA PIPELINE, DESERTS)
NASA UAV RDT&E OPPORTUNITIES

- NASA DRYDEN FLIGHT RES, CTR.- UAV BUSINESS UNIT:
  - ERAST PROGRAM MGT, EDWARDS AFB RESTRICTED AIRSPACE
  - TEST-RANGE, TRACKING, TELEMETRY, COMMUNICATIONS, FIXED OR MOBILE DATA TRANSMISSION AND DISPLAY, MISSION CONTROL CENTERS, UAV R&T PLATFORMS (HELIOS, PATHFINDER PLUS, ALTAIR, PROTEUS)
  - LEAD ON ACCESS 5 PARTNERSHIP WITH FAA, DOD, INDUSTRY FOR NAS INTEGRATION OF HALE UAV'S

- NASA AMES- UAV APPLICATIONS CENTER:
  - COLLABORATIVE R&D FOR SCIENTIFIC AND COMMERCIAL UTILIZATION OF UAVS AS HIGH-RESOLUTION IMAGING PLATFORMS IN NATIONAL AIRSPACE, FIRES, DISASTER ASST., COFFEE AND VINEYARDS, ETC.
  - NASA/GODDARD-WALLOPS FLIGHT FACILITY (WFF):
    - SMALL UAV (EXORONE, AEROSONDE) MISSION REGS., PERFORMANCE ENVELOPE, VIBRATION CHARACTERISTICS
    - PAYLOADS TESTING FOR EARTH SCIENCE RES. & APPLICATIONS

UAV CATEGORIES BY RADIUS, ALTITUDE, ENDURANCE

- Higher Altitude Program
  - Short Range
  - Medium Altitude
  - Higher Altitude
  - Long Range
  - Global Area

- Low Cost UAVs
  - Vertical Takeoff and Landing UAVs
    - Shadow 200
    - Shadow 600
    - Chiron
    - AV Pointer Micro Blimp
    - Trunk
    - SASS Lite Blimp
    - Syscom
    - Javelin
    - Heron
    - Hunter
    - Pelican
    - Transtar
    - Outrider
    - Perseus B
    - Thesues
    - Flash
    - Helios
    - HIT
    - Aerobot (FS-24)
    - Aerosonde
    - Cyber
    - NAV

NASA/GSFC/WFF UAV CATEGORIES
### UAV Types, Sizes, Payloads, Altitude, Range

<table>
<thead>
<tr>
<th>UAV Name</th>
<th>Endurance</th>
<th>Payload Weight</th>
<th>Altitude</th>
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<tbody>
<tr>
<td>Aerosonde</td>
<td>40 hrs.</td>
<td>2.2 lbs.</td>
<td>20,000 ft.</td>
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<tr>
<td>Altius2</td>
<td>24 hrs.</td>
<td>330 lbs.</td>
<td>65,000 ft.</td>
</tr>
<tr>
<td>BQM-34</td>
<td>1.25 hrs.</td>
<td>470 lbs.</td>
<td>60,000 ft.</td>
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<tr>
<td>Exdrone</td>
<td>2.5 hr.</td>
<td>25 lbs.</td>
<td>10,000 ft.</td>
</tr>
<tr>
<td>Global Hawk</td>
<td>42 hrs.</td>
<td>1,960 lbs.</td>
<td>65,000 ft.</td>
</tr>
<tr>
<td>Gnat 750</td>
<td>48 hrs.</td>
<td>140 lbs.</td>
<td>25,000 ft.</td>
</tr>
<tr>
<td>Pioneer</td>
<td>5.5 hrs.</td>
<td>75 lbs.</td>
<td>12,000 ft.</td>
</tr>
<tr>
<td>Shadow 200</td>
<td>4 hrs.</td>
<td>50 lbs.</td>
<td>15,000 ft.</td>
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### UAV’s Performance Range

- Horizontal TO/L (HTOL)
- HC Fuel
- VSTOL
- HC Fuel
- VSTOL (including solar propulsion)

### SMALL UAV’s

- I-Star
- Aerolight
- Exdrone
- Micro Craft
- Dragon Eye
- Pointer
FAA AIRCRAFT AND PILOT SAFETY CERTIFICATION REQUIREMENTS

- AIRWORTHINESS, CERTIFICATION BY TYPE-LONG AND COMPLEX
  [www.faa.gov/avr/avr.air/air200/200home.htm]
- FAA NATIONAL AIR SPACE (NAS) RESPONSIBILITIES: AIR TRAFFIC PLANNING (AP), AIR TRAFFIC OPERATIONS (ATO), FLIGHT STANDARDS SERVICE (AFS), REGULATIONS AND CERTIFICATION (JAR) PRODUCTION AND AIRWORTHINESS DIV (AR), FLIGHT STANDARDS (AFS, AEG), REGIONAL OFFICES- ALL INVOLVED
- "EQUIVALENT SAFETY" REQUIRED FOR REMOTELY CONTROLLED AIRCRAFT (ROA), E.G. "DETECT, SEE AND AVOID (DSA) CAPABILITY"
- FAA "CERTIFIED" ABOUT 20 HALE UAVS TO DATE: GLOBAL HAWK, PREDATOR, HELIOS UNDER "FAA CERTIFICATE OR WAIVER OF AUTHORIZATION" (MAY 1, 2001, WP REGION AIR TRAFFIC DIV.)
- EXPERIMENTAL AIRCRAFT CERTIFICATE - FAA FORM 8130-7, SPECIAL AIRWORTHINESS CERTIFICATE
- GROUPS I-IV AIRCRAFT (AIRCRAFT CONFIGURATION)
- AIRSPACE CLASSES C,D,E,G, FLIGHT TEST AREAS AND CORRIDORS, RESTRICTED AIRSPACE?

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Cambridge, MA

INNOVATION TECHNOLOGY
GLOBAL STRATEGIC

UAV'S BARRIERS AND CHALLENGES

- NATIONAL AIRSPACE SYSTEM (NAS) OPERATIONS REGULATIONS: "FILE AND FLY" IS GOAL, MAY TAKE 6 YRS FOR HALE UAV'S
- CERTIFICATION REQUIREMENTS NEEDED, BY TYPE, FOR:
  - RELIABILITY
  - SURVIVABILITY
  - AUTONOMY
  - FAIL-SAFE MODES (DETECT, SEE AND AVOID, COM-LINK LOSS)
- SUSTAINABILITY AND MAINTAINABILITY FOR SYSTEM
- ARCHITECTURE: AUTONOMOUS OR GROUND CONTROL?
- GROUND CREW TRAINING & CERTIFICATION (LIKE PILOTS?)
- REAL-TIME PROCESSING AND INFORMATION DISSEMINATION
- SECURITY CONCERNS FOR ROA'S (FRIEND OR FOE?)
- LIABILITY (WHO IS IN CHARGE, RISK ANALYSIS, MGT AND INSURANCE)
- ECONOMICS: SYSTEM AND LIFECYCLE COST FOR HARDWARE, SOFTWARE, DATA PRODUCTS, TRAINING AND CERTIFICATION OF GROUND CREW, ANALYSTS, ETC.

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INNOVATION TECHNOLOGY
GLOBAL STRATEGIC

BARRIERS TO AND SOLUTIONS FOR NEAR TERM UAV DEPLOYMENT (EXAMPLES)

- REGULATORY: DEVELOP FAA 14CFRXXX REGULATION AND CERTIFICATION FOR ROA'S - COMPLEX LONG, COSTLY AND UNCERTAIN (INTERIM BY WAIVER, OR CLASS ANALOGY)
- SECURITY: WHO CONTROLS OR AUTHORIZES FLIGHT PLAN? UAV COULD BE A THREAT; IS TECHNOLOGY CONTROLLED?
- SAFETY: HAZARDS TO OTHER AIRCRAFT, GROUND VEHICLES, PEOPLE AND FACILITIES
- LIABILITY: MANUFACTURER? OWNER? OPERATOR?
- PRIVACY FROM SURVEILLANCE
- MARKET & ECONOMIC: PUBLIC? PRIVATE? P3?
- USE UNREGULATED UAV'S (UUV): SMALL (< 500 LBS), LOW-ALTITUDE, LOW COST, MICRO AND MINI UAV (MAV), BUT LIMITED PAYLOAD AND RANGE, ONLY CLASS G AIRSPACE
- SECURE, ENCRYPTED COM-LINK, REQUIRE IFF TRANSPONDER (BUT NO SPECTRUM ASSIGNED FOR UAV'S)
- PREVENT ACCIDENTS FOR ALL FAILURE SCENARIOS
- COMMERCIAL OR SELF-INSURANCE
- PUBLIC, LAW ENFORCEMENT SUPPORT
- PUBLICIZE BENEFITS TO PUBLIC (SECURITY, SAFETY), S&T PAYOFFS

PUBLIC USE BENEFITS TO PUBLIC (SECURITY, SAFETY), S&T PAYOFFS