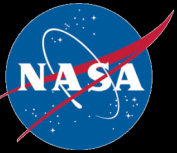


Ikhana: A NASA Unmanned Aerial System Supporting Long- Duration Earth Science Missions

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Center**

**32nd International Symposium on
Remote Sensing of Environment**





Project Goals

IKHANA

- Ikhana = Choctaw Native American word for “intelligent, conscious, or aware”
- Airborne platform to conduct Earth observation and atmospheric sampling science missions both nationally and internationally
 - Example: 2007 Western States Fire Mission with USFS
- Develop and demonstrate technologies that improve the capability of UAVs to conduct science data collection missions
 - Example: Precision Trajectory capability enabling high resolution synthetic aperture radar missions
- Develop technologies that improve manned and unmanned aircraft systems
 - Example: 2007/2008 Demonstration of a fiber-optic measurement system for determining real-time wing deflection in a flexible structure
- Support important national UAV development activities
 - Example: Demonstration of a “sense and avoid” system to prevent mid-air collision



Aircraft Selection Criteria

IKHANA

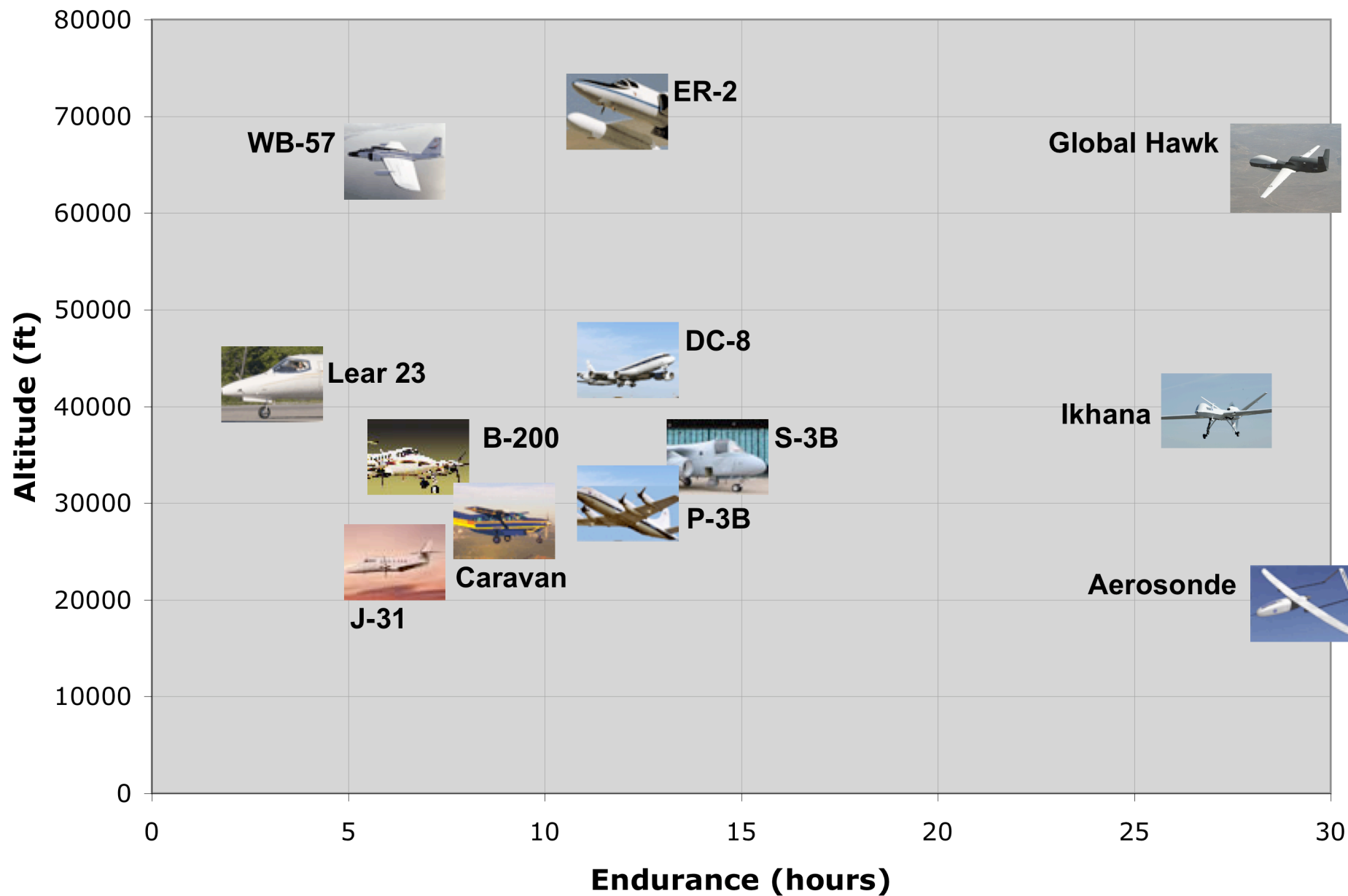
- **Endurance > 24 hours**
 - Allows measurements of day/night atmospheric variations
 - Access to remote areas
- **Altitude >40,000 ft**
 - Currently useful for flight above majority of air traffic in national airspace
 - Required for in-situ measurement of atmospheric conditions



- **Payload Capability**
 - More than 2000 lbs of science instruments
- **Reliability**
 - Triple redundant flight control systems, dual redundant power & networks
 - Highly reliable engine
 - More than 200,000 flight hours
 - Proven “lost link” capability



NASA Suborbital Science Aircraft



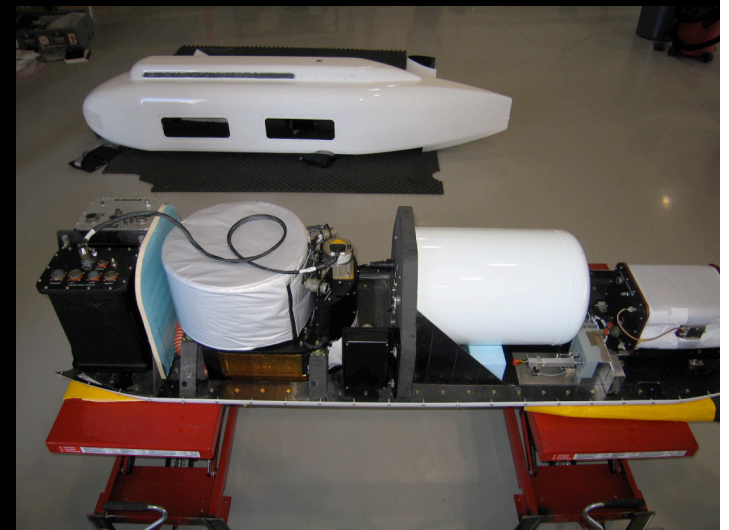
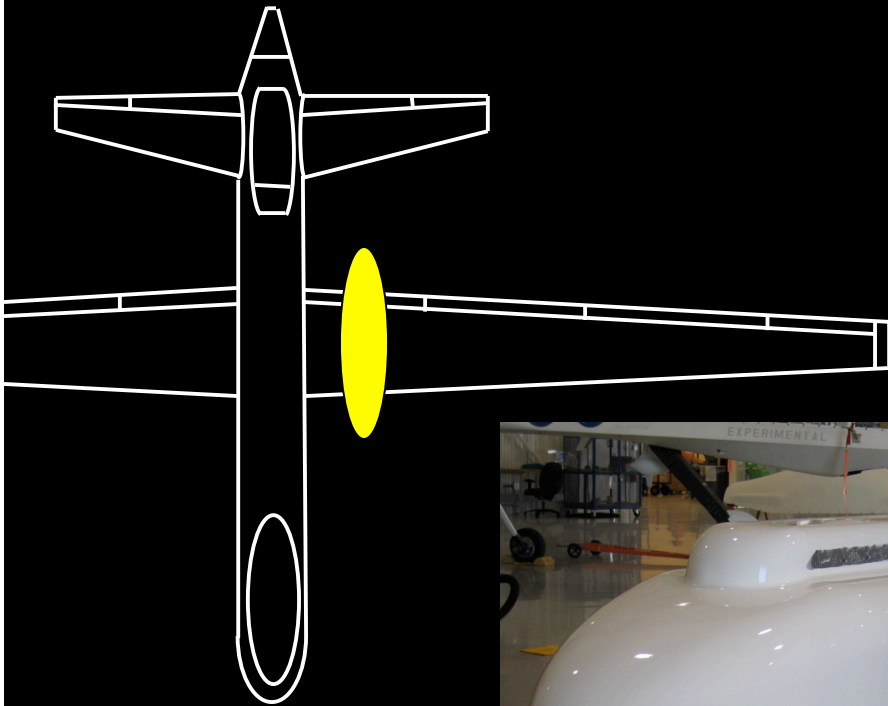


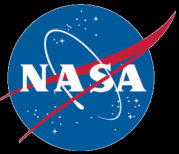
Ikhana Research Systems

IKHANA

Payload Areas

- Wing-mounted pods
- Avionics Bay
 - Payload Tray
 - Chin compartment



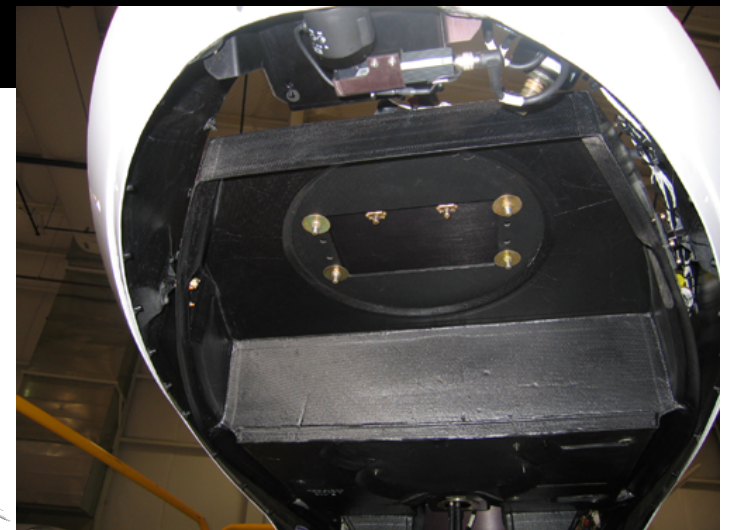
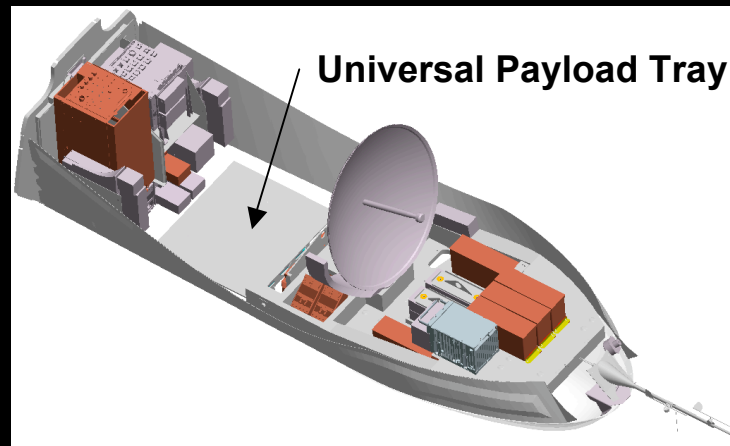
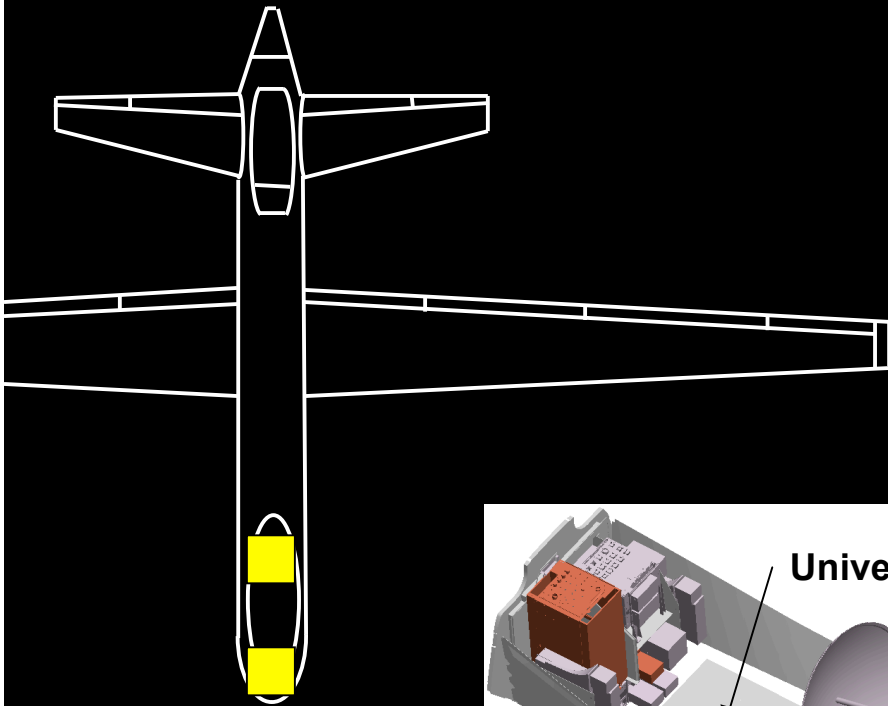


Ikhana Research Systems

IKHANA

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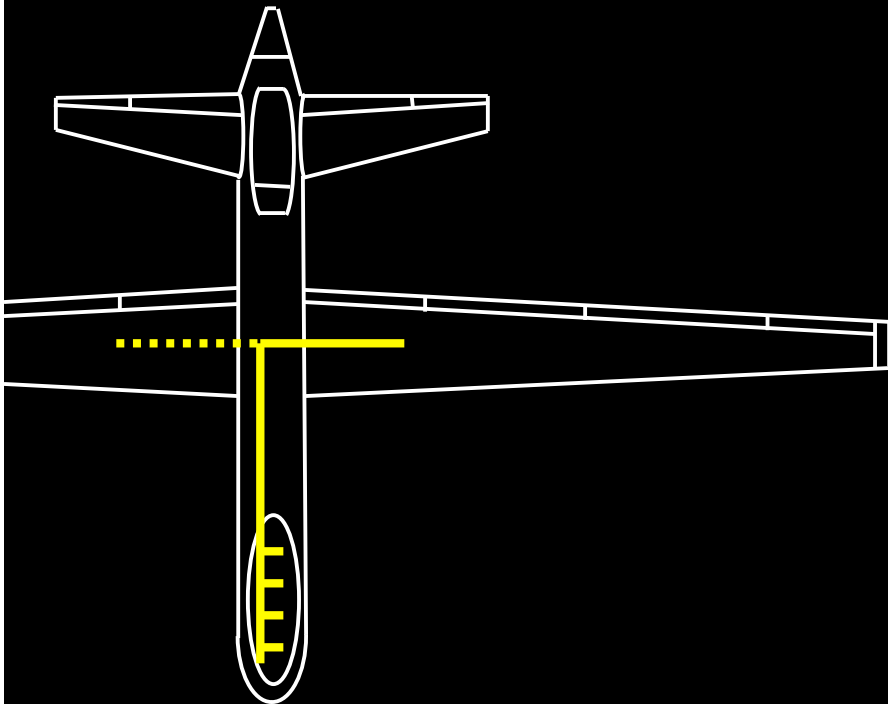


Ikhana Research Systems

IKHANA

Experimenter Network

- Ethernet network connecting systems in the avionics bay and remote pods
- Allows payloads to:
 - Communicate
 - Send data to recorder
 - Send data to satellite downlink
 - Receive common time
 - Receive aircraft state data (planned)





Ikhana Research Systems

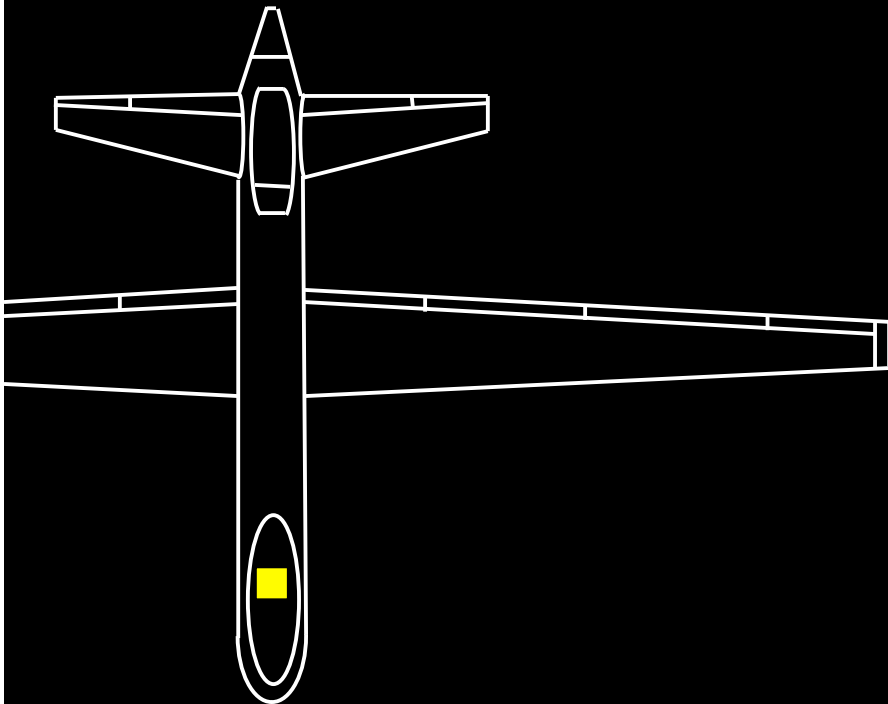
IKHANA

Network Data Recorder

- 64 GB storage
- Networked multi-Gigabit input/output
- Four 100Base-T Ethernet switch ports
- 10 Mbps PCM serial data streams
- 16 analog inputs

NTP Time Server

- Provides common time to recorder and experimenter network



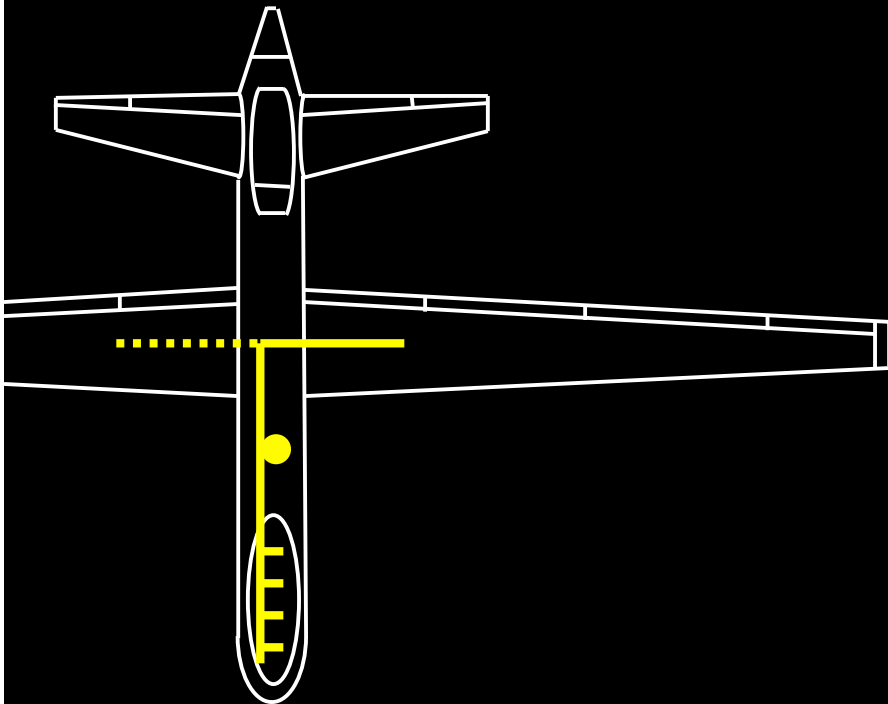


Ikhana Research Systems

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GPS Antenna connections

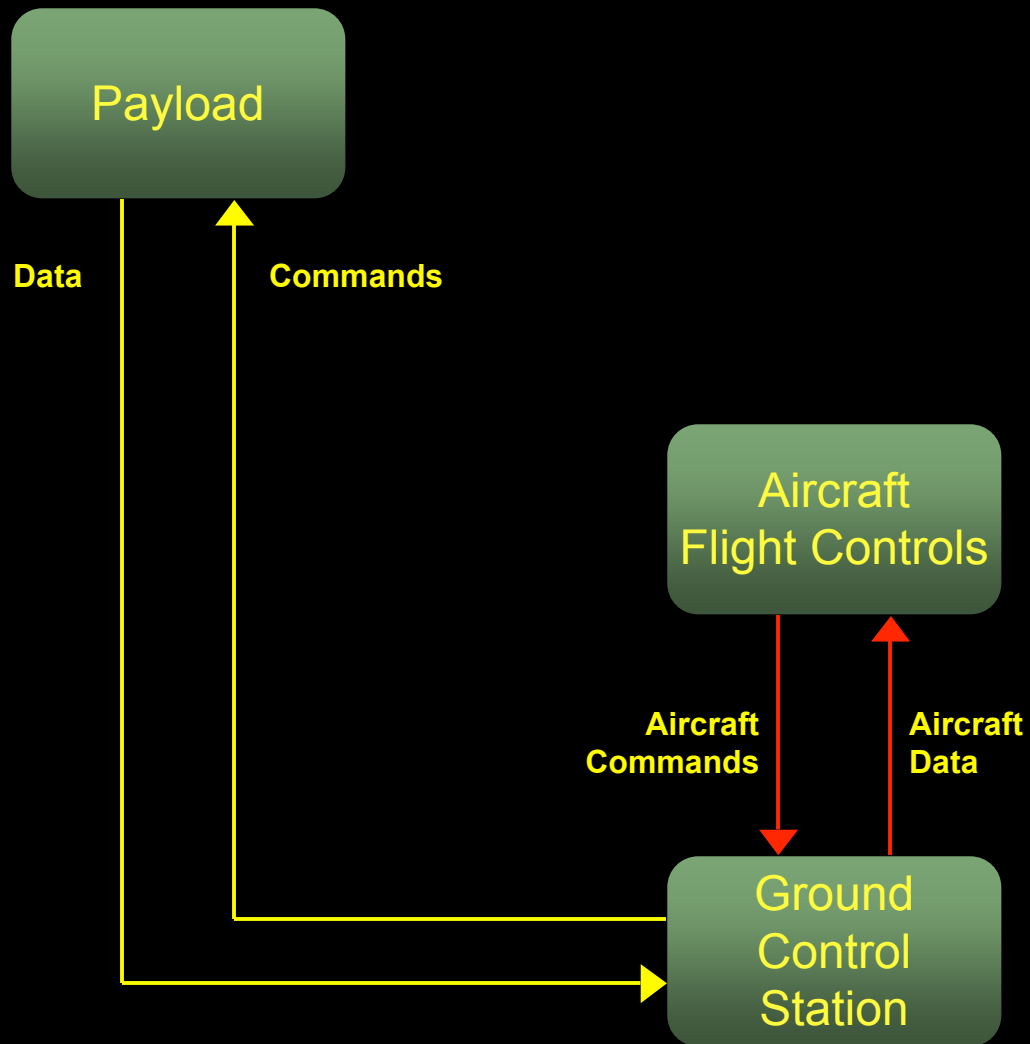
- 8 powered L1/L2 antenna connections





Airborne Research Test System (ARTS)

IKHANA

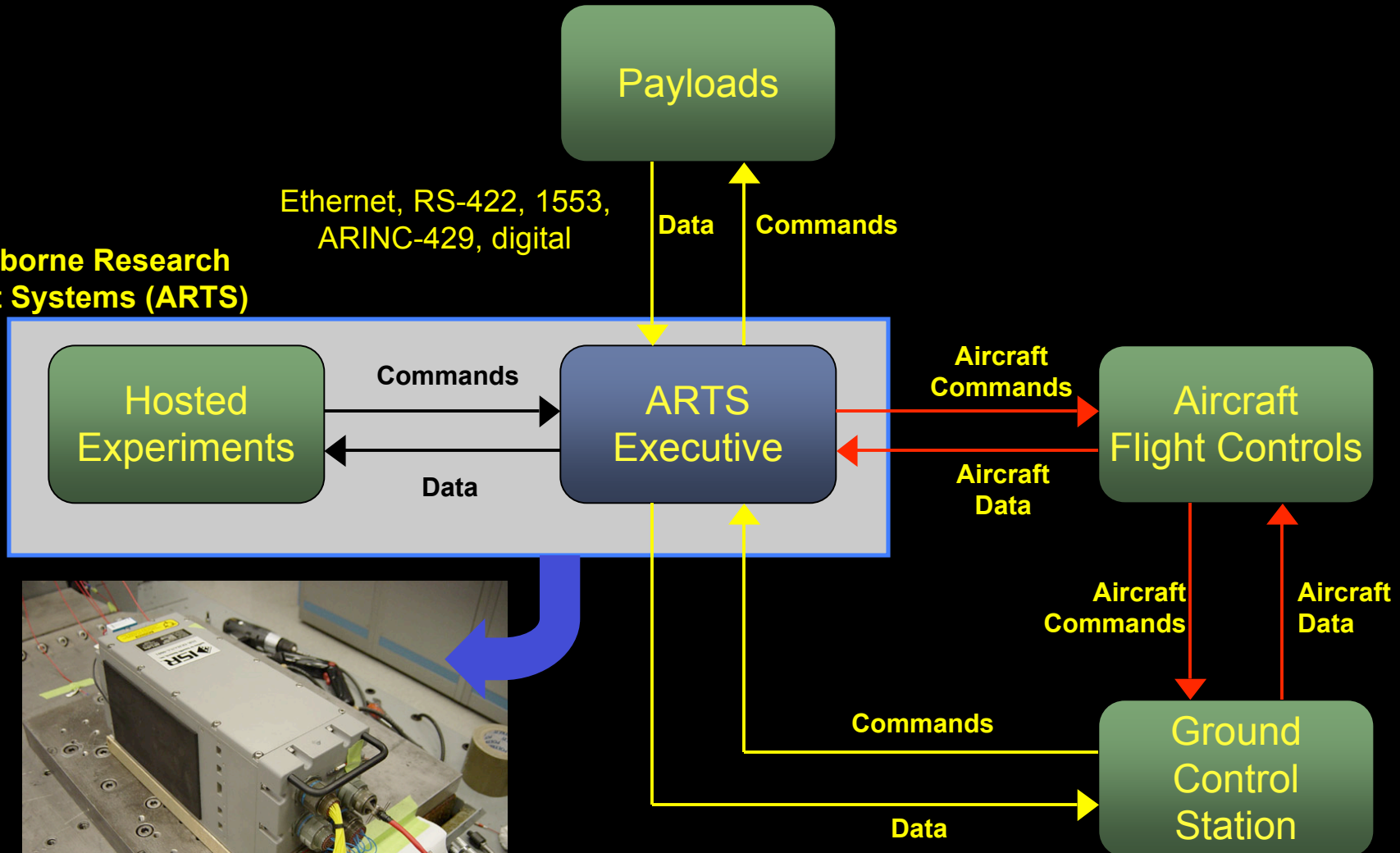




Airborne Research Test System (ARTS)

IKHANA

Airborne Research Test Systems (ARTS)



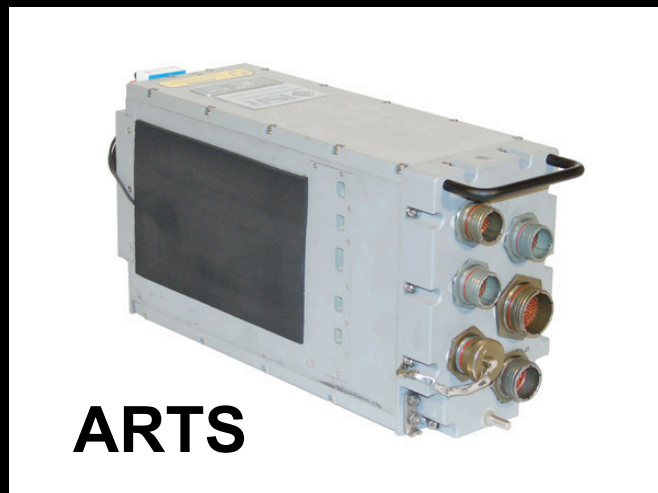
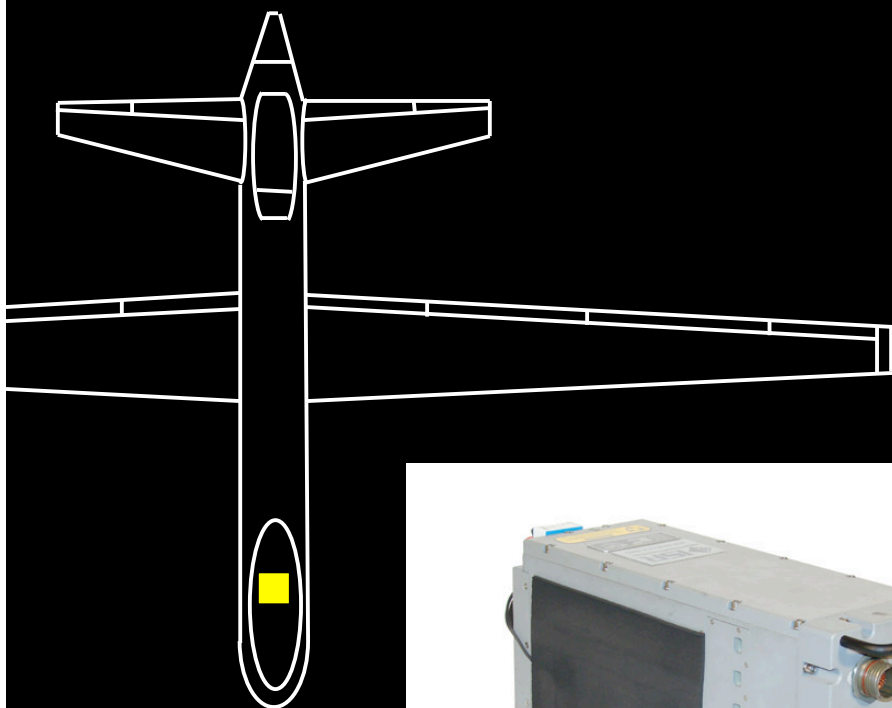


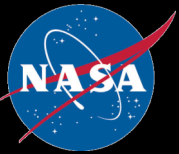
Ikhana Research Systems

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Airborne Research Test System (ARTS)

- Receives data from aircraft and payload sensors
- Hosts research flight controls
 - Autonomous mission management
 - Collision Avoidance
 - Precision trajectory
- Hosts payload processing algorithms
- Processes data for downlink





Ground Systems

IKHANA

- Mobile Ground Control Station
 - Dual pilot control station
 - 6 Engineering/Science workstations
 - Range safety workstation
 - Intercom system throughout
 - Overhead mission displays
 - Telephones
 - Printer
 - Remote video from aircraft start-up/shut-down site
 - Downlink video and data recording
- Mobile 2.4m Ku SatCom Antenna
 - Dual redundant receiver/transmitters

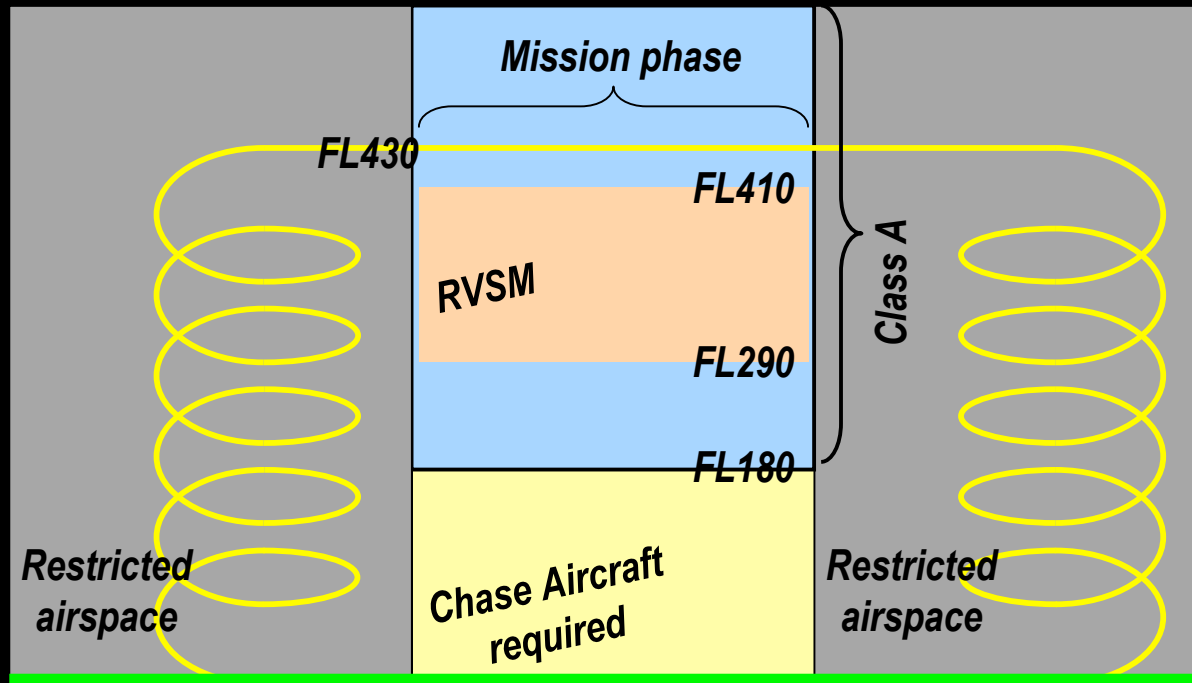


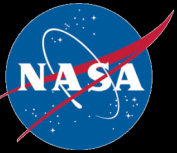


Operations Concept

IKHANA

- Currently UAS operations in the U.S. require certificate of authorization (COA) outside segregated airspace
- Chase aircraft required below 18k in the U.S. National Airspace (NAS)
- Air traffic control (ATC) used for collision avoidance above 18,000 ft
- UAS systems not qualified for Reduced Vertical Separation Minima (RVSM)
- Air traffic control prefers UAS flight above majority of air traffic
- Missions in the NAS will follow specific routes, separate from commercial airways
- Slow airspeed difficult to integrate with commercial air traffic
- Vertical profiling discouraged due to difficulty in routing traffic





Concluding Remarks

IKHANA

- Ikhana will begin operations this summer
- Focused on simple integration of sensor payloads
- Advanced capability to network sensors, communication, and flight control
- UAS operations will continue to be challenging
 - Airspace access
 - Contingency planning
 - Human machine interface
 - Altitude vs endurance vs payload trade-off