

# Update on Piloted and Un-Piloted Aircraft at NASA Dryden



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(NASA-NICT Joint Workshop on HALE UAV and Wireless Systems)  
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Palmdale, CA



# Agenda

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- Dryden
- HAP Potential
- Gulfstream II
  - UAV SAR
  - Precision Trajectory Capability
- Global Hawk (ACTD)
- ER-2
- Ikhana (Predator B)





**Palmdale &  
Lancaster**

**Dryden Flight  
Research Center**

# **Satellite View of the Antelope Valley And Los Angeles Areas**



# Unmatched Environment for Experimental Flight Test

- ✓ Premier Edwards AFB Range
- ✓ Linked to Vast Western Range
- ✓ 350 Test Days/Year
- ✓ Unmatched Experimental Test Range

Dryden Flight  
Research Center









# Summary of Capabilities

## Core Competencies

- Atmospheric Flight Research and Test
  - Flight Safety and Risk Management
  - Flight Project and Mission Management
  - Flight Research Technology
  - Flight Test Operations
  - Experimental Aircraft - piloted and unpiloted

## Facility Capability

- Flight Operations & Engineering Staff
- Experimental and Testbed Aircraft
- Unmanned Aircraft Systems
  - Extensive experience in securing Certificates of Authorization (COA) for UAS flights
  - Extensive UAS flights conducted in National Air Space (NAS) without a chase
- Airborne Science Platforms
- Range and Aircraft Test Facilities
  - Western Aeronautical Test Range
  - Research Aircraft Integration Facility
  - Flight Loads Laboratory

## On-Going Partnerships

- Other NASA Centers: ARC, GRC, LaRC, JSC, KSC, MSFC
- DoD Partnerships: AFFTC Alliance, USN, AFRL, DARPA
- Other Government Agencies: DOT, NOAA, DHS, ...



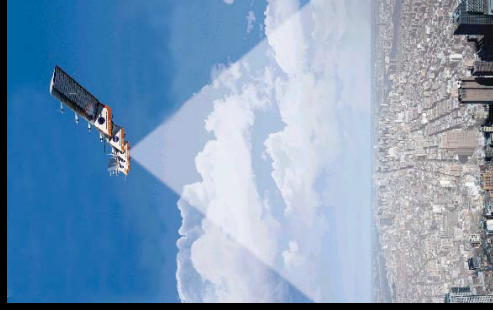
**FY07 Staffing:**  
Civil Servant Staff ~ 515  
On-site Contractors ~ 600

# HAP Potential

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## Commercial



Global high quality communications that truly connect the world

## Science & Weather Forecasting



In-situ real-time global atmospheric information 24/7 sharply reducing uncertainties in atmospheric and weather models & forecasting

## Resource Management



World-wide low-cost coverage of agriculture, water resources, forests, etc.

## Surveillance & Disaster Monitoring



Reliable, low cost, flexible surveillance and communications platform



# HAP Capabilities at NASA



ER-2



Altair/Ikhana (Predator B)



Global Hawk (ACTD)



Gulfstream III



# Gulfstream III



## Capabilities

- Endurance: 5 - 7 hours
- Ceiling altitude: ~ 45,000 ft (~ 14km)
- Payload: ~ 2,000 lbs with full fuel load (~ 1,400 kg)
- Range: ~ 3,400 Nautical Miles (~ 6,300 km)
- Top Speed: 0.82M without pod
- Electric Power Types: 28VDC, 115AC/60Hz, 400Hz Single Phase, and 400Hz 3-Phase

## Background & Status

- Serving NASA approximately 2 years.

## Missions

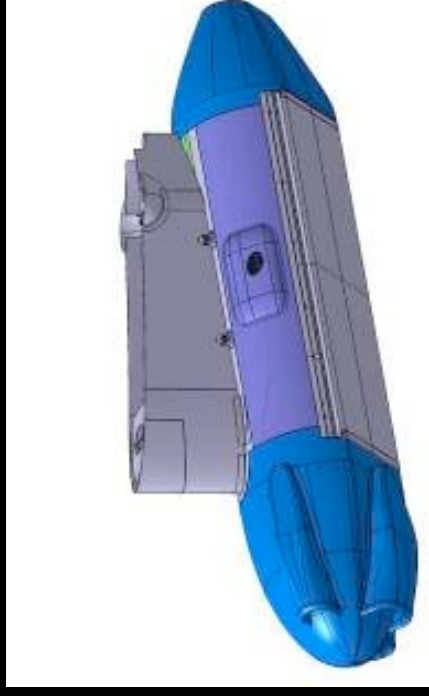
- Currently being outfitted to carry the UAV SAR (synthetic aperture radar).
- The G-3 is a development platform for the UAV-SAR payload. The payload may some day transition to a UAV.

## Versatility

- Uses standard racks for instrumentation.
- Structurally modified to carry external pod.
- Offers shirt sleeve environment for experimenters.
- Versatile instrumentation system.
- Precision flight path capability (+/- 5m laterally and vertically.

# UAVSAR Overview

- Mission Objective
  - Perform airborne repeat pass radar
  - Interferometrically map rapidly deforming surfaces.
- Organization
  - Mission Lead: Jet Propulsion Laboratory
  - Collaboration with Dryden Flight Research Center
- Instrument:
  - L-Band Synthetic Aperture Radar
- Description
  - 24 element Array
  - Pod mounted instrument
  - Capable of being flown on Gulfstream GIII or UAV
  - Fully polarimetric at L-Band (1.2 GHz)
  - Steerable electronically scanned array antenna
  - < 10 m tube flight path using real-time GPS and modified autopilot
  - Autonomous radar operation in flight

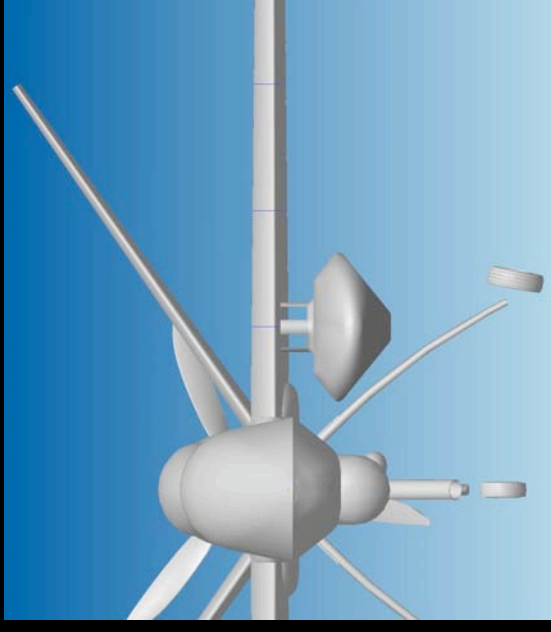




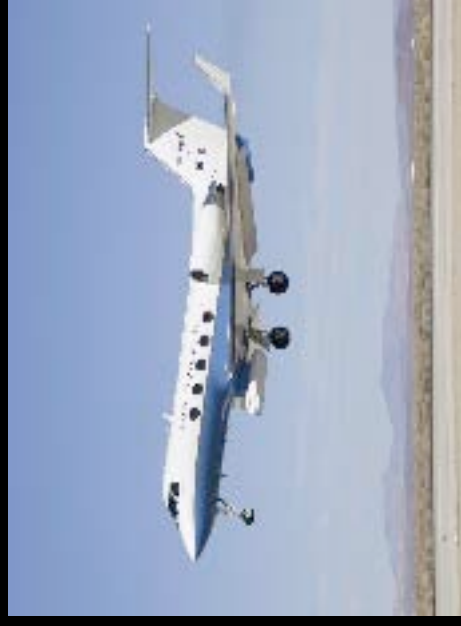


# Precision Trajectory Capability for Repeat Pass Interferometry

- Airborne Repeat Pass Interferometry Synthetic Aperture Radar (SAR) requires precision trajectory control ( $\pm 5\text{m}$ )
  - Measure the surface deformation of volcanoes, glaciers, earthquakes, and fault lines
- Utilizes Global Differential GPS requiring satellite link
- Sensor pod-mounted for later transition to HALE
- Flight on G-III UAV surrogate used to develop and demonstrate SAR and precision navigation/control
- UAV surrogate used due to:
  - Large flight hours expected,  $>100$  hrs of development/calibration
  - Ability to fly over areas of interest on short notice
- SAR, SAR-Pod, and aircraft modifications in-work
  - Demos in 2007



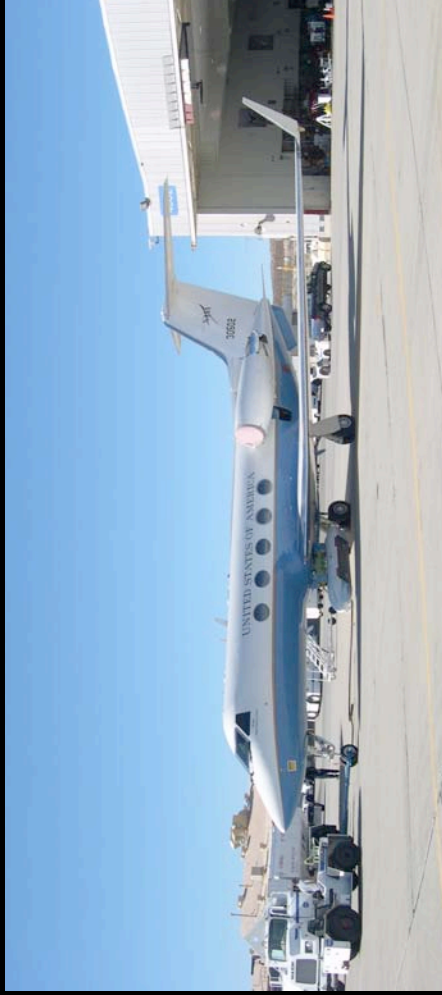
SAR Pod on Predator-B



G-III UAV Surrogate



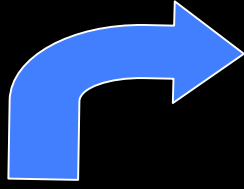
# UAV SAR Installation on G-III







# Global Hawk (ACTD) Overview



## **Background & Status**

- Original Global Hawk prototype aircraft built (#1 and #6).
- USAF is in the process of transferring the aircraft to NASA.
- The aircraft could be operational as soon as 2008.

## **Missions**

- Communications systems testing
- Earth Science
- Payload developments and testing
- In-situ measurements and collection
- Hurricane tracking

## **Capabilities**

- Endurance: > 30 hours
- Ceiling altitude: 65,000 ft (19.8 km)
- Payload: > 1,500 lbs (> 680 kg)
- Ku Satcom and/or Iridium for over the horizon missions



# Global Hawk Equipment Expected to be Transferred to NASA This Year

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AV-3 internal components.

5 sets of ground segment air vehicle command and control (C2) legacy equipment.

ACTD unique support equipment, spares, and documentation owned by USAF.

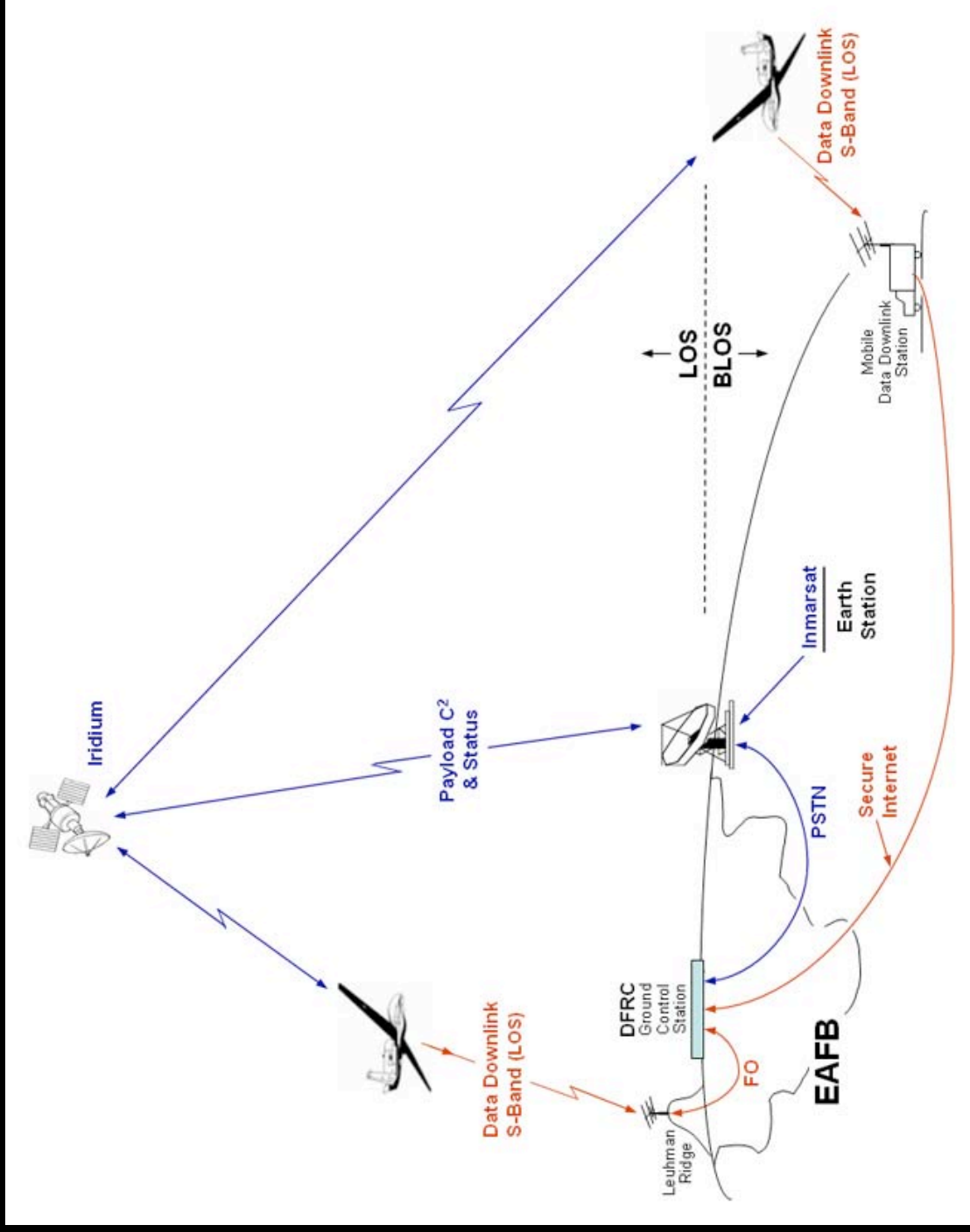
ACTD Software Integration Lab (SIL) assets owned by USAF.







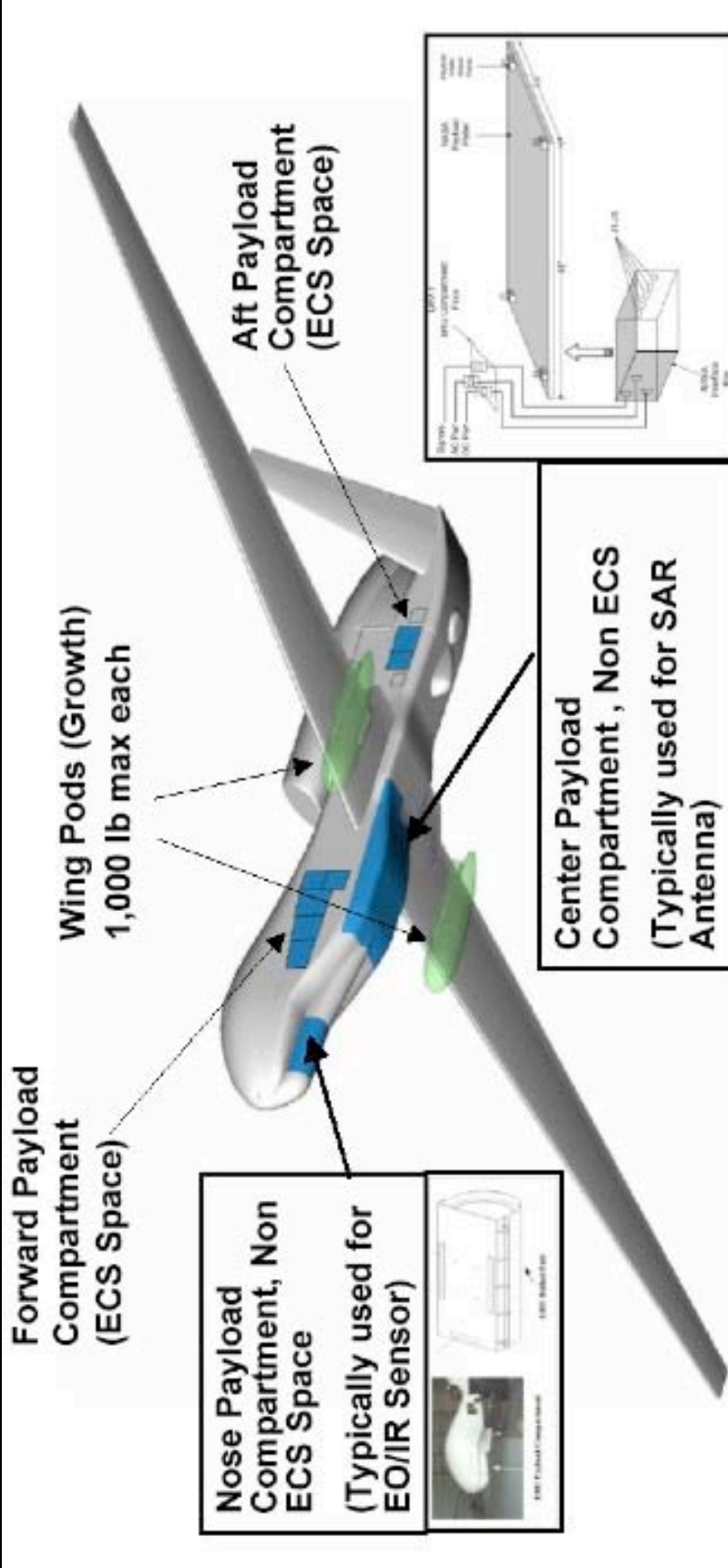
# Payload Communications Architecture (C2 & Status, and LOS Data Downlink)



The Payload C2 and Data Storage/Transmission System is independent of the Vehicle's C2 System



# Payload Capability



**2,000 lbs Payload – Closed Architecture –10 KVA power**

- 40 ft<sup>3</sup> Mission Payload Volume (ECS Space)
- 62 ft<sup>3</sup> Mission Payload Volume (Non ECS Space)



# ER-2 Overview



## **Background & Status**

- Two aircraft (806 and 809); variants of the military U-2 aircraft.
- Serving NASA since the early 70's.

## **Missions**

- Remote sensing
- Satellite calibration/validation
- In-situ measurements and atmospheric sampling
- Instrument demonstration, test and evaluation

## **Versatility**

- Multiple locations for payload instruments
- Pressurized and un-pressurized compartments
- Standardized cockpit control panel for activation and control of payload instruments.
- Iridium communications system

## **Capabilities**

- Endurance: > 8 hours
- Ceiling altitude: > 70,000 ft (21.3 km)
- Payload: 2,600 lbs (1,180 kg)
- Range: > 4,000 miles (> 6,400 km)

# Ikhana Project Overview



## **Background & Status**

- Ikhana is a Predator B.
- Ikhana has been delivered to NASA.
- Aircraft pilots/crew will complete training this year.

## **Missions**

- Earth Science
  - USFS Fire detection mapping in 07
  - UAV AVE satellite validation in 08
- Unmanned Aerial System technology testbed
  - Fiber-optic Wing Shape Sensing
  - Collision Avoidance

## **Ikhana Airborne Research Test System**

- 3 processor research flight control and/or mission computer
- Able to autonomously control the aircraft and some systems
- Able to host research control laws

## **Ikhana Capabilities**

- Endurance: 30 hours
- Ceiling altitude: > 40,000 ft (> 12 km)
- Payload: > 2,000 lbs (> 900 kg)
- Payload Pod: 750 lbs (340 kg)
- Ku satcom for over the horizon missions