Barriers to UAV Deployment for Diverse Applications

DOT/NASA Program on Transportation Applications of Remote Sensing and Spatial Information

National Consortium on Remote Sensing in Transportation

Unmanned Aerial Vehicles
New Frontiers in Fire Research and Applications

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Highlight NASA UAV Technology Developments

- UAVs - Landscape
- First Response Experiment (FiRE)
- Looking to the future

NASA's Vision

- To improve life here
- To extend life to there
- To find life beyond

NASA's Mission

- To understand and protect our home planet
- To explore the Universe and search for life
- To inspire the next generation of explorers

…as only NASA can.

Why UAVs ?

UAVs are an emerging and innovative Aerospace industry in the US

UAVs have a niche performing *Dull, Dirty and Dangerous* missions

Long duration, long distance capabilities

UAVs can assist emergency response

- **Real-time and near real-time remote sensing**
- **In-situ Measurements of air masses**
- **Communications Relay**

UAVs have great potential as science and applications platforms

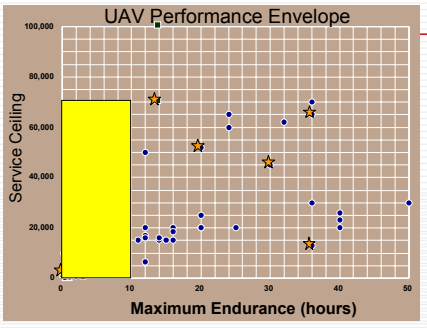
Measurements beyond current piloted platform capabilities

- Altitudes above U-2
- Durations beyond DC-8
- Locations dangerous to pilots

Low cost atmospheric satellites

- Timely insertion of new sensor technology
- Inexpensive flight costs
- Sensor repair feasible
- Inexpensive cycle of new sensor technology
- Science timeframes compatible with emerging graduate students

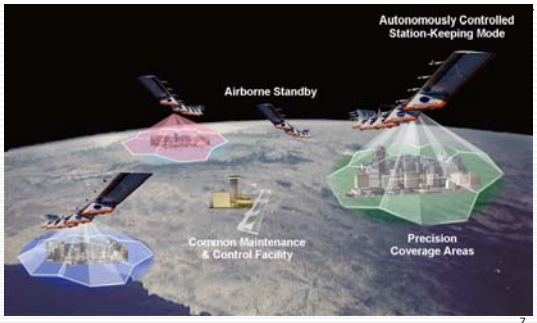
UAVs Today



UAVs can make observations beyond the reach of manned aircraft

Commercial Telecom Applications

✓Fixed & Mobile Broadband ✓Direct Broadcast ✓Fixed & Mobile Voice



Compatible With Emergency Communications Systems

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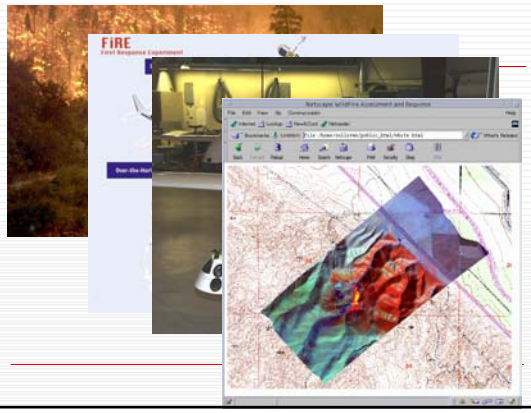
FiRE Demonstration



ALTUS II PLATFORM

ALTUS Specifications:

Wing Span: 55.3 ft.; Length: 23.6 ft.; Height: 9.8 ft.

Weights: Max GTOW: 2150 lb; Payload: 330 lb

Navigation: Litton LN-100G INS/P-Code GPS

Avionics: C-Band Line-Of-Sight RF; adaptable for OTH Operations; Remote Operations or autonomous

Performance:

Max Altitude: 65,000 Feet

Endurance: 8 Hours @ 60K ft.
18 Hours @ 30K ft.
24 Hours @ 25K ft.

Max Speed: 100 KIAS

Cruise / Loiter Speed: 65 KIAS

Range: ~1500 Mi. at 25K ft.

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AIRDAS

The Airborne Infrared Disaster Assessment System

System Composition
Power Requirements: 28V DC @20 amps
Weight, Head: 80 pounds
Rack: 190 pounds
Total: 270 pounds
Scanner Port Size: 8in. x 14in.
System Composition: Pentium I 233 Mz System
Non-linear Detector Amps
16-bit Digitizer
Dichroic filters
Trimble TN2000 GPS
2-axis gyro stabilizer
Removable Hard Drive
Real-Time Video Monitor

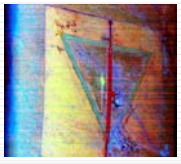
AIRDAS Channel Wavelength mm
1 0.64 - 0.71
2 1.57 - 1.70
3 3.75 - 4.05
4 5.50 - 13.0
*Channels 3 & 4 are filterable
Sensor/Aircraft Parameters:
FOV: 108 degrees
IFOV: 2.62 milliradians
Scan Rate: 5 - 23 scans/second
Digitized Swath Width: 720 pixels
Spatial Resolution: 26 ft. at 10,000 feet

Email: vambrosia@mail.arc.nasa.gov **or**
jbrass@mail.arc.nasa.gov
AIRDAS information can be viewed at:
http://geo.arc.nasa.gov/sge/

FiRE Demo Controlled Burn

ALTUS II takeoff – 6 Sept. 2001

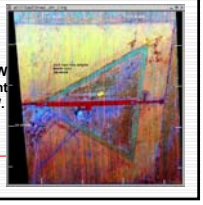
Geo-Rectification



"Raw", un-rectified 3-band color composite image telemetered from ALTUS

Terra-Mar's Data Acquisition Control System (DACS) software uses navigation geometry data to project each pixel to ground location and adjust for terrain (if a DEM is employed in the modeling). Geo-rectification took approximately 6-7 minutes.

Geo-rectified data and TFW processed in ~10 min., sent to, and accessed at WWW.



FiRE Altair Science Demonstration Missions

The ALTUS Cumulus Electrification Study (ACES) Campaign Summary & Highlights

- Demonstrated the utility and promise of UAVs for investigating weather
- Demonstrated the real-time monitoring and control of UAV science payload
- Obtained data to
  - Investigate lightning relationships and storm morphology
  - Provide critical TRMM Lightning Imaging Sensor validation
  - Study storm electrical budgets
  - Benefit science relevant to NASA Earth Science themes
  - Develop lesson plans for students
- 13 Flights
  - 2 Functional checkout flights (2 hours)
  - 11 Science flights (35.8 hours)
- ~ 115 storm overpasses
- 20 Gigabytes science and weather datasets acquired (not including weather briefing or flight videos)
- Web page activity
  - Real time project management and information exchange
  - Public access and information dissemination
- Public outreach
  - Excellent and positive public relations achieved
  - More than 30 interviews, resulting in numerous articles, TV, radio stories, and NASA news releases

QuickTime™ and a Microsoft Video 1 decompressor are needed to see this picture.

Coffee Harvest Optimization

- A solar-powered UAV successfully completed a NASA remote-sensing applications demonstration, flying more than four hours over Hawaii's largest coffee plantation on the island of Kauai, taking digital images to make a "clear-sky" mosaic.
- The NASA team combined pre-planned, fixed flight lines with spontaneous, remotely controlled maneuvers to guide the UAV into cloud-free areas over the coffee fields. Despite an often 80 percent cloud cover, the project demonstrated how a solar-powered UAV, equipped with a ground-controlled aerial-imaging system, could aid coffee growers by informing them of the ripest fields for daily harvest.
- The mission was conducted in national airspace, and the UAV was treated like any conventionally piloted plane by air traffic controllers in Honolulu
- More than 300 high resolution images were transmitted wirelessly
- For part of the mission, an undergraduate student, 2,500 miles away at California State University, Monterey Bay, Calif.
- During the NASA demonstration, the Pathfinder-Plus was based at the U.S. Navy's Pacific Missile Range Facility at Barking Sands on Kauai. AeroVironment, Inc

Pathfinder Solar Powered UAV

QuickTime™ and a Video decompressor are needed to see this picture.

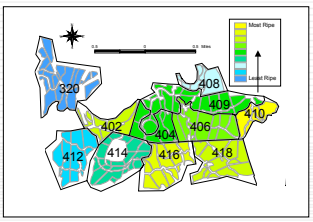
Ripening coffee cherries

UAV Coffee Project (Clark University)

Field ripeness ranking: high priority section

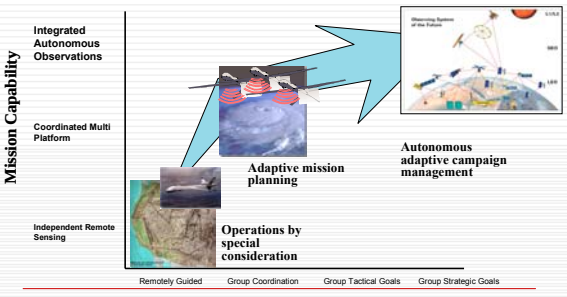
UAV Pathfinder-Plus flight (30Sep02)

Rank	Field	Ripeness index
1	410	113
2	416	112
3	402	104
4	418	104
5	406	102
6	404	99
7	409	99
8	414	94
9	408	89
10	412	75
11	320	64



UAV Science Demonstrations

Enhancing Science Capability through Autonomy



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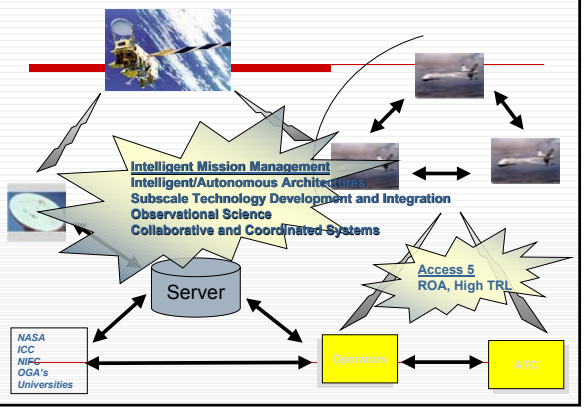
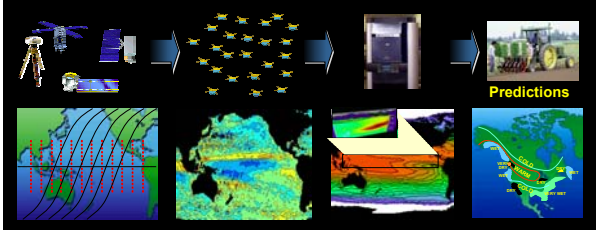
Intelligent Mission Management Model



Approach to Knowledge Development

Challenge: Integrate massive amounts of data with computationally demanding scientific models and produce products for research and decision support

Advanced Sensors	Data Processing & Analysis	Information Synthesis	Access to Knowledge
Multi-platform, multi-parameter, high spatial and temporal resolution, remote & in-situ sensing	Calibration, Transformation To Characterized Geophysical Parameters	Interaction Between Modeling/Forecasting and Observation Systems	Interactive Dissemination



Fire Management Decision Support Systems

Models
Weather
Fuel condition
Fire progression

Data
MODIS
ASTER
Real-time Airborne products

Fire DSS

-Real-time GIS fire imagery

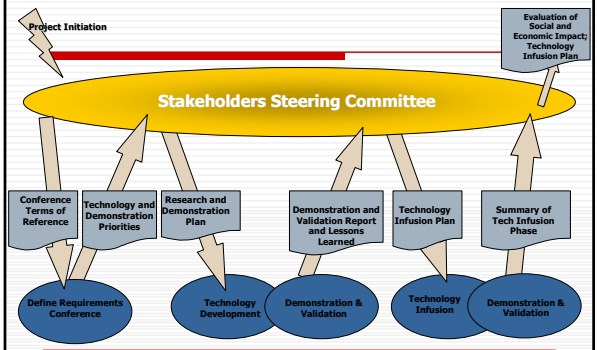
-Higher resolution fire models

-More efficient ground asset management (crew, engines, etc.)

-Better tasking of tankers and manned reconnaissance

-Protection of citizens in urban-wildland interface

UAV Applications Partnering Approach



Enabling Commercial UAV Applications

New customer investment needs improvements in system reliability, stable regulatory framework, and competitive cost environment

- Systems reliability (improving)
- National Airspace System integration (new rules in development)
- Operations cost (economies of scale expected with usage)

UAV Applications Center

www.uav-applications.org

NASA Partnership
(Contributions and Benefits)

Resource for new technology development, testing and commercialization (NASA Research Park)

UAV Coffee Project Outreach

Commercial Outreach
- identify potential commercial partners
- payload systems development
- new UAV commercial demonstrations
- promote UAV Applications Center

Public Outreach
- symposia & guest lectures
- web page development
- media coverage
- trade journals &scientific journals

Educational Outreach
- stimulate graduate student interest in UAV technology and applications
- student involvement in directed research
- film department student editing of acquired documentary footage

UAV Applications Incubator

(Promote expanded civil UAV user-base)

Extend Technology Readiness and Transfer
- •Value-added Processing
  - •Decision Support Tools
- •Mission Planning
- •Platforms
- •Sensors
- •Real-time communications
  - •Virtual Presence
- •Flight Operations

to Promising Self Sustaining Applications
- •Wildfire Management
- •Disaster Management
- •Pipeline Security
- •Homeland Security
- •Code Y Science Mission Support
- •TV News

New technology tools for
- •Unmanned Aerial Vehicles
- •Remote Sensing Systems
- •Real-time processing
- •Mission Planning

Innovative observational capabilities
- •Earth Science Research and Applications
- •Commercial Remote Sensing applications
- •Homeland Security
- •Next generation scientists and engineers

Extending TRLs enabling commercial support of NASA priorities

UAV Applications Center

Systems Engineering Capabilities

Benchmarking UAV Applications
- **Defining mission requirements**
- **Flight planning and airspace management**
- **Sensor development and testing**
- **Establishing formal contracts with UAV and Range Providers**
- **Managing cost and scheduling**
- **Implementing payload integration and network centric telemetry**
- **Defining risk mitigation strategies**
- **Conducting aircraft and payload safety reviews**
- **Deployment planning and implementation**
- **Organizing ground-based site logistics**
- **Finalizing operational procedures and checklists**
- **Optimizing flight rules for mission success**

Summary

UAVs - New Frontiers

- UAVs are emerging as capable remote sensing platforms
- New sensor, platform and information technologies are evolving to support first responders

Contact Information

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LYNX™ SYNTHETIC APERTURE RADAR (SAR)

RIO GRANDE VALLEY
Resolution = 12 in. (0.3 m)

- Available now as a commercial off-the-shelf (COTS) sensor
- Designed for use in medium-altitude UAVs and manned platforms
- State-of-the-art technology at Ku-band frequency
- Operating modes: stripmap, spotlight, ground moving target indicator
- Innovative ZoomSAR: 0.3 to 3.0 m in stripmap mode; 0.1 to 3.0 m in spotlight mode
- Real-time video and digital displays
- Coherent change detection
- Image formation on board
- Weight: 115 lbs (52 kg)

GENERAL ATOMICS
AND AFFILIATED COMPANIES