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

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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

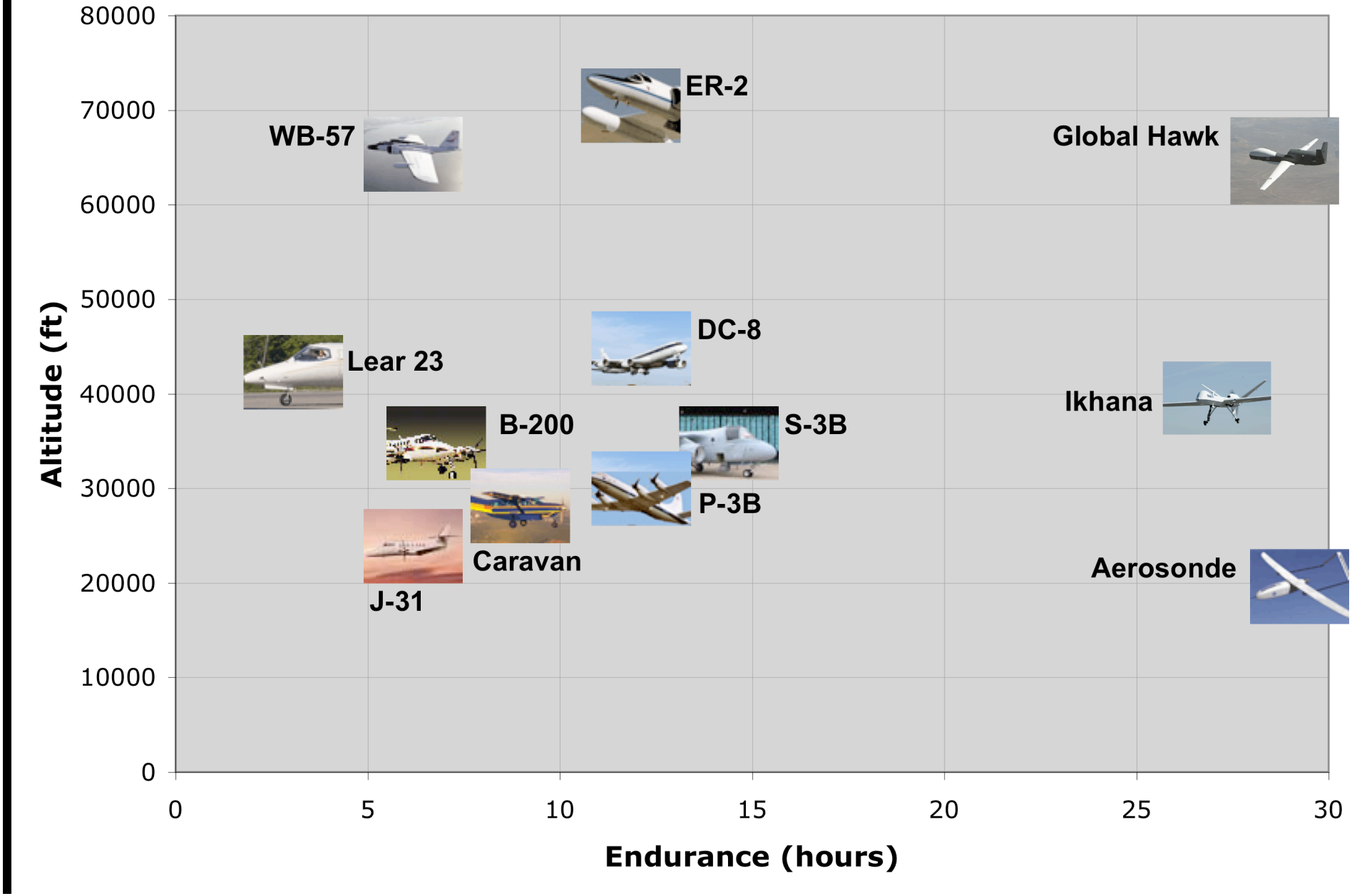
Aircraft Selection Criteria

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

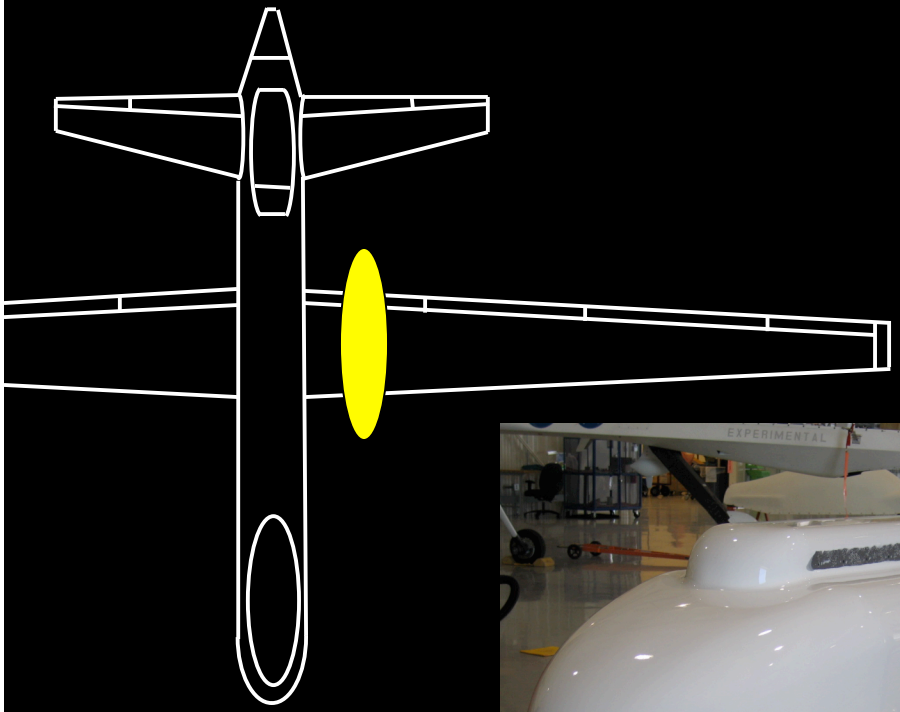


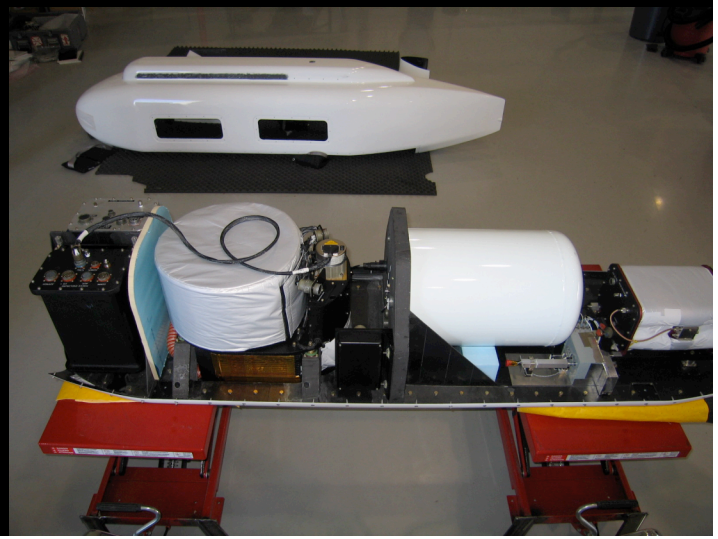
Ikhana Research Systems

IKHANA

Payload Areas

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





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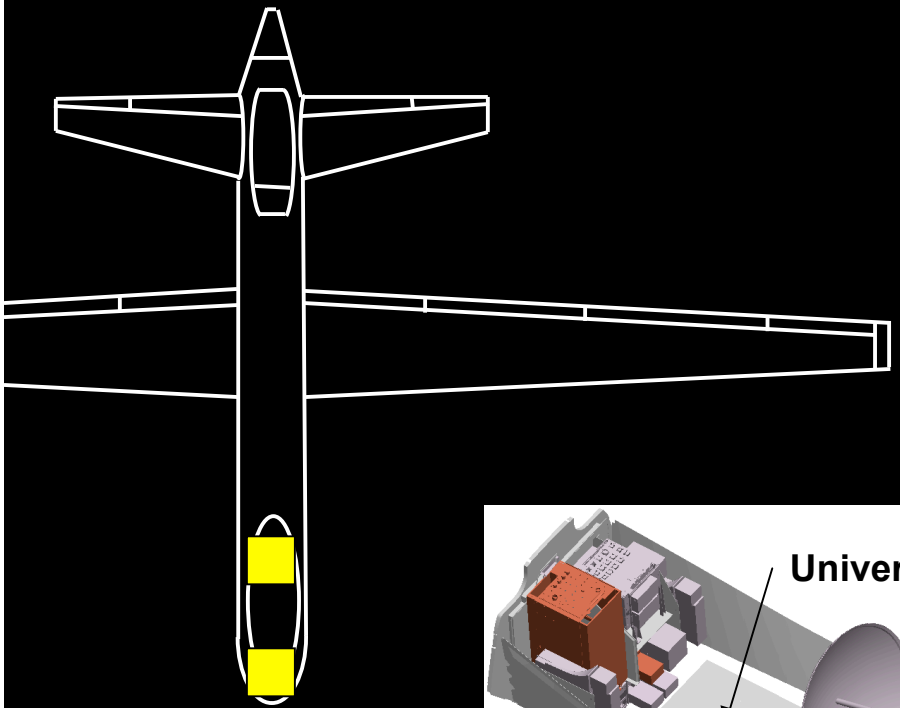

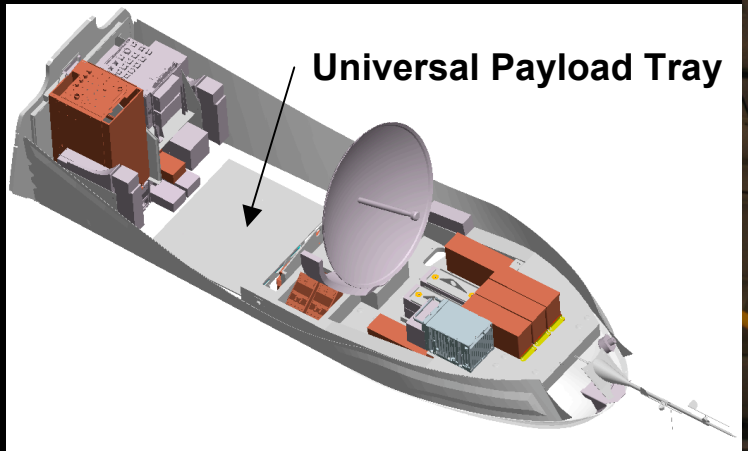

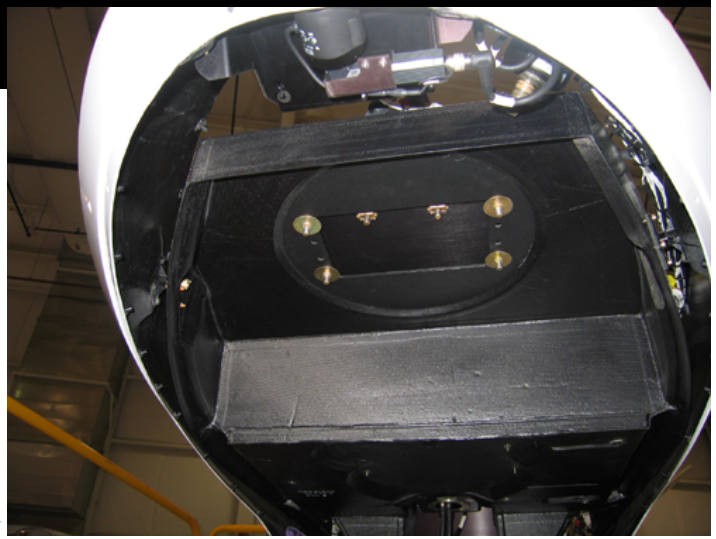

Ikhana Research Systems

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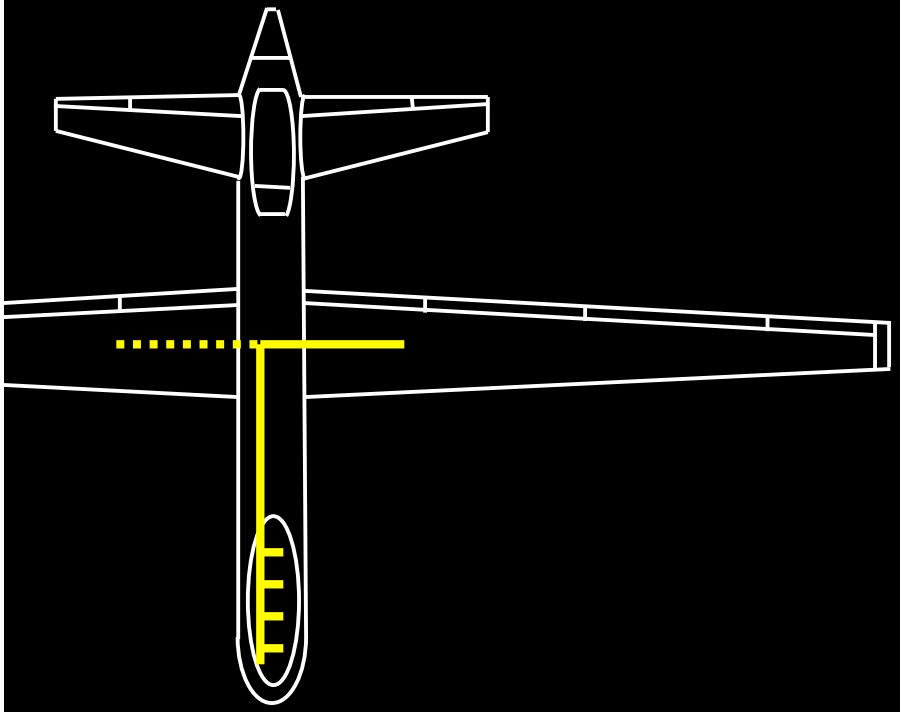

Experimenter Network

- 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

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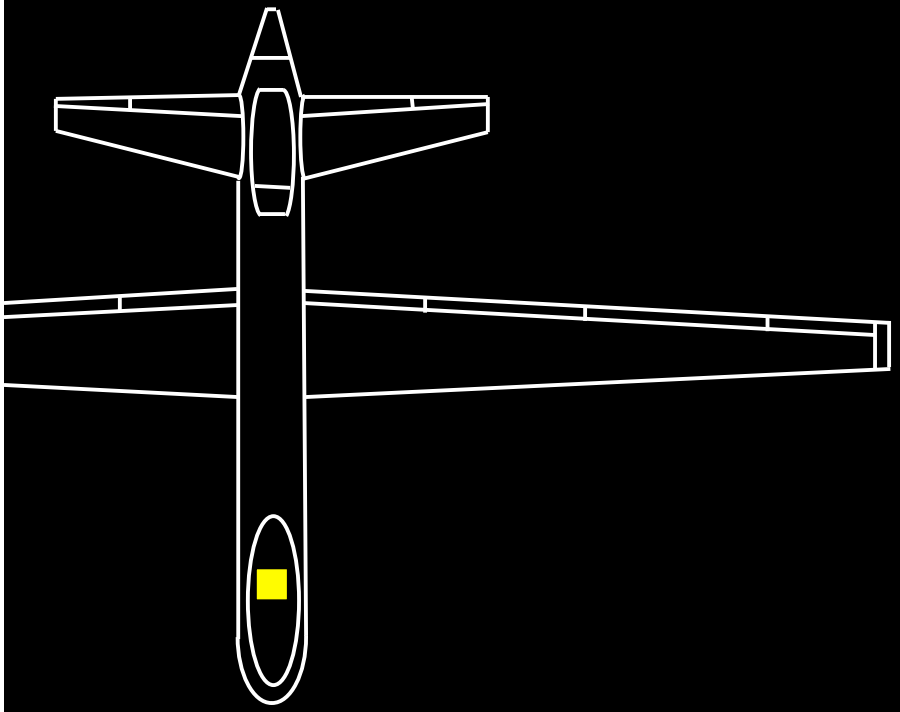

Network Data Recorder

- 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

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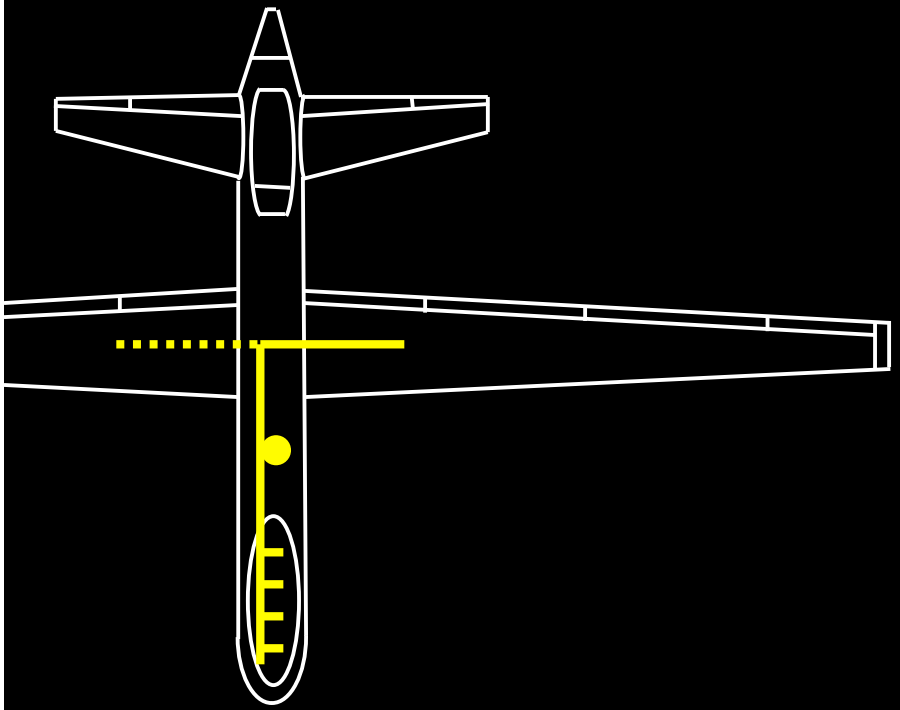
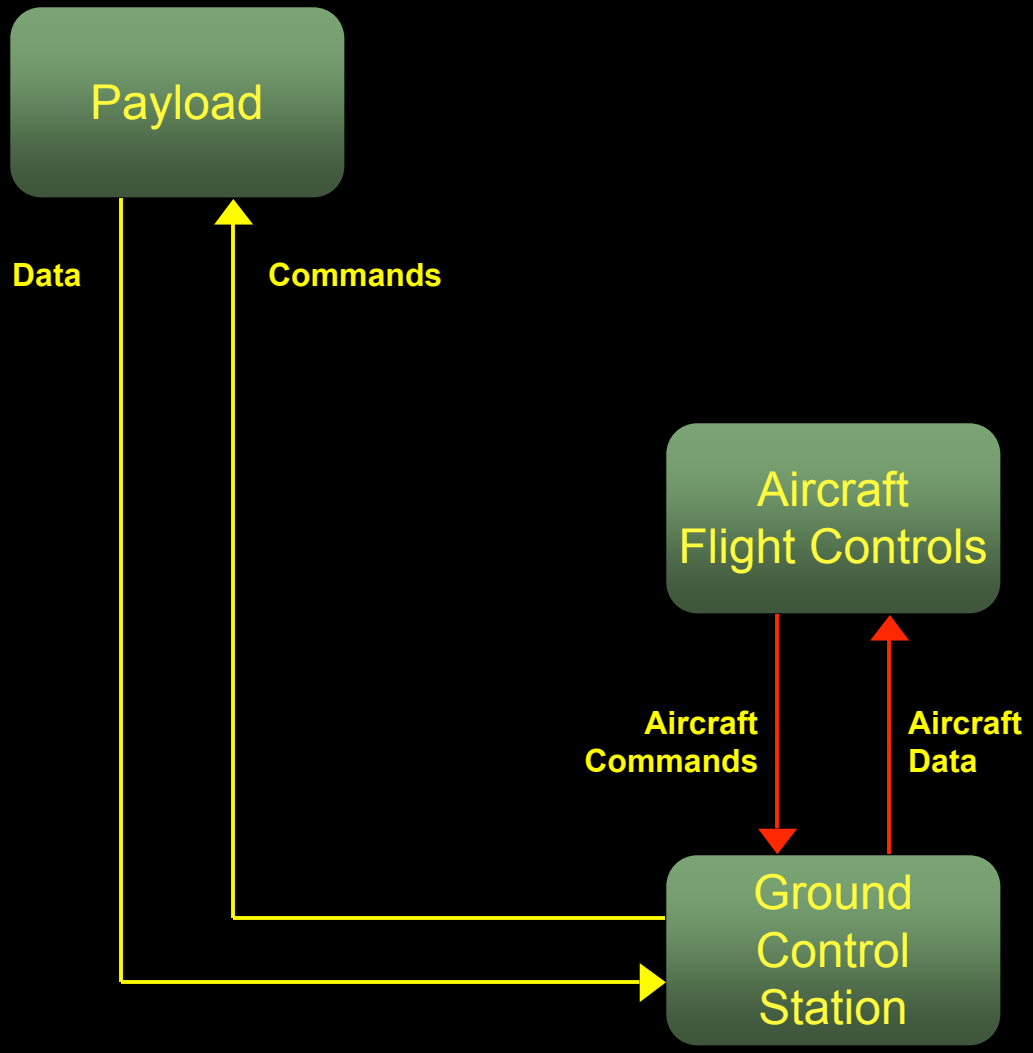


GPS Antenna connections

- 8 powered L1/L2 antenna connections

Airborne Research Test System (ARTS)

IKHANA



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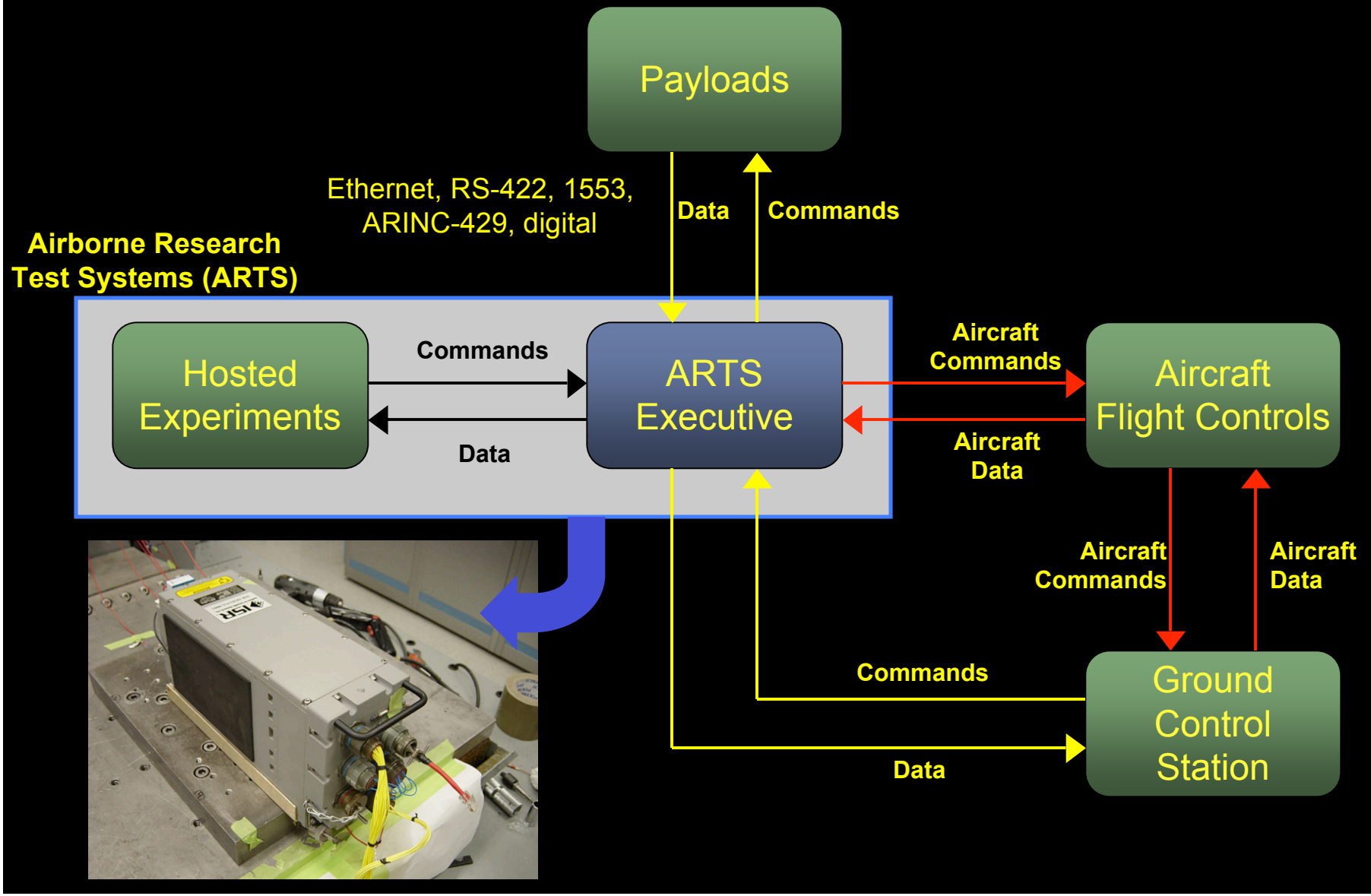

Ikhana Research Systems

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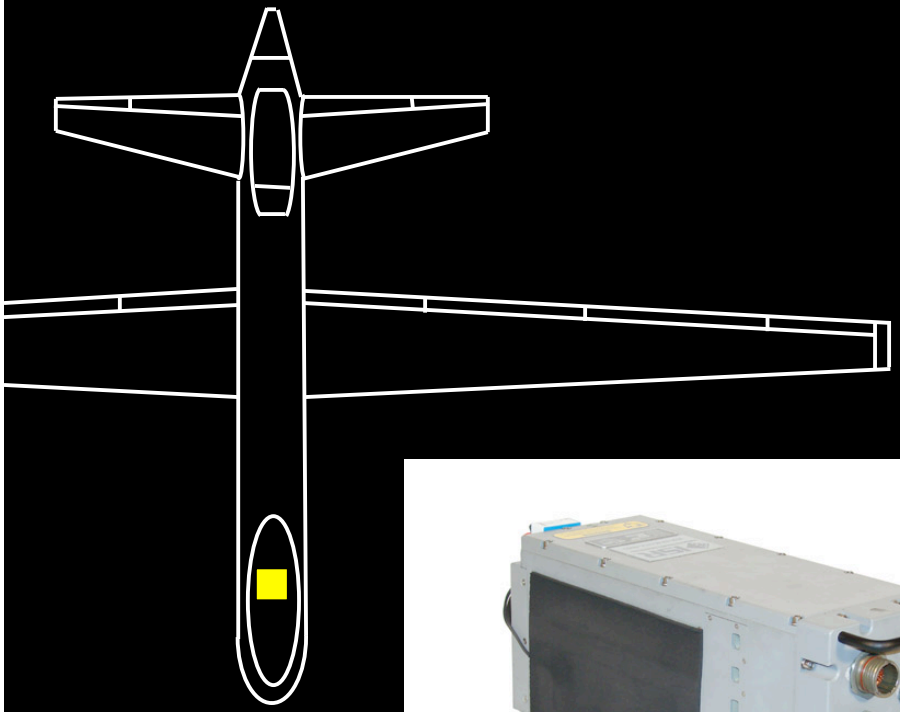
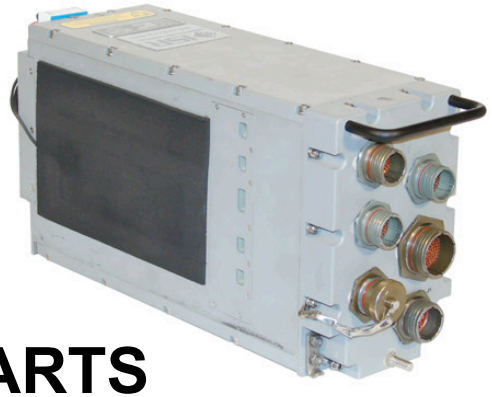


Airborne Research Test System (ARTS)

- 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



ARTS

Ground Systems

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- 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

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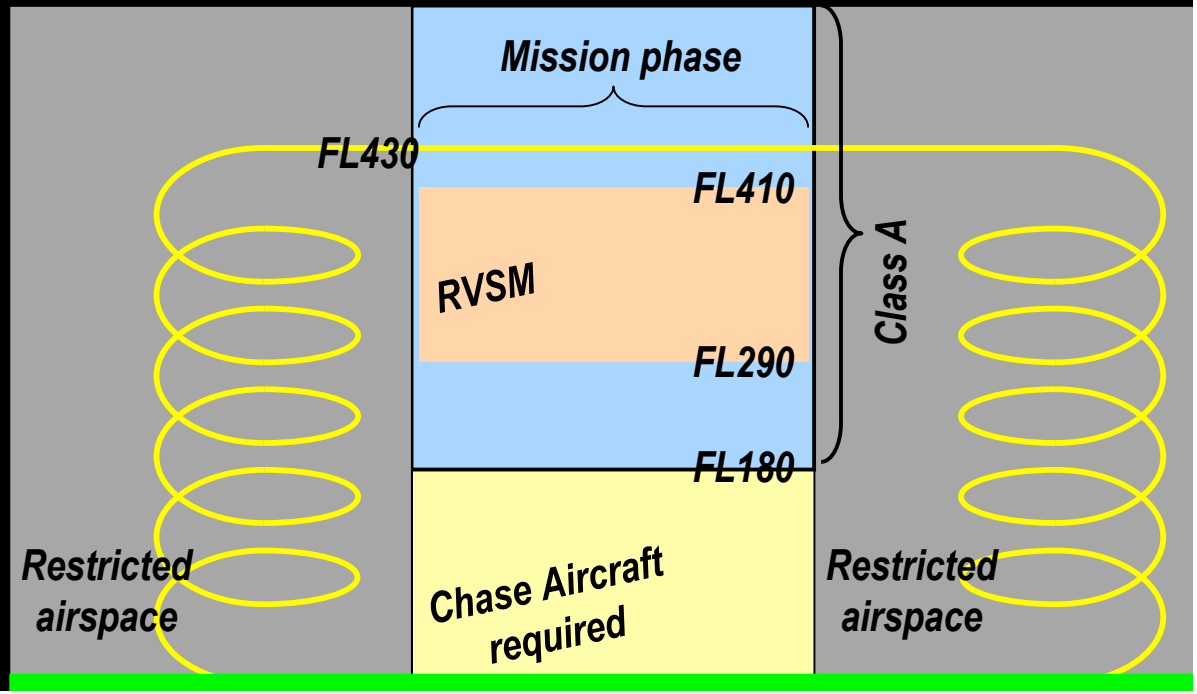
- Currently UAS operations in the U.S. require certificate of authorization (COA) outside segregated airspace
- Chase aircraft required below 18k in the U.S. National Airspace (NAS)
- Air traffic control (ATC) used for collision avoidance above 18,000 ft
- UAS systems not qualified for Reduced Vertical 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

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- 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