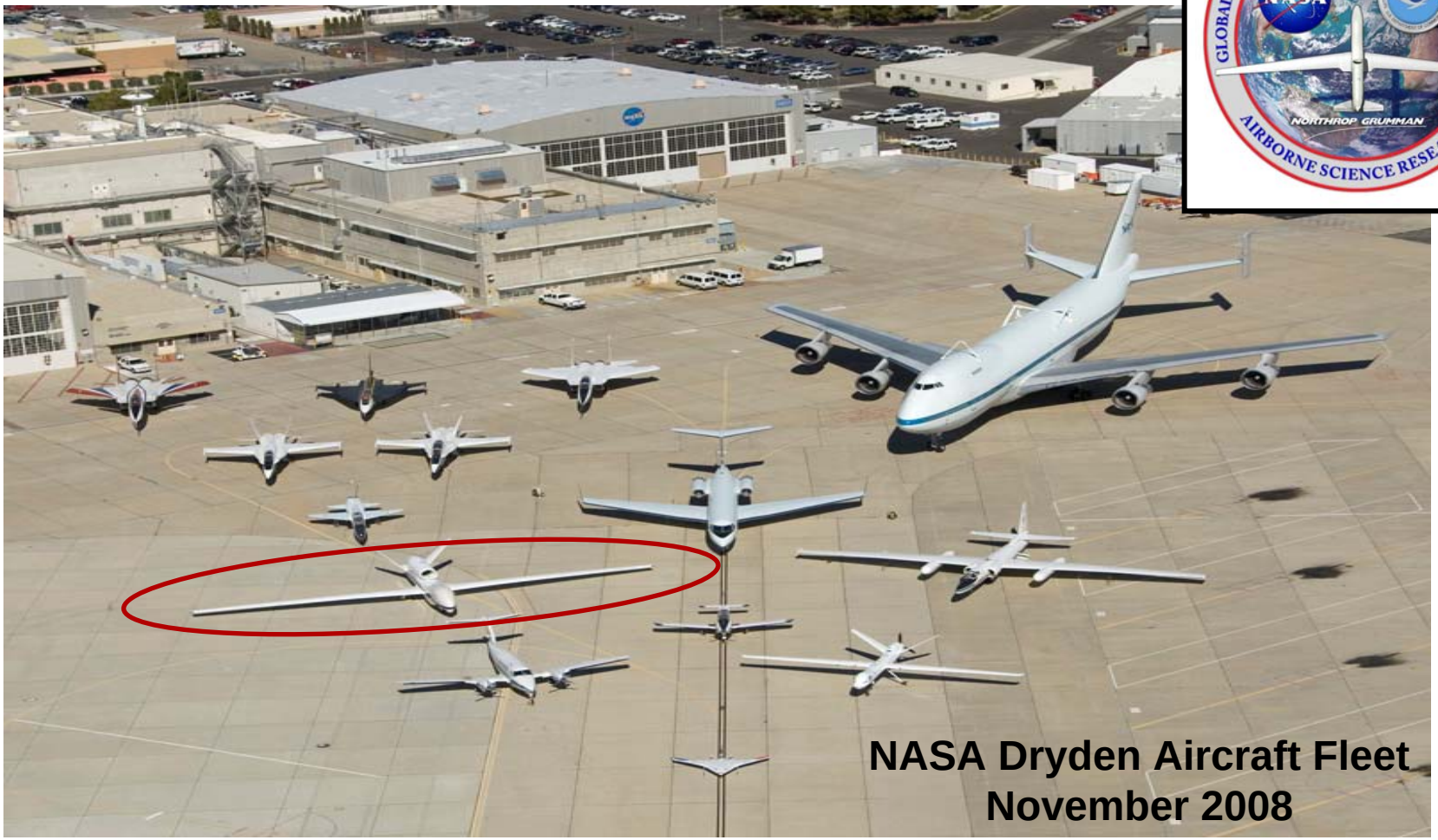
NASA Global Hawk
Project Description and Status

Dave Fratello, Payload Manager
Dee Porter, Pilot
7 April 2009

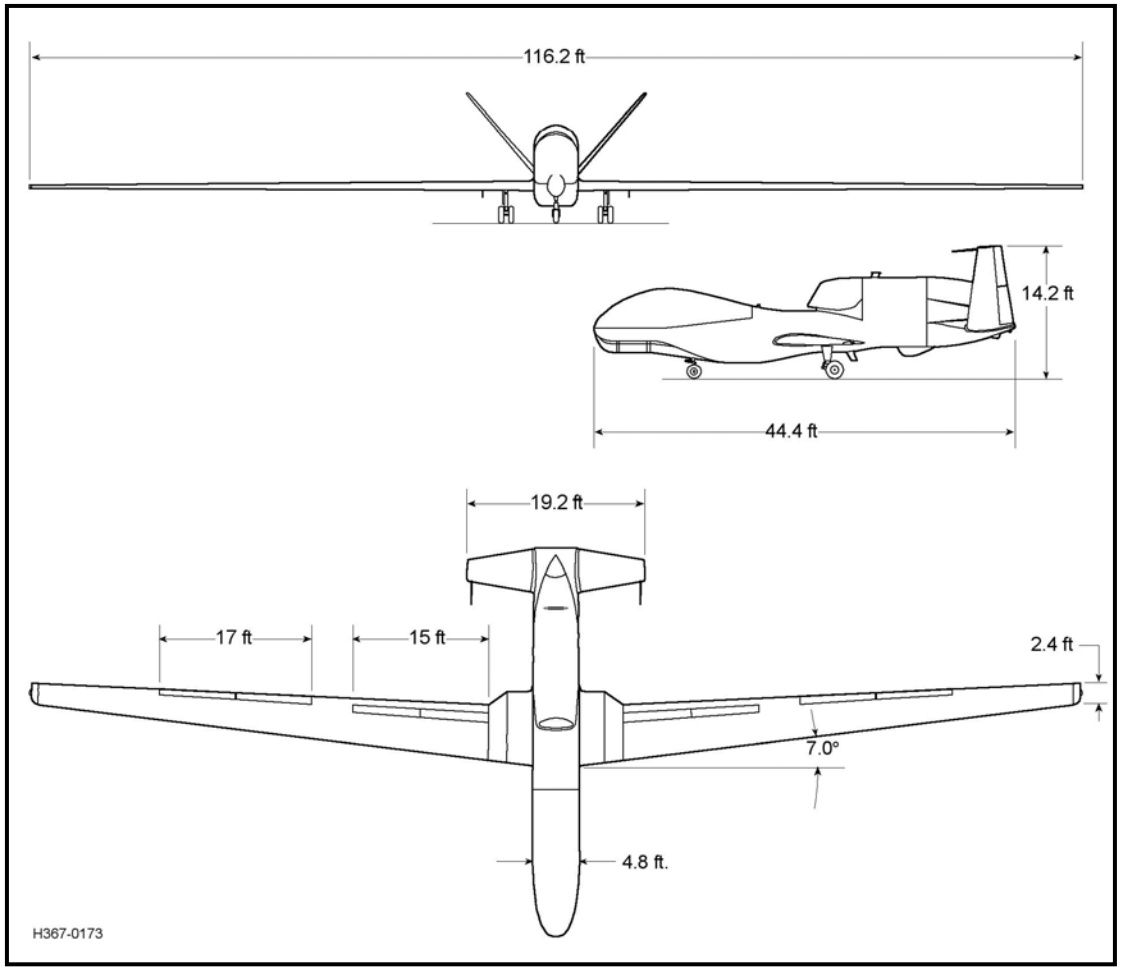


NASA Dryden Aircraft Fleet
November 2008

Topics

- **Status of the NASA GH Program**
  - **Progress Towards First Flight**
  - **Changes to the NASA G.H. for Science Flights**
  - **Payload System Overview**
    - New Infrastructure
    - Data and Payload C2 Communications
    - Payload Integration Options
    - Example of Capability – GloPac ‘09
- **Mission Capabilities**
  - Examples of Range and Loiter
  - Mission Turn-around Time
- **Capabilities in-work**
  - Sensors for Flight into Convection / Hurricanes
  - Remote LRE for East-coast Deployment

Global Hawk Characteristics

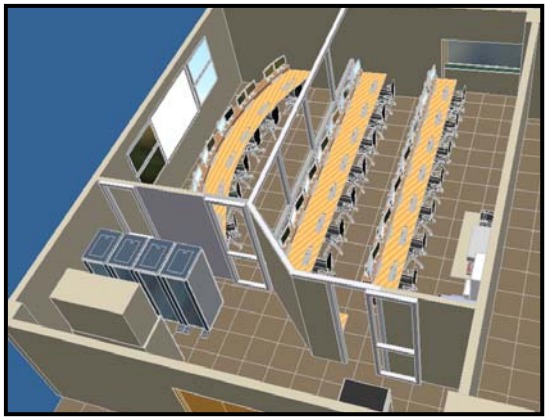


Range	>10,000 nmi
Endurance	>31.5 hours
Maximum Altitude	65,000 feet
Gross Weight	26,750 lbs
Fuel Capacity	15,300 lbs
True Airspeed	335 knots
Payload Weight	2000 lbs
Payload Power	10 kVA
Payload Volume	>100 ft3
Airfield requirement	8,000 x 150 feet
Engine	AE-3007H
Fuel	JP-8
AV-1	<600 flight hours
AV-6	<200 flight hours
Autonomous all phases of flight	

Progress Toward First Flight

- **Partnerships Established:**
  - NGC - five-year Partnership Agreement
  - NOAA - three-year Science Partnership

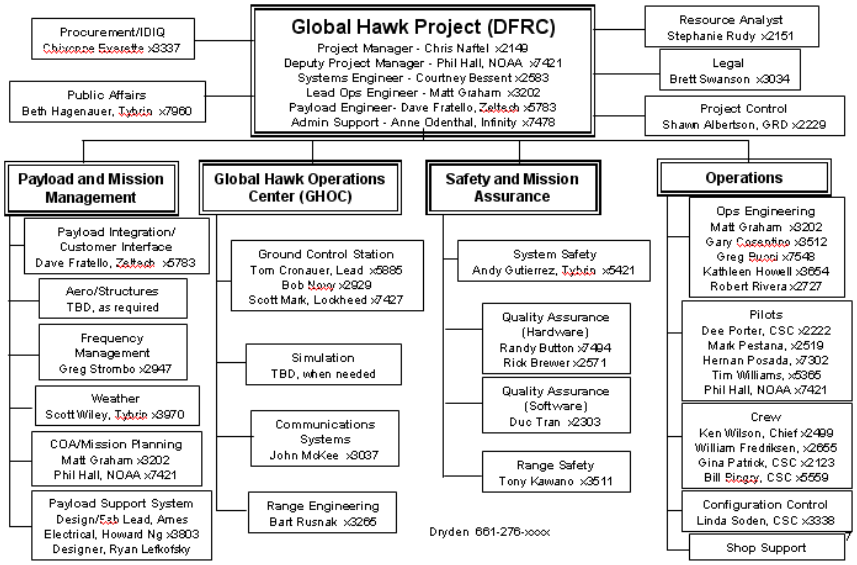
- **Aircraft Being Prepared for Flight**
  - 2 operational aircraft.
  - Working with USAF to obtain 3rd aircraft (AV-7).

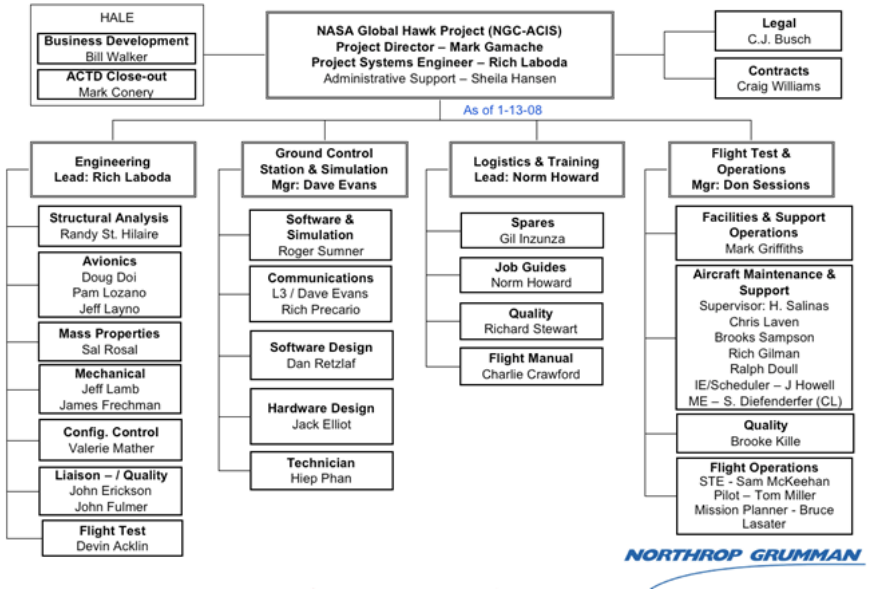


- **AV-6 Flight Team Briefing FRR this Week**
  - First Flight in May
  - Three test flights scheduled, then GloPac Prep.

- **Progress with FAA on UAS COA Process**
  - 90% complete for GloPac Missions to Pacific
  - Will begin GRIP COA planning 6-months before mission

NASA / NGC Joint G.H. Team





AV-6 High Power Engine Run

AV-6 500-hr Phase Inspection

Dryden Building 4800 Complex

NASA's Changes to G.H. for Enhanced Airborne Science Capability

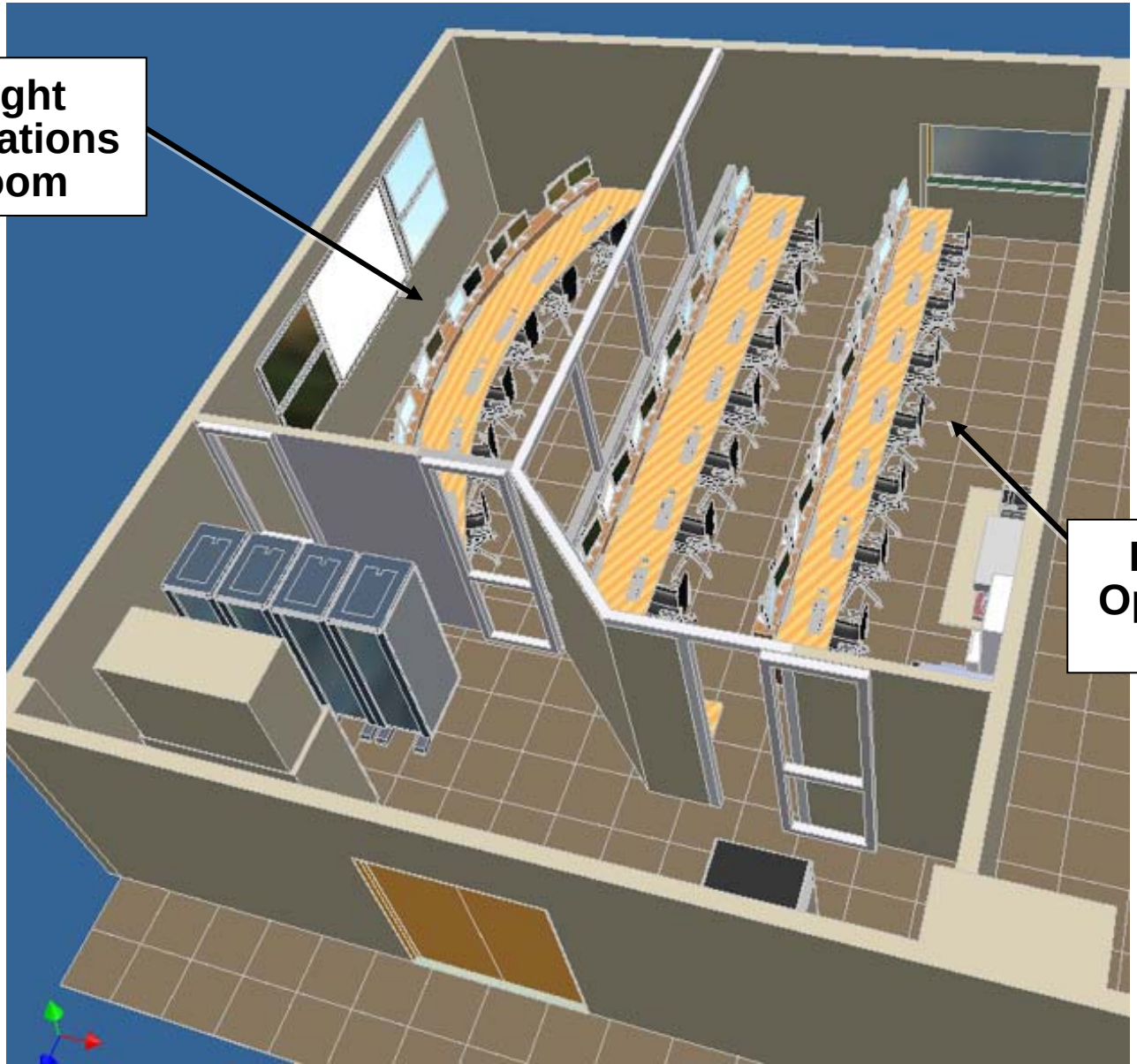
- **New (non-USAF) Ground Control Station**
  - Building-based Ground Control Station.
  - NGC has developed a new GCS architecture.

- **New A/C and Payload Communications Architecture**
  - De-integration of Payload Comm's from Aircraft C2.
  - Conversion of A/C primary C2 to of redundant 2-channel Iridium
  - Addition of Iridium for Payload C2/Status.
  - Addition of Ku Satcom for Payload wideband data downlink (5MB – 45MB).

- **New Payload Bays (10) and Plug/Play Interfaces**
  - Attach-points added to Zones 7, 25, 61
  - Slide-out pallets in pressurized Zones 12,13,16, 22.
  - Power and ethernet interfaces available throughout aircraft.

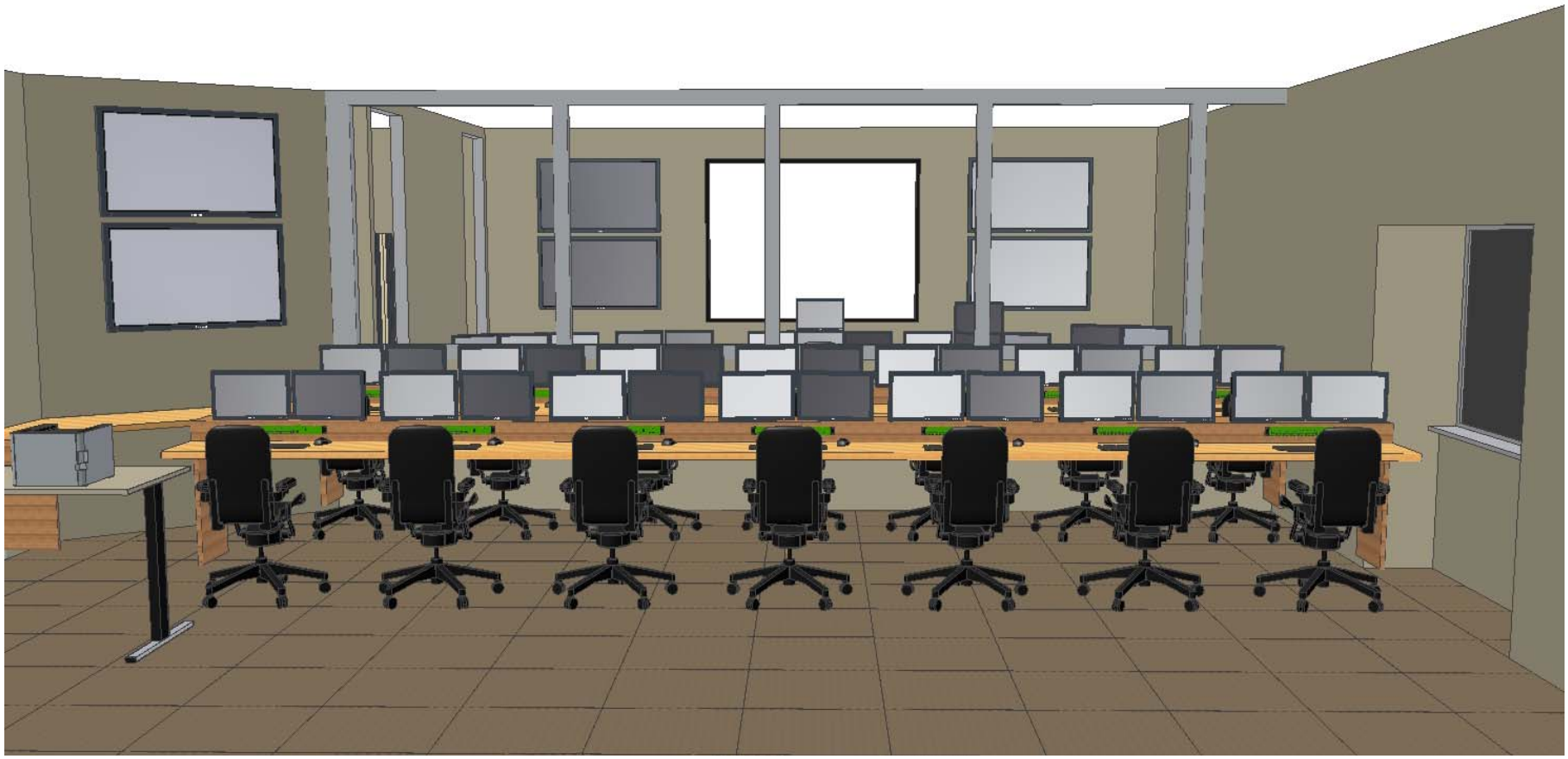
New Integrated Air/Ground Payload C^3 System
  - Next-gen Airborne Payload System (new EIP, IP-based data network)
  - TC/IP Connectivity between PI and the instrument
  - Onboard wideband digital recording when >65° N Latitude

DFRC Global Hawk Operations Center (GHOC)



GHOC Flight Operations Room

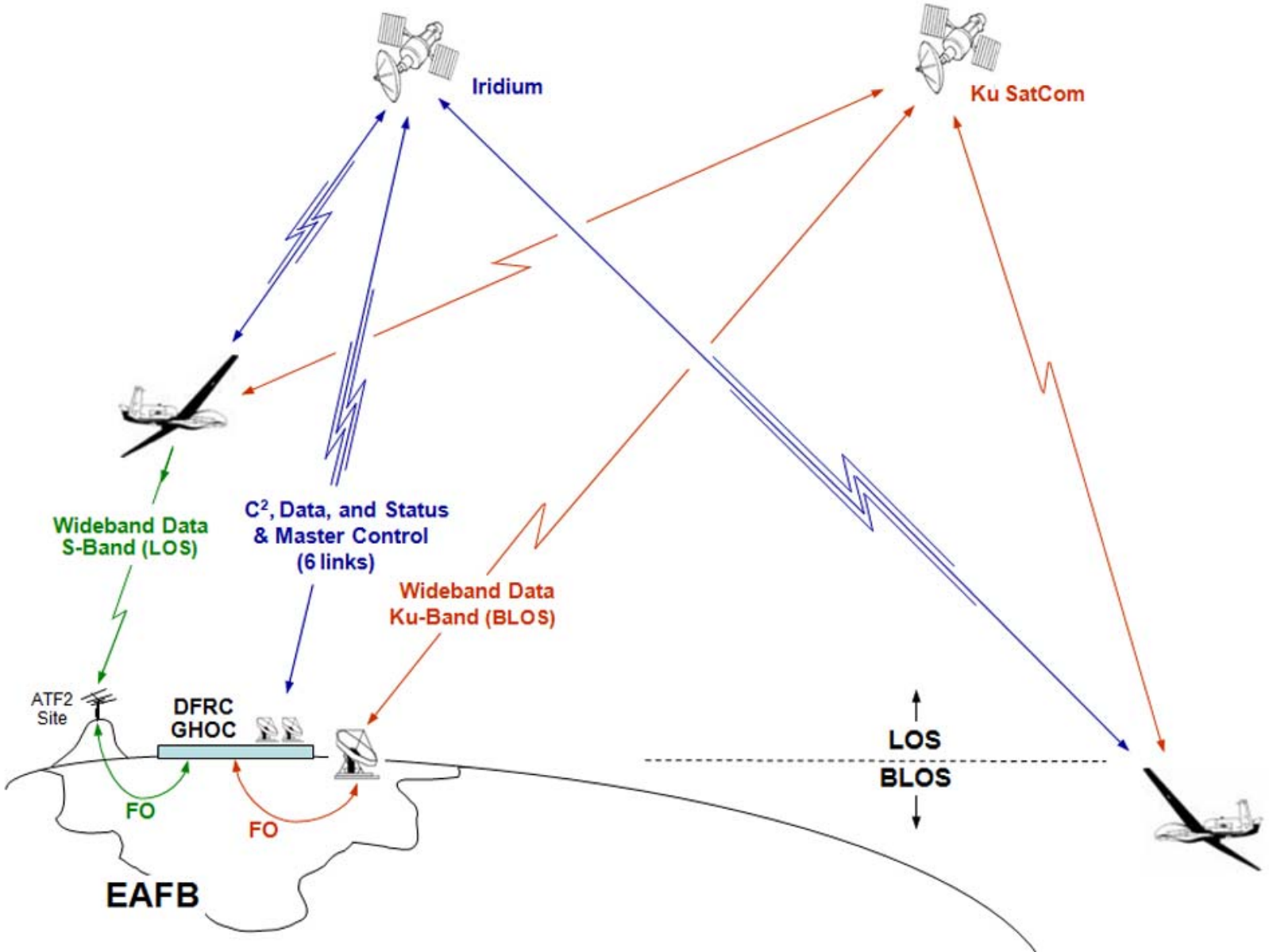
GHOC Payload Ops Room



14 Payload Workstations

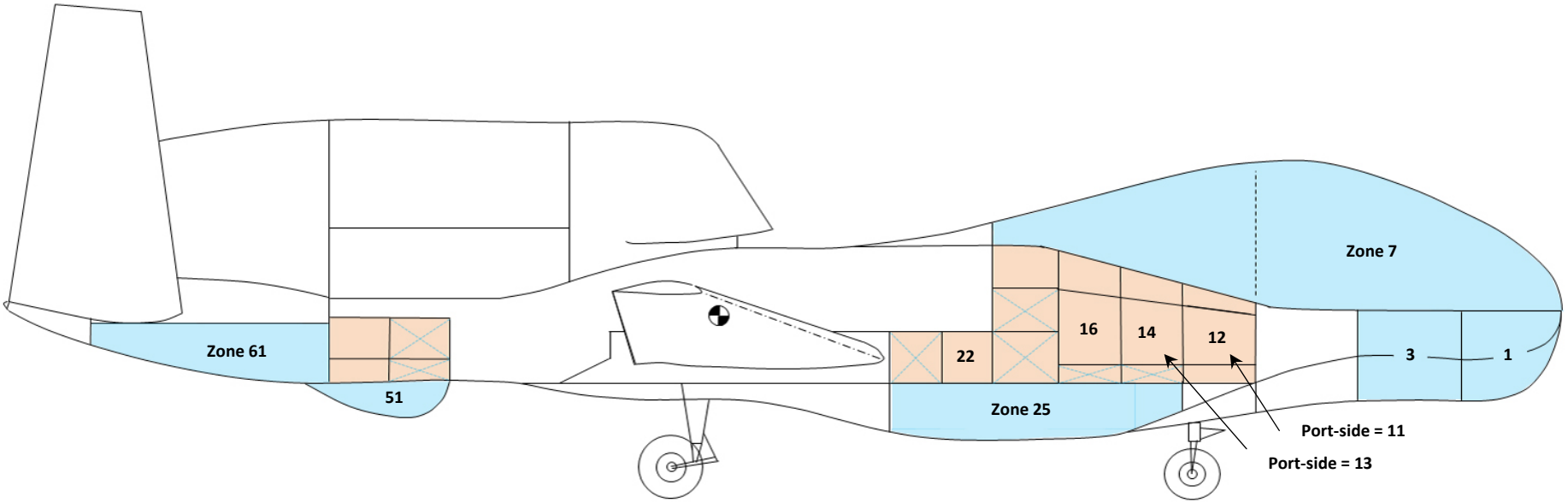
Note: Payload Team Overflow Area (with 30 Workstations) equipped with Wall Displays and GHOC Network Connectivity is located in the GH Hanger

Payload System Communications Architecture



GH Airborne Payload System

12 Zones Available for Payloads on the NASA GH



Legend:

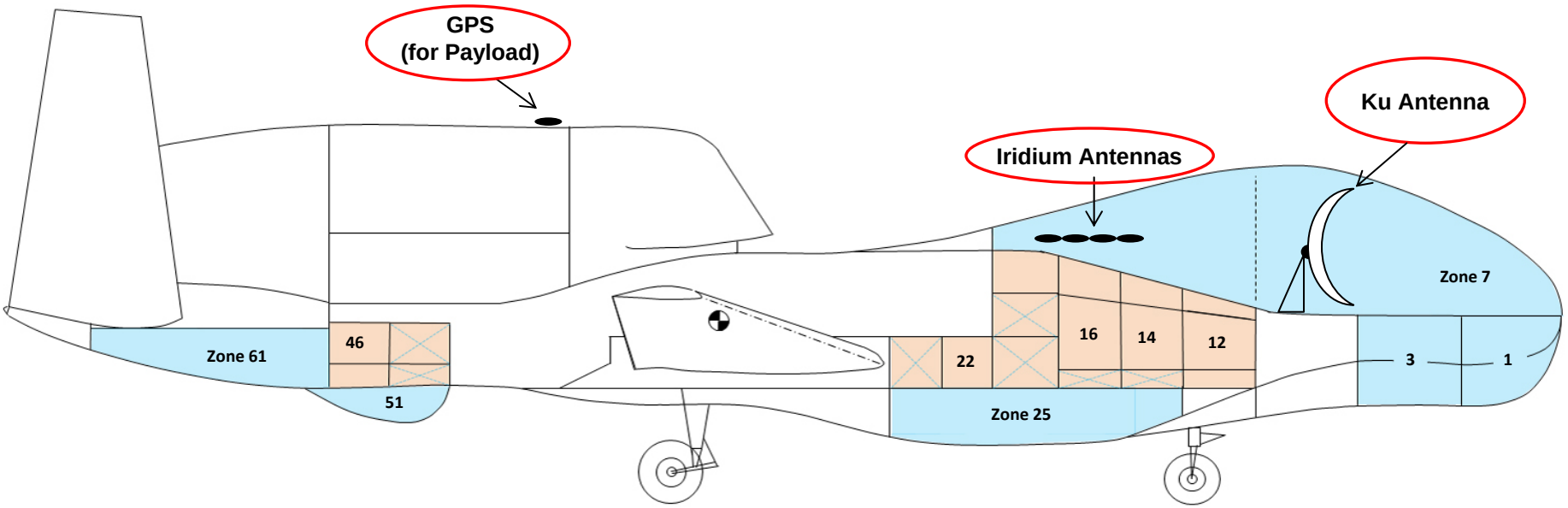
ECS controlled, pressurized compartments:

Non-ECS controlled, unpressurized compartments:

Compartment space unavailable to payloads:

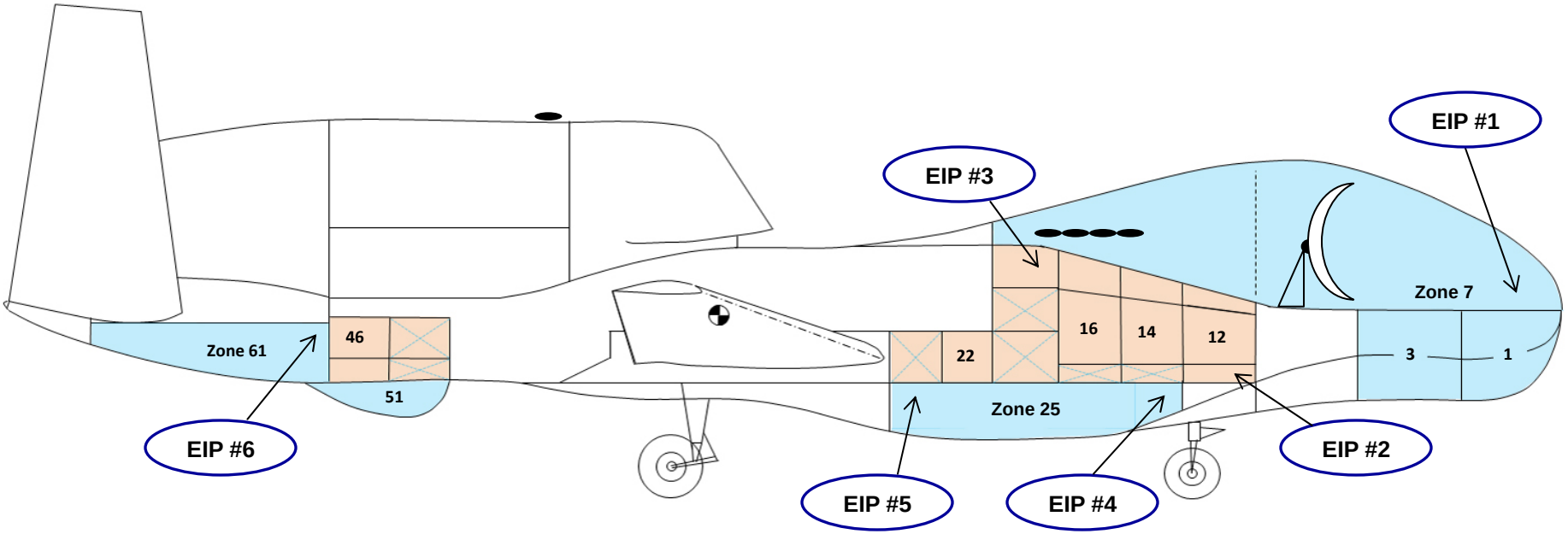
GH Airborne Payload System

Key Airborne Payload C3 System Components



GH Airborne Payload System

Payload System Instrument Interface Components

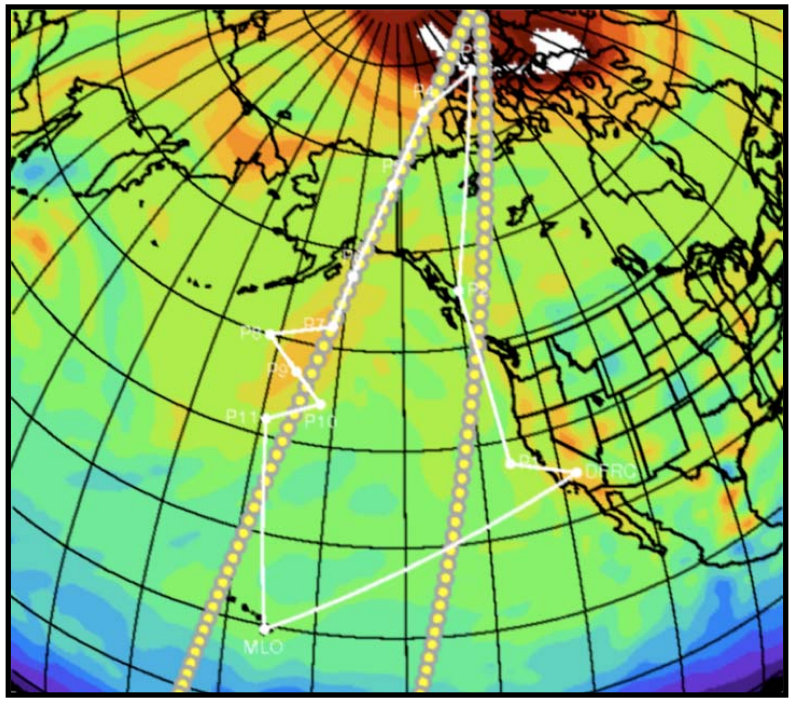


Note: Each "EIP" is comprised of:

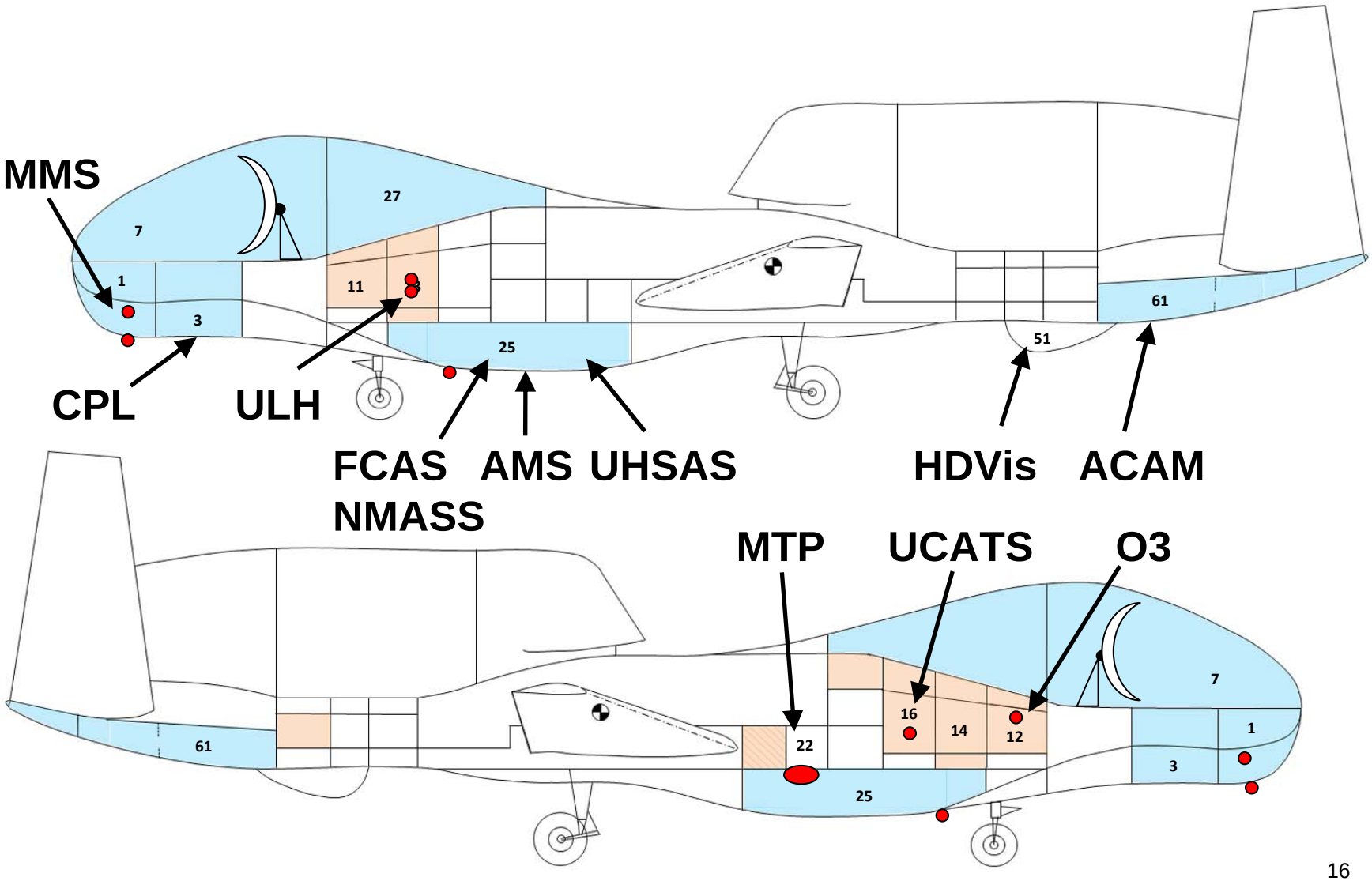
- Experiment Interface Panel (EIP)
- 1400W TRU (50A 28vDC)
- Ethernet Switch

Global Hawk Pacific Science Campaign (GloPac 2009)

- **Flights planned for Summer 2009.**
- **Flights will be conducted over the Pacific Ocean, and possibly over parts of the Arctic.**
- **12 instruments, NASA and NOAA sponsored.**



GloPac '09 Instruments



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Baseline Mission Capability

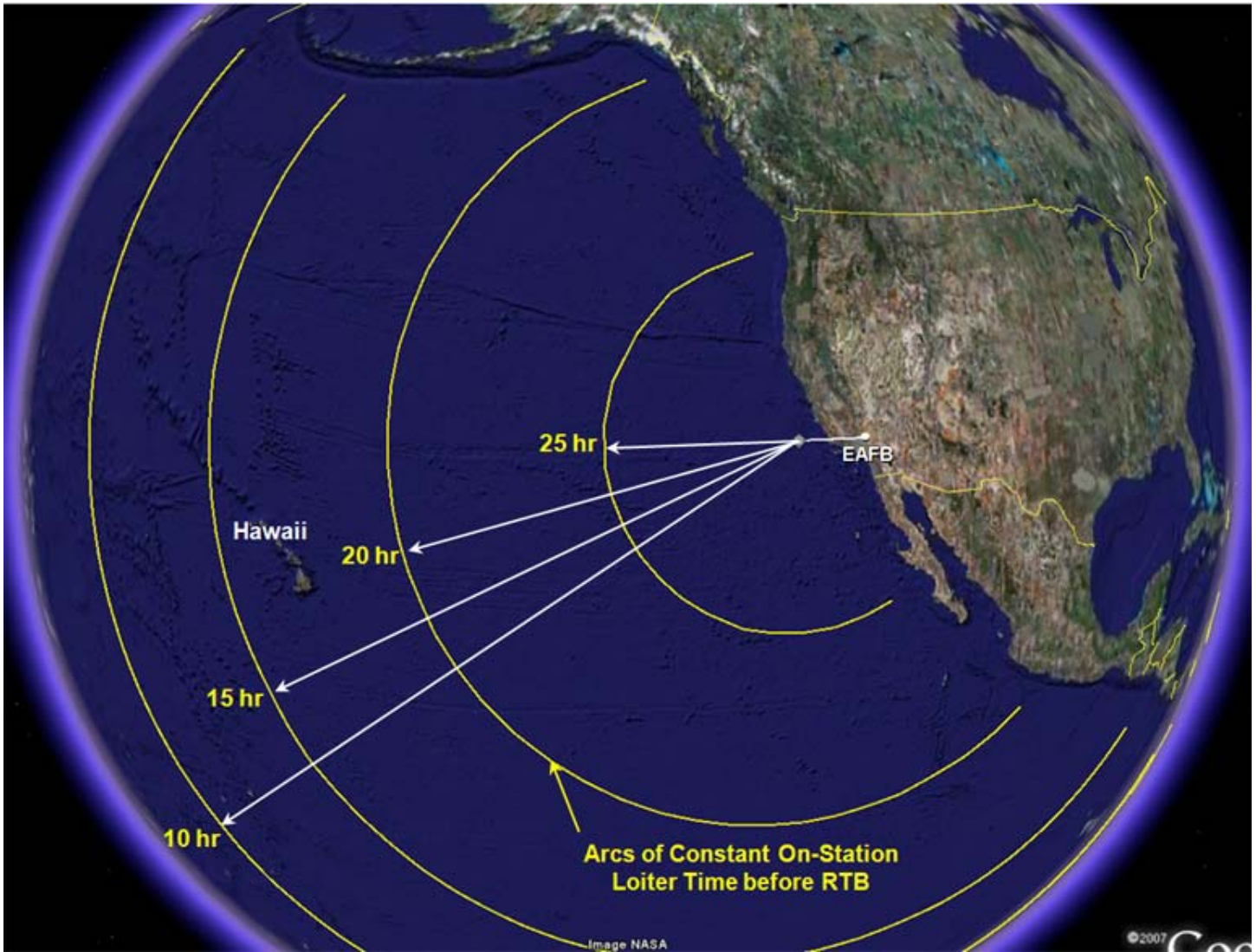
Gulf / Caribbean Range and Loiter Capability from DFRC

Baseline Mission Capability

- **Flight from DFRC to 1700 nm East of Barbados (30 deg longitude)**
- **Could loiter at <u>40 deg</u> longitude for 4 hours**

Baseline Mission Capability

Pacific Ocean Range and Loiter Capability from DFRC



Mission Turn-around Time

- **The NASA G.H. CONOP is Unique to Airborne Science**
  - NASA has 5 Pilots being Global Hawk Qualified
  - NGC has 2-Pilots on staff, with plans to expand
  - Plan is to fly with a 2-Pilot Team sharing a 12-hour Shift
  - Aircraft will be recovered with a fresh Op's Team – new shift
- **Initial Assessment is that Aircraft can be Fueled, and Re-launched fairly quickly**
  - Refueling time – may be biggest issue (4 hours)
  - Hanger / Operations Team will not be issue
- **Nine-hours from Barbados to DFRC**
  - If aircraft can be re-launched in 6 hours – Global Hawk could return to Barbados area in 24 hours

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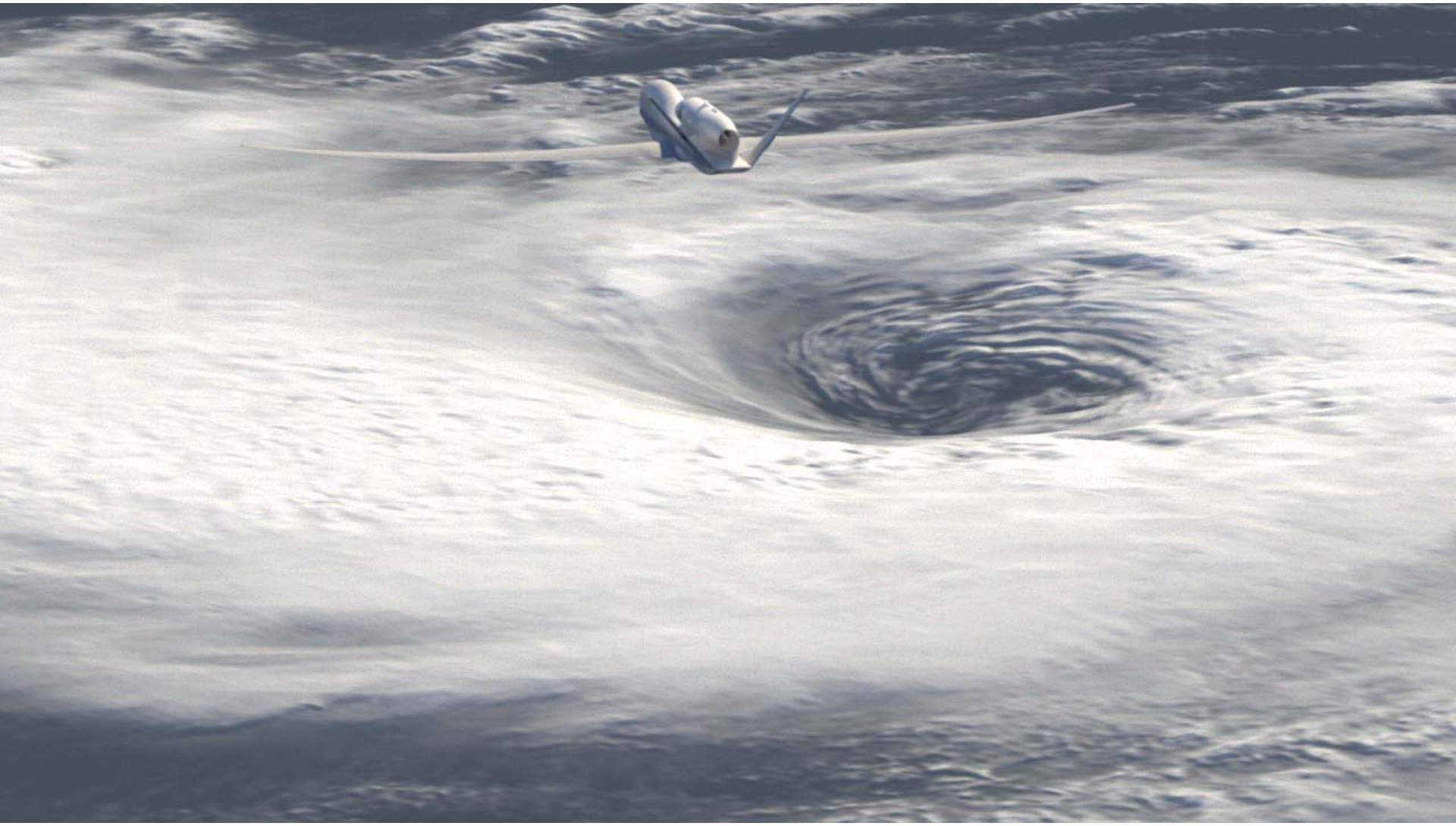
What Will Make Our Pilot Happy



What Will Make Our Pilot Unhappy

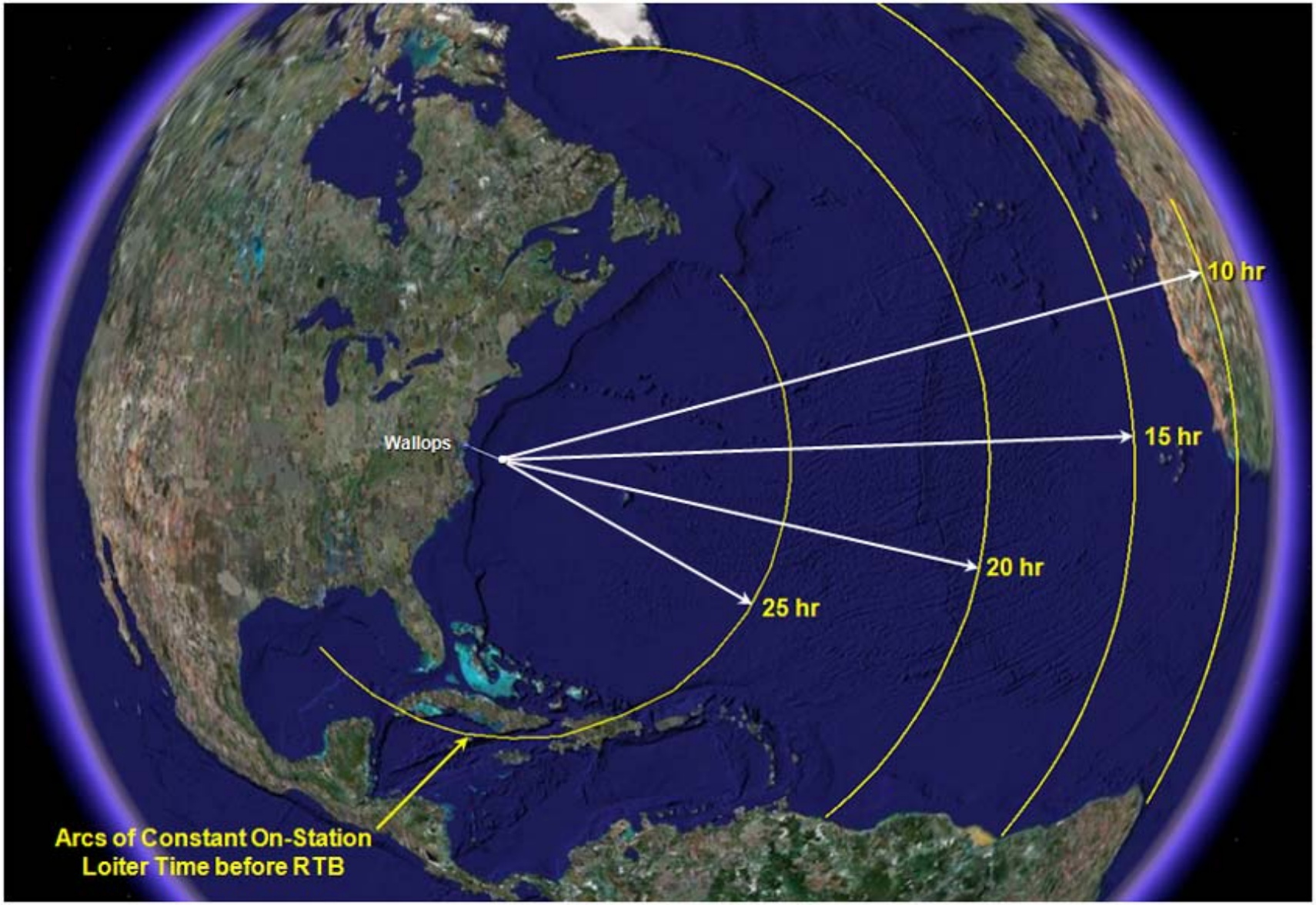
Sensors for Severe Weather

- **Plan to install HD Camera's in Nose of Aircraft**
  - Visual Camera
  - Low-Light Camera
  - IR Camera
- **Plan to consult weather experts on best set of systems**
  - Stormscope for lightening detection
  - Weather Radar
- **Turbulence Sensor Package**
  - Provide Pilot with strip-chart display of turbulence

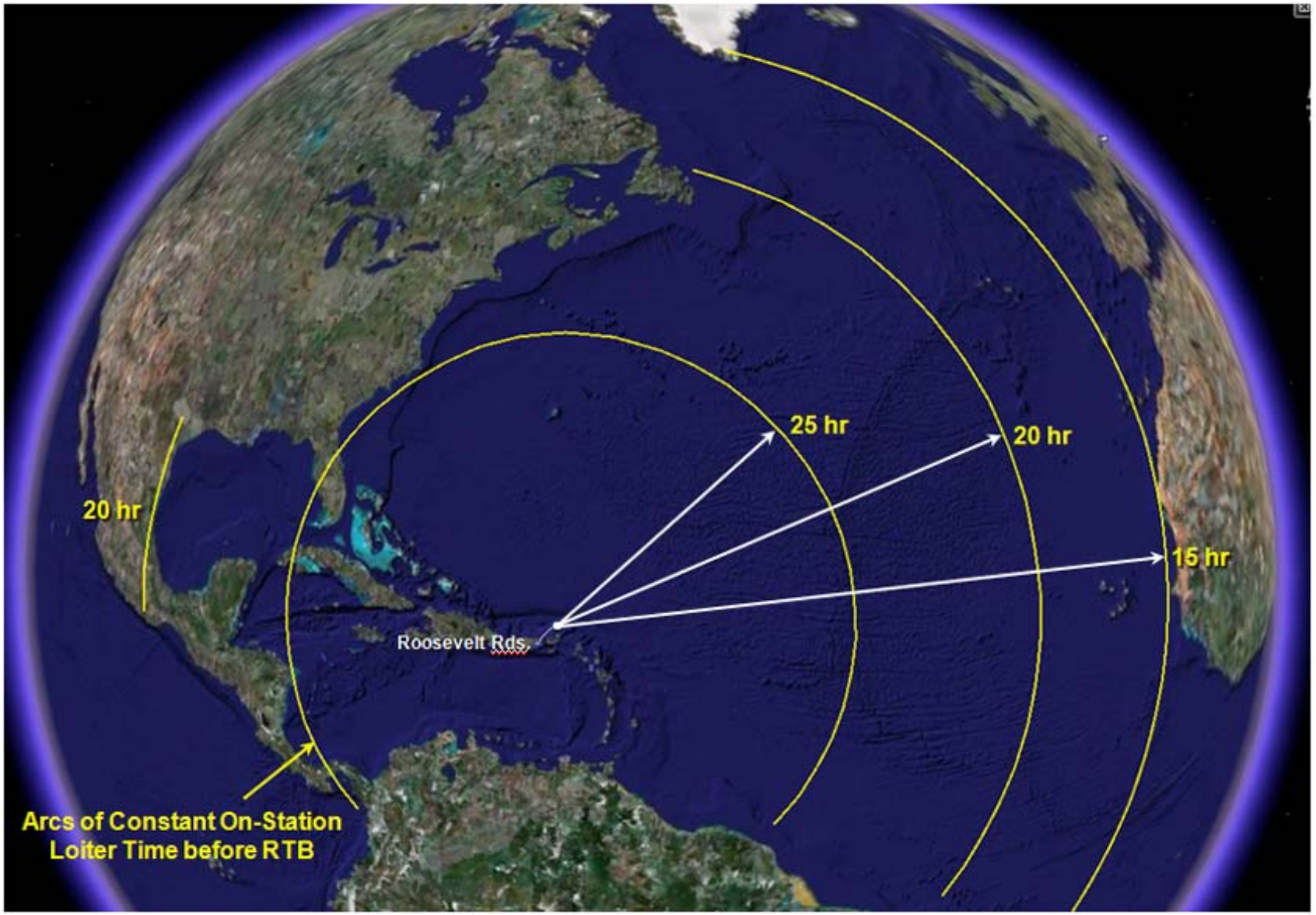
Remote Launch & Recovery

- **Several Proposals for Funding to Develop a Remote LRE**
  - Ice-Bridge Proposal
  - NGC / DFRC DARPA Proposal for Air-to-Air Refueling
  - $6M Cost – 18-month Development
- **Launch & Recovery System**
  - Single Pilot used only for Take-off and Landing
  - Line-of-Sight Comm's to Aircraft only
  - Aircraft and Payload Flight Op's would remain at DFRC
- **Remote Deployment Considerably Expands Capability**

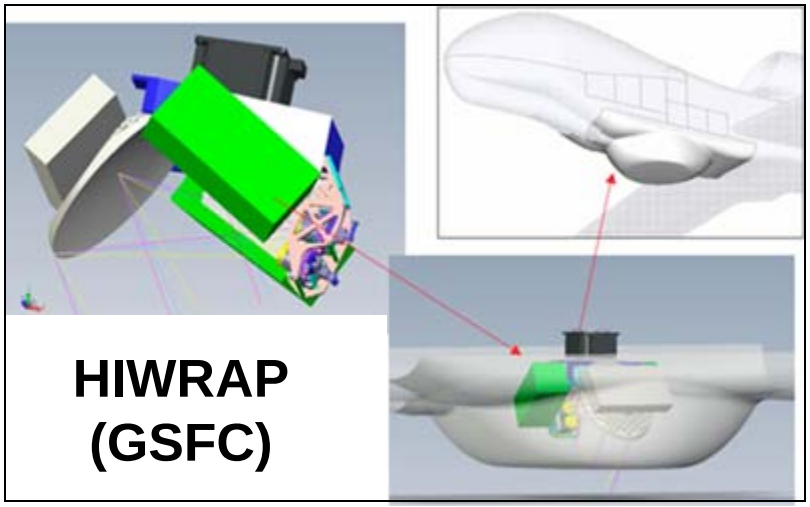
Global Hawk Operational Capability
Atlantic Coverage from NASA Wallops



Global Hawk Operational Capability
Atlantic Coverage from Roosevelt Rds.

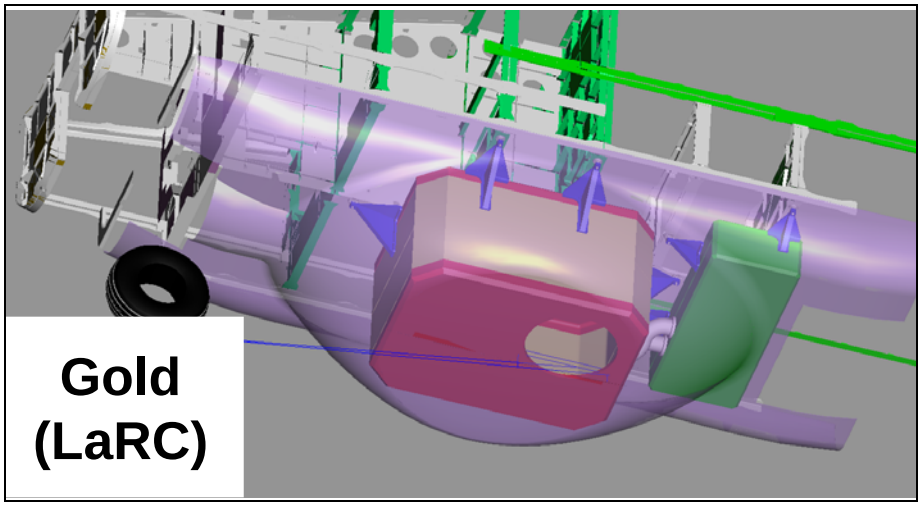


Future Payloads



HIWRAP (GSFC)

Ku and Ka band radar for the measurement of wind and rain profiles.

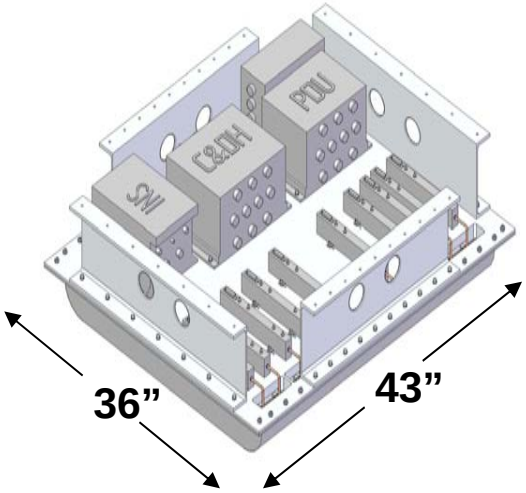


Gold (LaRC)

Backscatter LIDAR for accurate measurements of ozone and aerosols in the troposphere.

Both instruments will require a NGC developed "Deep Radome"

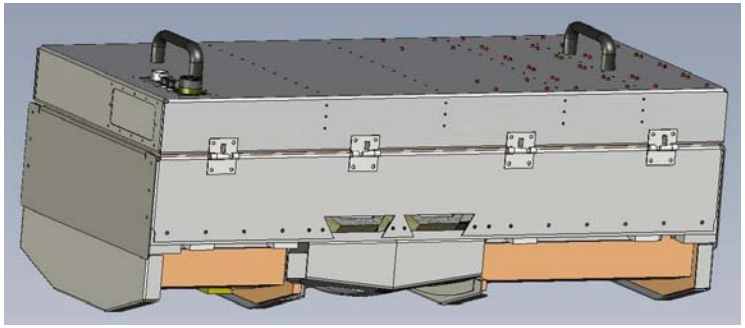
Future Payloads (cont)



HIRAD (MSFC)

Hurricane Imaging Radiometer for high resolution measurements of ocean surface vector winds.

Dropsonde Dispenser (NOAA)



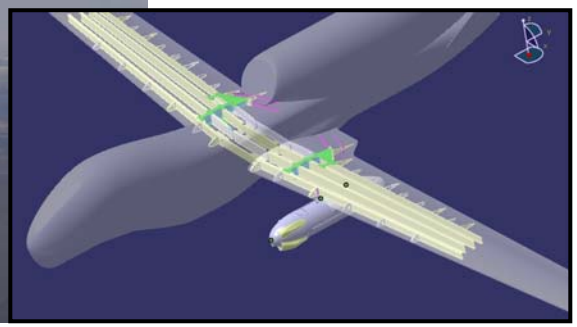
HAMSR (JPL)

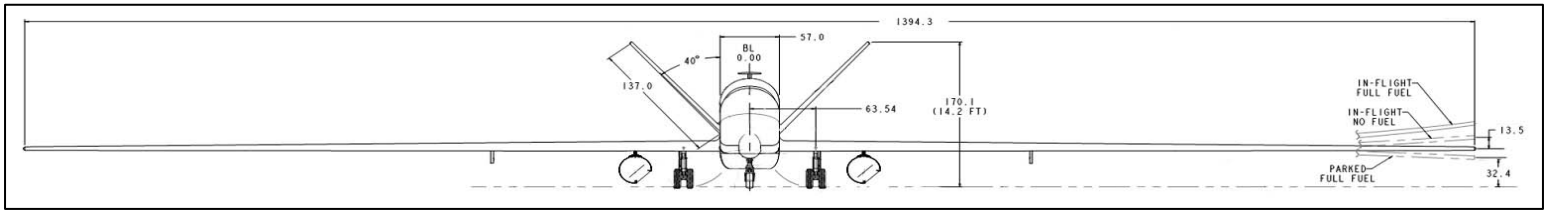
Microwave Sounder providing 3D measurements of temperature and Water vapor content.

Future Wing Pod Capability

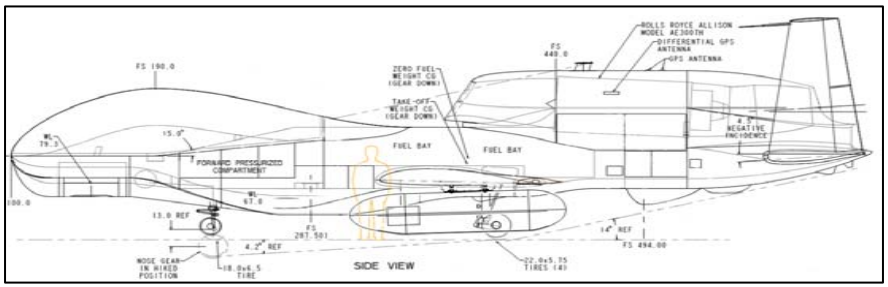
UAVSAR (JPL)

UAVSAR on G-III





Effort will lead to the development of Generic GH Pods for future Payloads



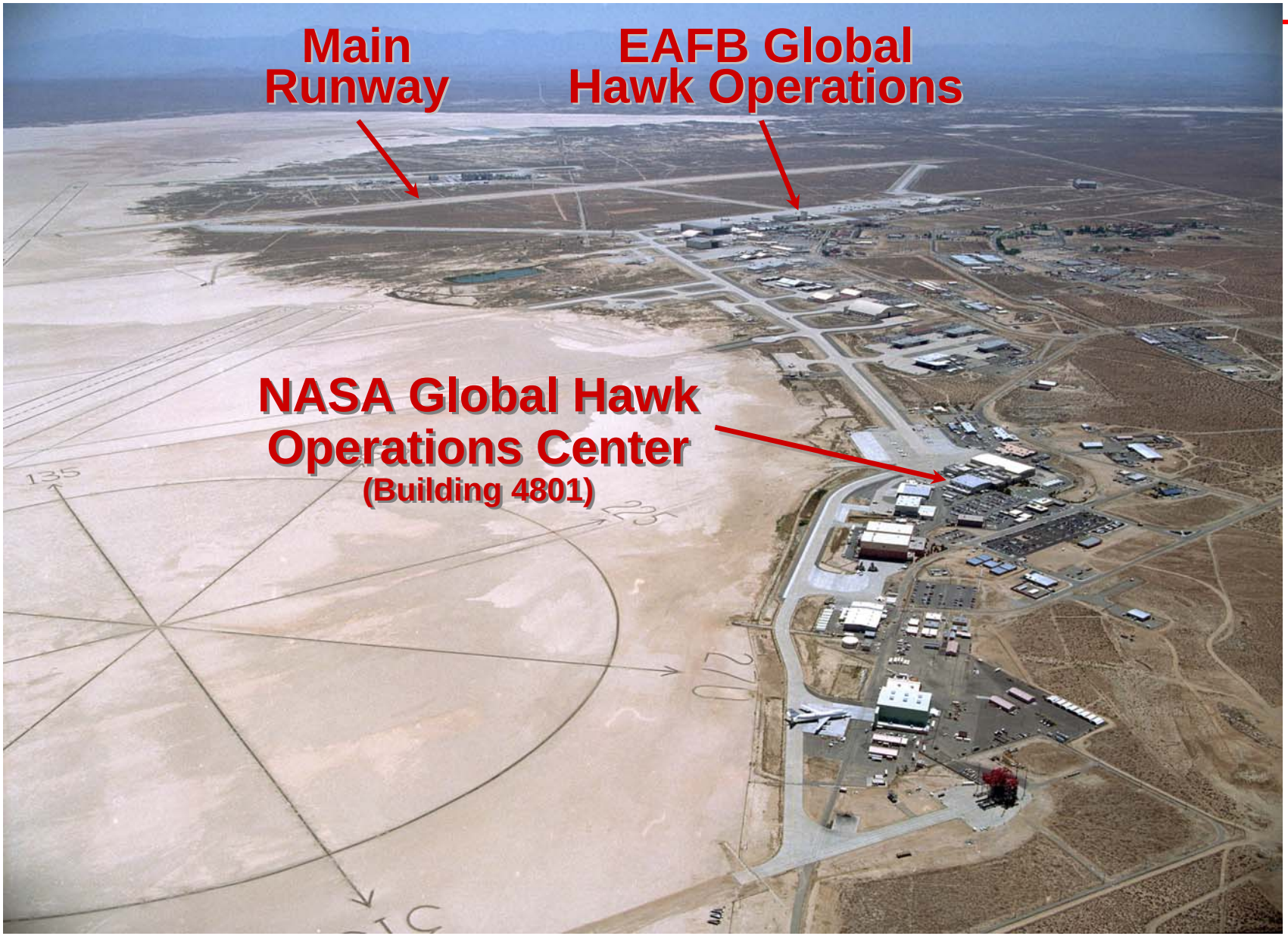
Summary

- NASA Dryden owns two Global Hawk aircraft.
- Significant modifications have been made to enhance Airborne Science capabilities with the aircraft
- Preparations for initial flights are nearly complete.
- Flights within the EAFB range will begin in May 2009.
- Customer flights begin in July 2009.
- We look forward to supporting GRIP in 2010.


NASA
4801
NASA
NORTHROP GRUMMAN
DRYDEN FLIGHT RESEARCH CENTER

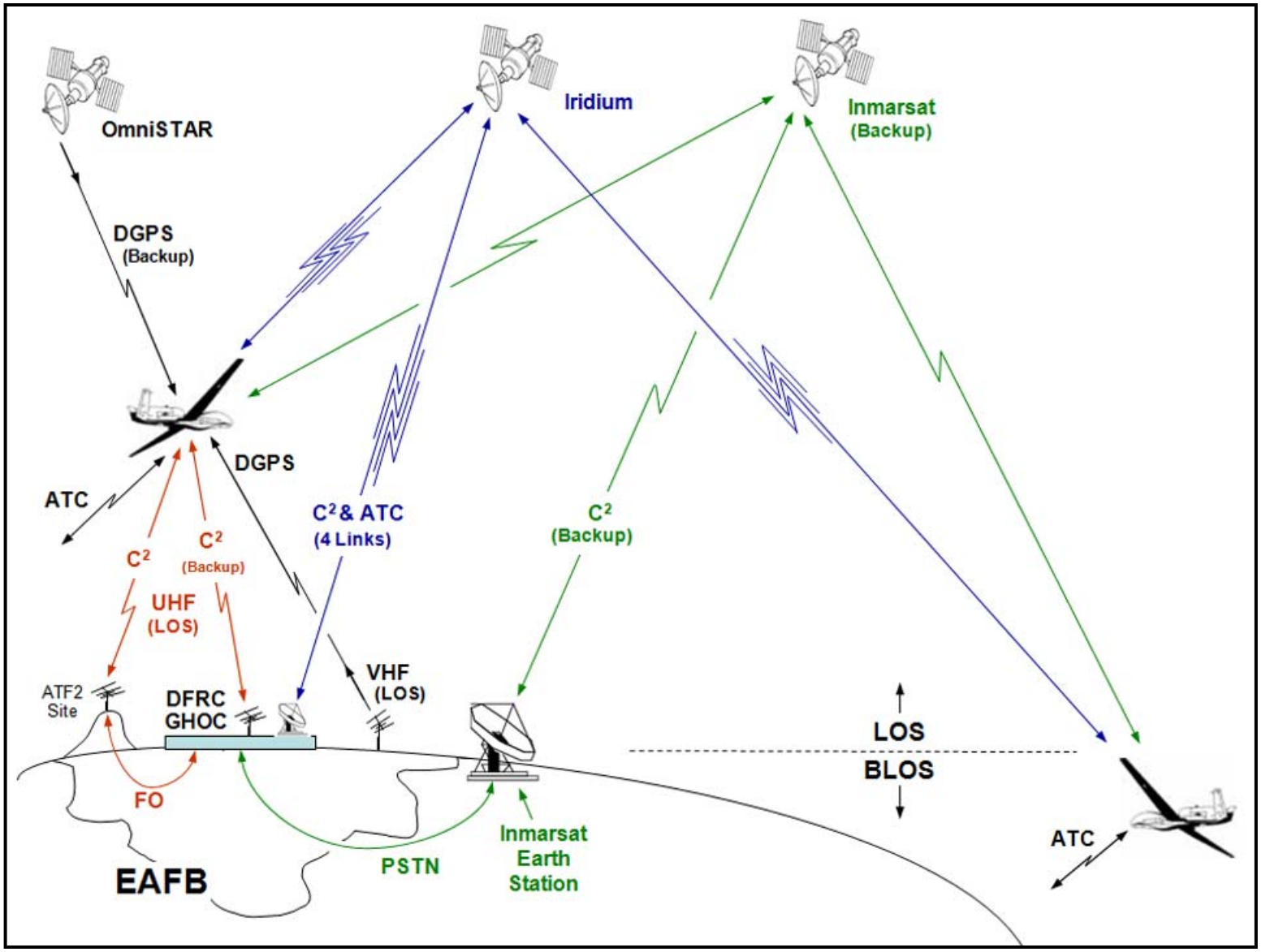
Backup Slides

Edwards Air Force Base and NASA Dryden Flight Research Center

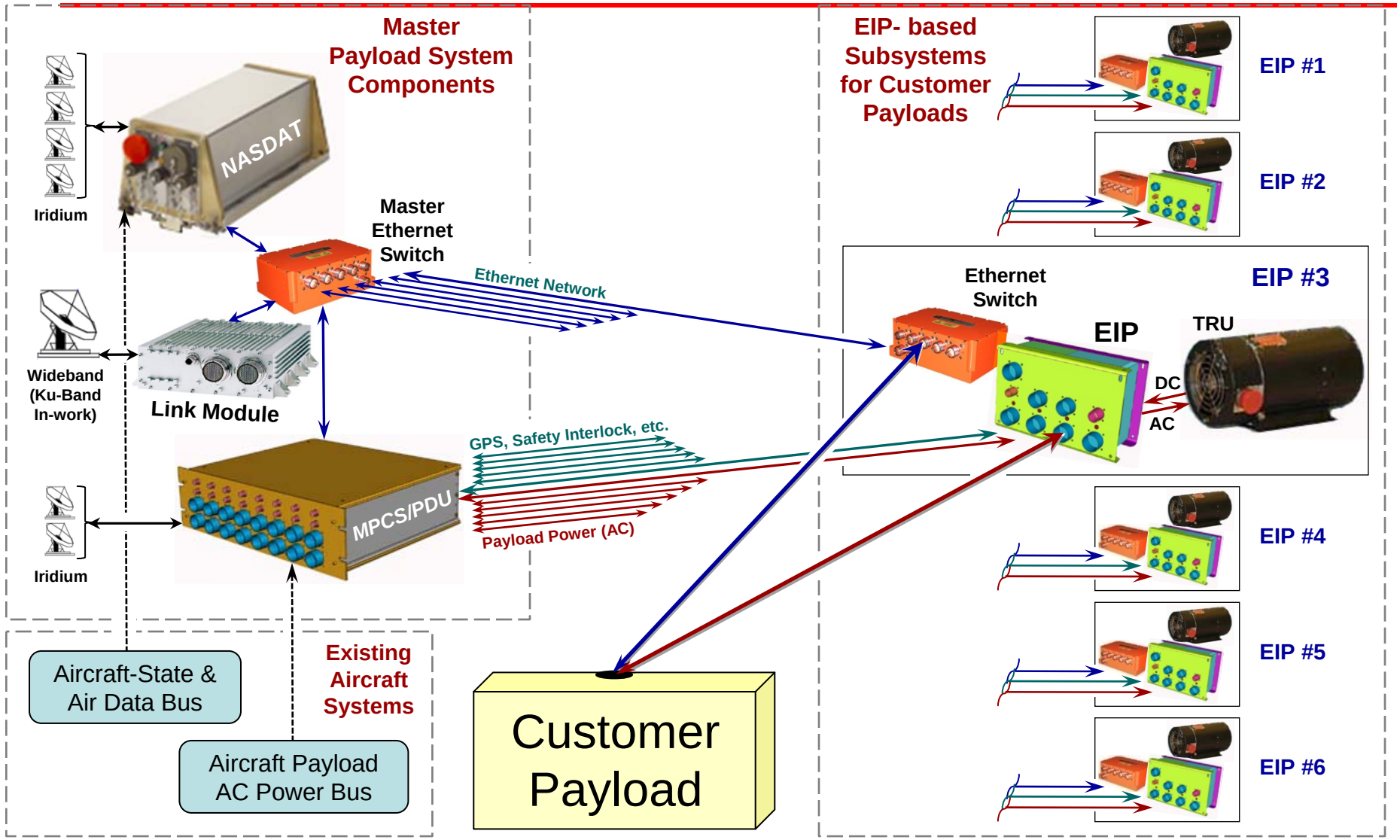


Dryden Building 4840 Complex

Flight Control and Air Traffic Control Communications Architecture



Global Hawk APCS Architecture



DFRC Global Hawk Organization Chart

Global Hawk Project (DFRC)

Project Manager - Chris Naftel x2149
Deputy Project Manager - Phil Hall, NOAA x7421
Systems Engineer - Courtney Bessent x2583
Lead Ops Engineer - Matt Graham x3202
Payload Engineer- Dave Fratello, Zeltech x5783
Admin Support - Anne Odenthal, Infinity x7478

Procurement/IDIQ
Chivonne Everette x3337

Public Affairs
Beth Hagenauer, Tybrin x7960

Resource Analyst
Stephanie Rudy x2151

Legal
Brett Swanson x3034

Project Control
Shawn Albertson, GRD x2229

Payload and Mission Management

Payload Integration/ Customer Interface
Dave Fratello, Zeltech x5783

Aero/Structures
TBD, as required

Frequency Management
Greg Strombo x2947

Weather
Scott Wiley, Tybrin x3970

COA/Mission Planning
Matt Graham x3202
Phil Hall, NOAA x7421

Payload Support System
Design/Fab Lead, Ames
Electrical, Howard Ng x3803
Designer, Ryan Lefkofsky

Global Hawk Operations Center (GHOC)

Ground Control Station
Tom Cronauer, Lead x5885
Bob Novy x2929
Scott Mark, Lockheed x7427

Simulation
TBD, when needed

Communications Systems
John McKee x3037

Range Engineering
Bart Rusnak x3265

Safety and Mission Assurance

System Safety
Andy Gutierrez, Tybrin x5421

Quality Assurance (Hardware)
Randy Button x7494
Rick Brewer x2571

Quality Assurance (Software)
Duc Tran x2303

Range Safety
Tony Kawano x3511

Operations

Ops Engineering
Matt Graham x3202
Gary Cosentino x3512
Greg Buoni x7548
Kathleen Howell x3654
Robert Rivera x2727

Pilots
Dee Porter, CSC x2222
Mark Pestana, x2519
Hernan Posada, x7302
Tim Williams, x5365
Phil Hall, NOAA x7421

Crew
Ken Wilson, Chief x2499
William Fredriksen, x2655
Gina Patrick, CSC x2123
Bill Pingry, CSC x5559

Configuration Control
Linda Soden, CSC x3338

Shop Support

Dryden 661-276-xxxx

NASA Global Hawk Debut Ceremony
Jan 15, 2009

Global Hawk 872 on display during the debut ceremony

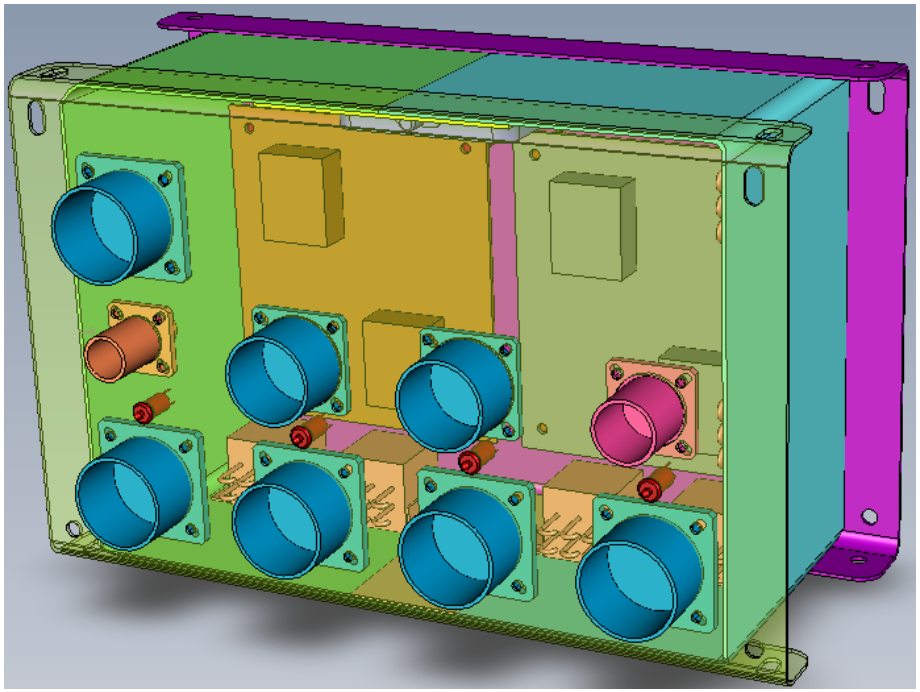
Dr. Yvette Weber, Director of Engineering, 303 AESG, talking about AV-6's transition to NASA

Scientists interacting with ceremony guests during the hangar tours

GH Pilot Mark Pestana describing the Global Hawk Operations Center

EIP Development at ARC

EIP Electrical/Mechanical Design:



Features:

- 4 Independent Instrument Plugs, each with:
  - 2 – 28VDC Circuits
  - 2 – 115VAC (400Hz, 115V) Circuits
  - GPS (from amplified switch)
  - IRIG-B
  - Safety Enable Loop Circuit
- Internal & External Temp. Reporting
- Current Reporting (each Power Circuit)
- Voltage Reporting (each Power Circuit)
- Separate Power Relays for each DC Circuit (independently-controlled from MPCS)
- Slightly smaller than previous EIP
  - 10.5”x6.5”x4.5”

Est. of Available Payload Power

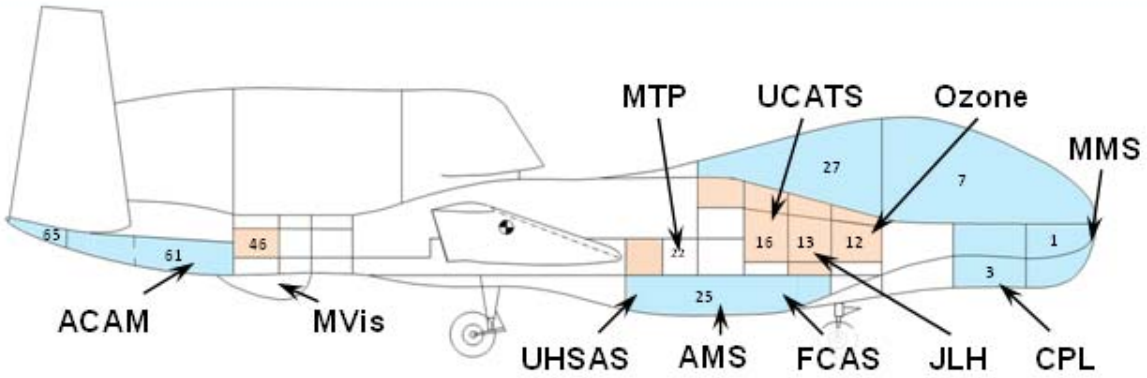
Summary of Electrical Power Available through the GH Payload System	
Total AC Power Available[1]:	**8.2 KVA** @ 115VAC, 400Hz, 3Φ
Total DC Power Available[2]:	**7.8 KW** @ 28VDC
Total "DC-Aux." Power Available[3]:	**2.0 KW** @ 28VDC

[1] Assumes no payload use of "nominal" DC payload power available, and is the total AC power available to payloads with the GH Payload System.

[2] Assumes no payload use of AC power, and is the total "nominal" DC power available to payloads. Based on TRU-converted AC @95% Power Factor.

[3] This is supplemental DC Power via use of the GH DC-bus, and is only available with an add-on EIP "DC-Aux. Module" (Contact the NASA GH Project Office for info.)

GloPac '09 Payloads



ACAM - Cross-track scanning spectrographs of NO_2, O_3, & aerosols.

AMS - Multi-spectral scanner for upper tropospheric water vapor meas.

CPL - Backscatter LIDAR for hi-res profiling of clouds & aerosols.

FCAS - Aerosol size and concentration measurements.

MMS - Science quality aircraft state variable measurements.

MPT - Passive microwave radiometer meas. of O_2 thermal emissions.

MVis - Time-lapse nadir color digital imagery w/ georeferencing.

Ozone - Dual-beam UV photometer for accurate O_3 measurements.

UCATS - Dual gas chromatographs for N_2O, SF_6, H_2, CO, & CH_4 meas.

UHSAS - Ultra-high sensitivity aerosol spectrometer.

ULH - In-situ hi-accuracy atmospheric water vapor measurements.

GloPac '09 Mission Planning