Senior Design

Autonomous
Quad-Rotor Project:

ICARUS

Saluki Engineering Company

Integrated Complex Advanced Robotic Unmanned System

David Gitz, EE, **ICARUS** Lead Engineer

Topics:

- ICARUS Team
- System Description
- Capabilities and Technologies
- System Specifications
- Senior Design Proposals

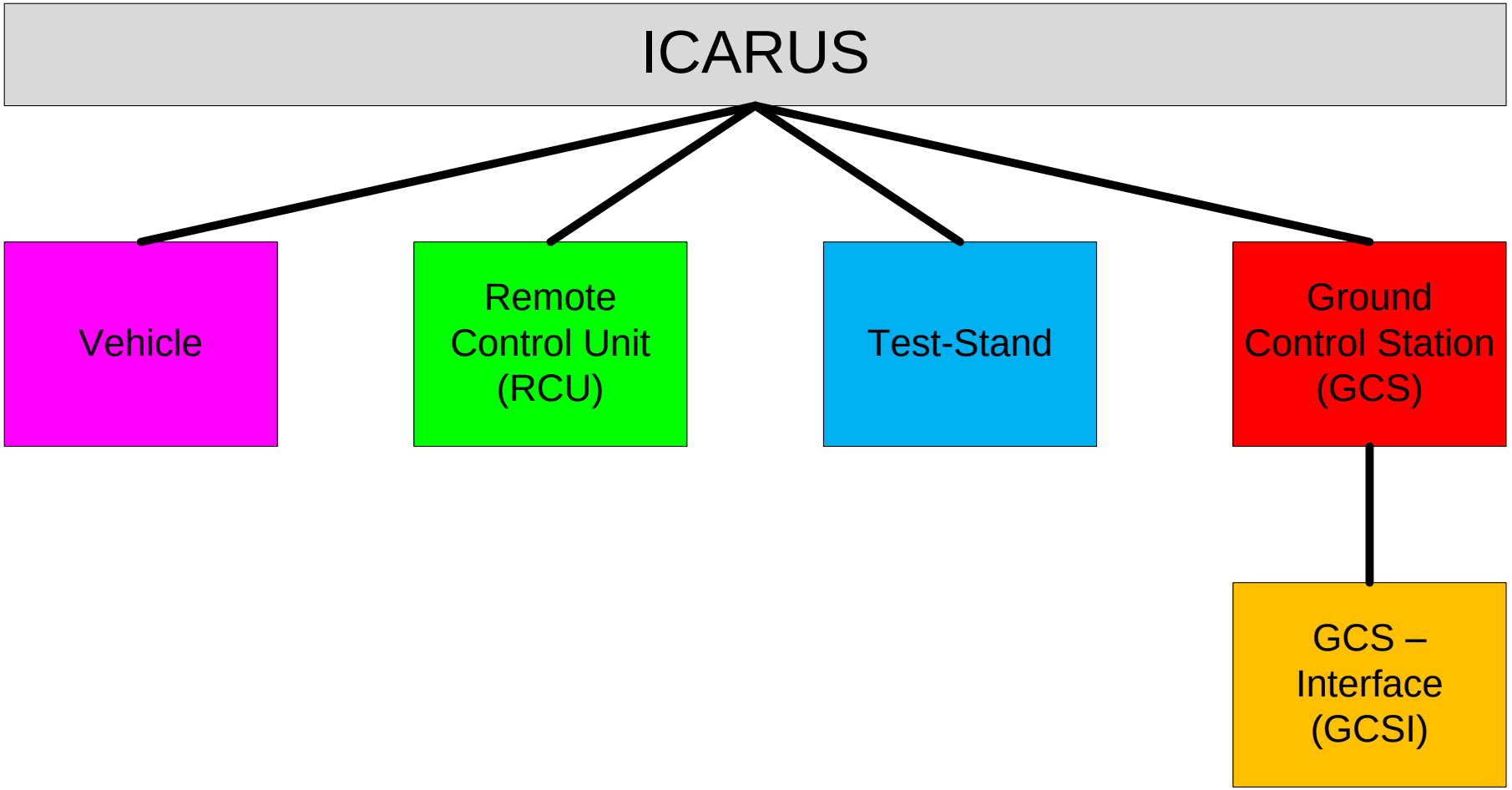
Core Team

- David Gitz
  - Electrical Engineer
  - **ICARUS** Lead Engineer
  - **FAST Robotics** CEO
- Ben Wasson
  - Masters Student
  - **FAST Robotics** Business Manager
- Amy Welling
  - **FAST Robotics** Accounting Director
- Michael Welling
  - PhD Candidate
  - **ICARUS** Systems Engineer
- Arjun Sadahalli
  - PhD Candidate
  - **ICARUS** Vehicle Support Engineer
- Ed Langenderfer
  - Mechanical Engineer
  - **ICARUS** Vehicle Fabrication Engineer
- James Chaklos
  - Masters Student
  - **ICARUS** Test-Stand Engineer
- Steve Warren
  - Computer Engineer
  - **ICARUS** Communications Engineer

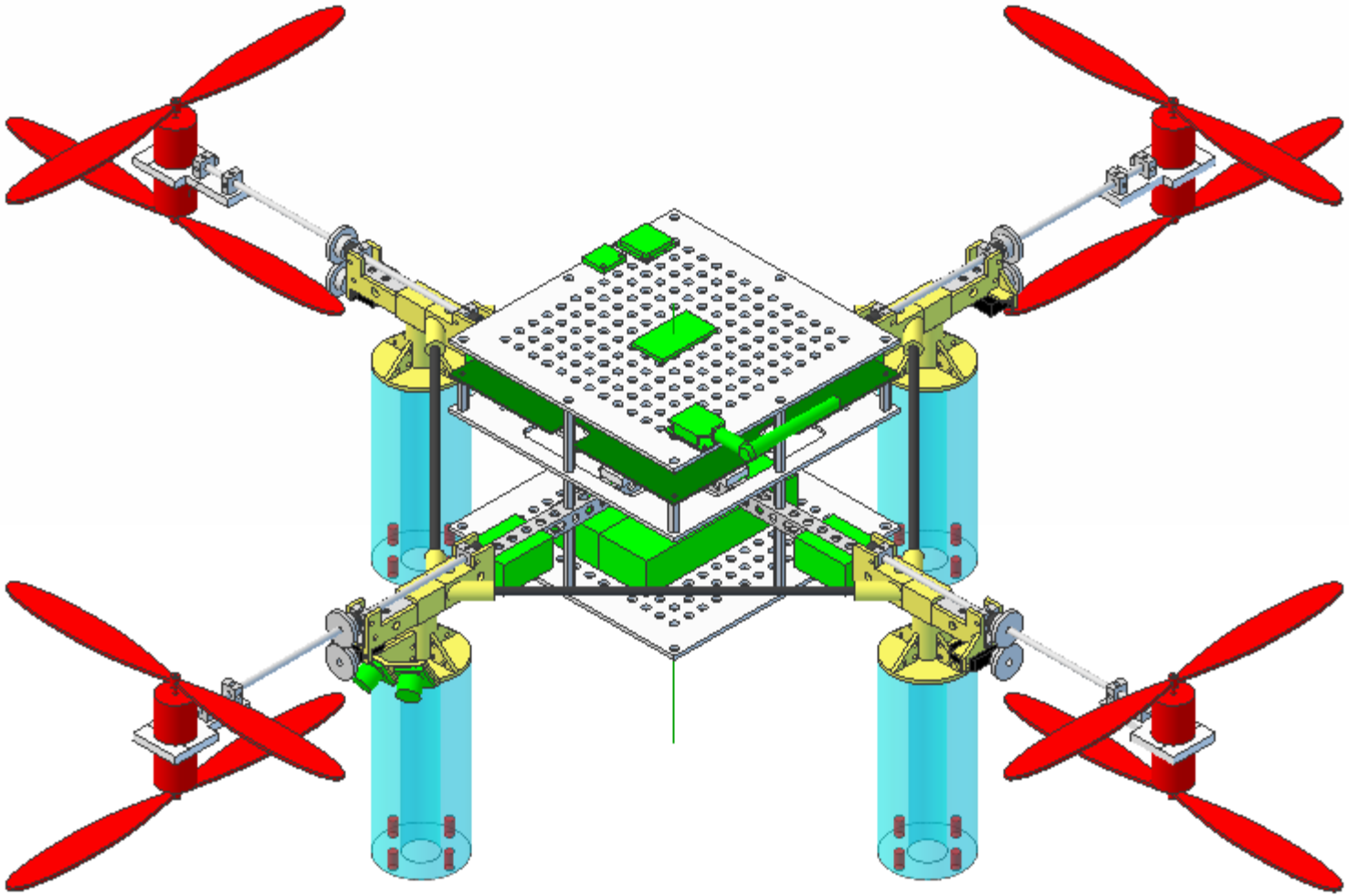
Satellite Teams

- Washington University UAV Team
- SIU-Carbondale Control Systems Lab
- Boeing Volunteers

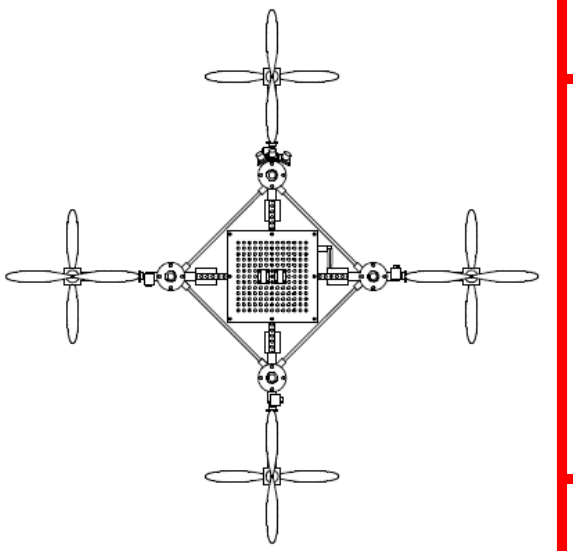
System Description

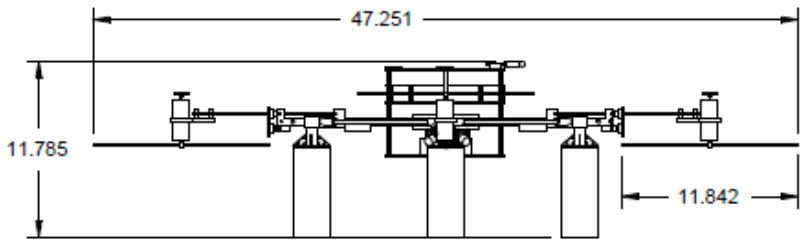


Vehicle



Vehicle



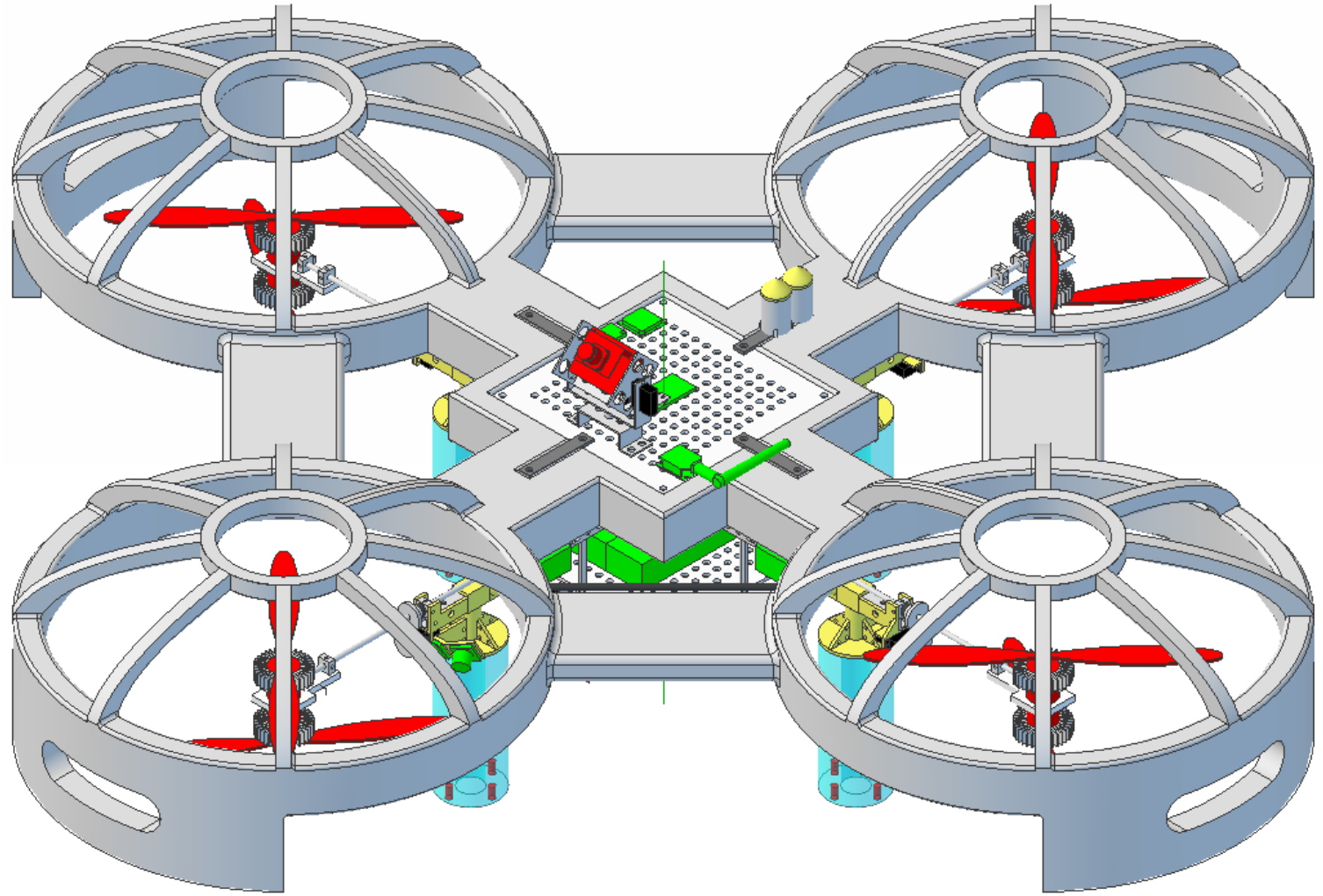


- Quad-Rotor design – Offers simpler control system with fewer moving parts than a single rotor helicopter and minor reduction in lift capacity

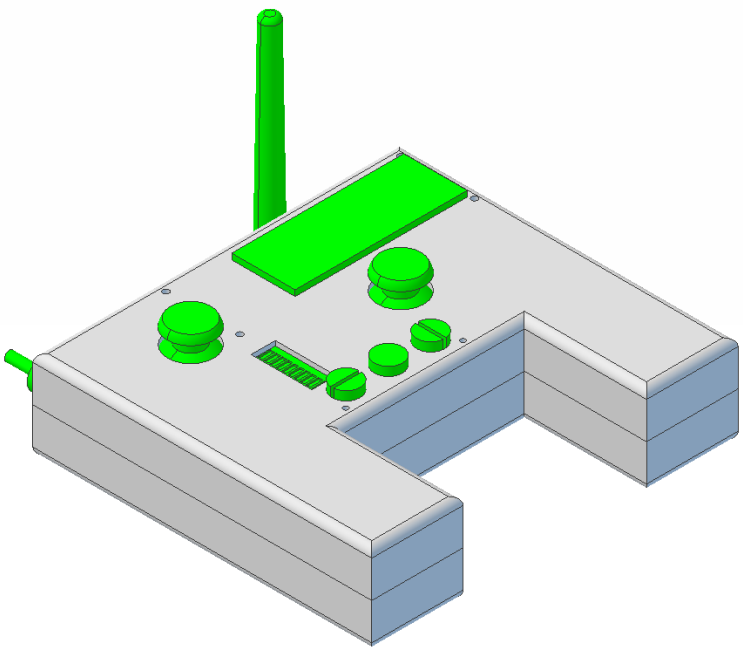
Vehicle Specifications

- Sensors: 3-Axis Accelerometer, 3-Axis Gyroscope, 3-Axis Magnetometer (INU), Digital Compass, Altimeter, GPS, 7 Ultrasonic Sensors
- Power: 8 Brushless DC 200 Watt Motors, 4 Micro Servo's, 2 Lithium-Poly 11.1V 5 Amp-Hours Batteries, 8 18A Electronic Speed Controllers, 5V and 3.3V Linear Voltage Regulators.
- Control: SoM Controller (Primary), Propeller Controller (Secondary), custom PCB.
- Communications: Xbee Radio for Command/Control, Video Transmitter, Wi-Fi.
- Fabrication: ~50% COTS, ~50% produced by MakerBot/Ponoku.

Vehicle w/ Prototype Systems



RCU

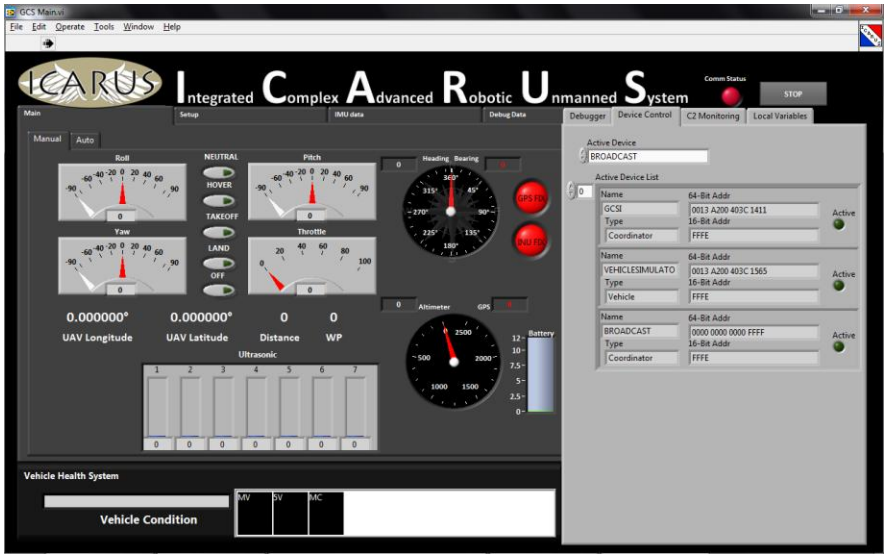


- Features:
  - Dual 2-Axis Joysticks and Button Pad, Kill Switch
  - Mode and Error Display
  - Vehicle Battery Indicator,
  - Force-Feedback
  - 5 hours of continuous operation.

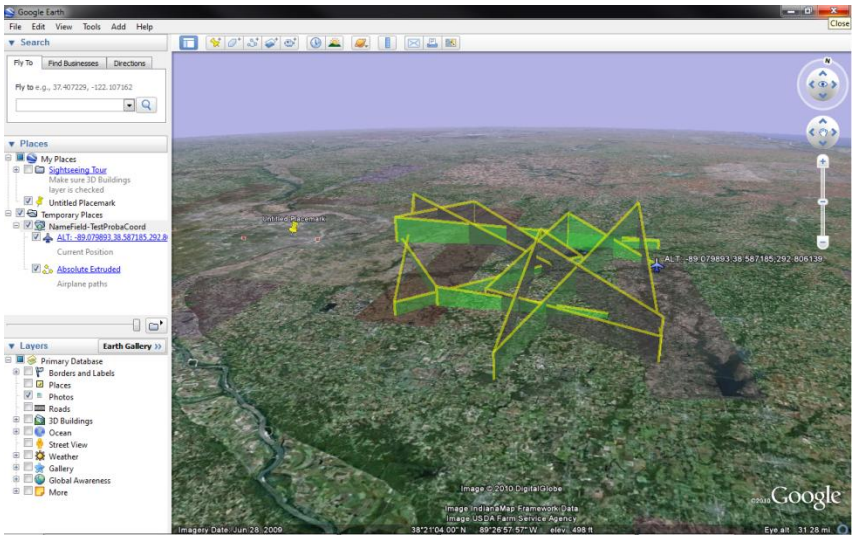
GCS

- Includes computer, touch-screen monitor and batteries for field operation.
- Communications Radio and Video Receiver
- Heavy-duty field transportable case

GCS Interface



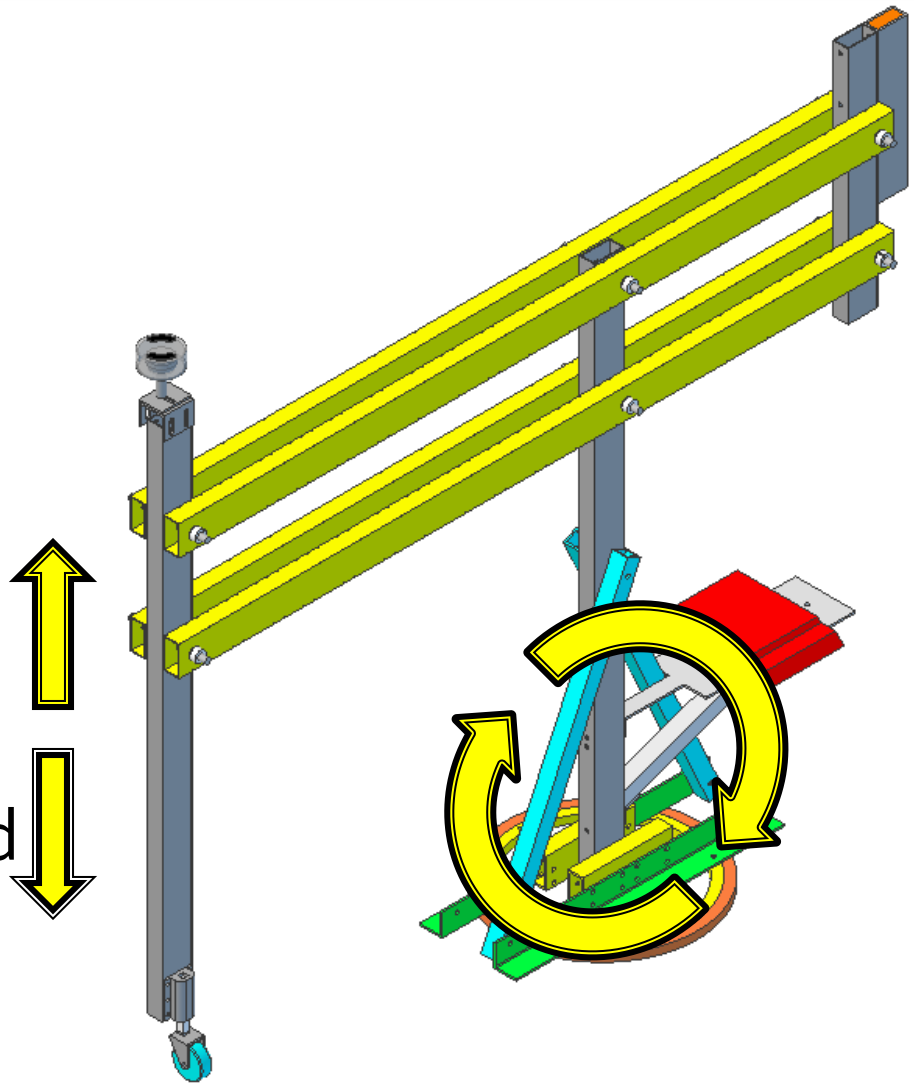
- Manual Control
  - Vehicle Sensor Display
  - Vehicle Health/Feedback System
- Autonomous Control
  - Set, Transmit Waypoints
- Communications
  - View Network Status
- Configuration/Debugging



- Google Earth Integration
  - Fully controllable Google Earth (location search, zoom, pan, etc).
- View Waypoints and Vehicle Location/Path

Test-Stand

- Used for Vehicle Calibration and Capacity measurements
- Able to Pivot vertically, rotate continuously and pitch/yaw/roll on Test-Fixture Assembly
- Power applied to Vehicle via Slip-Ring – No tangled wires



Capabilities

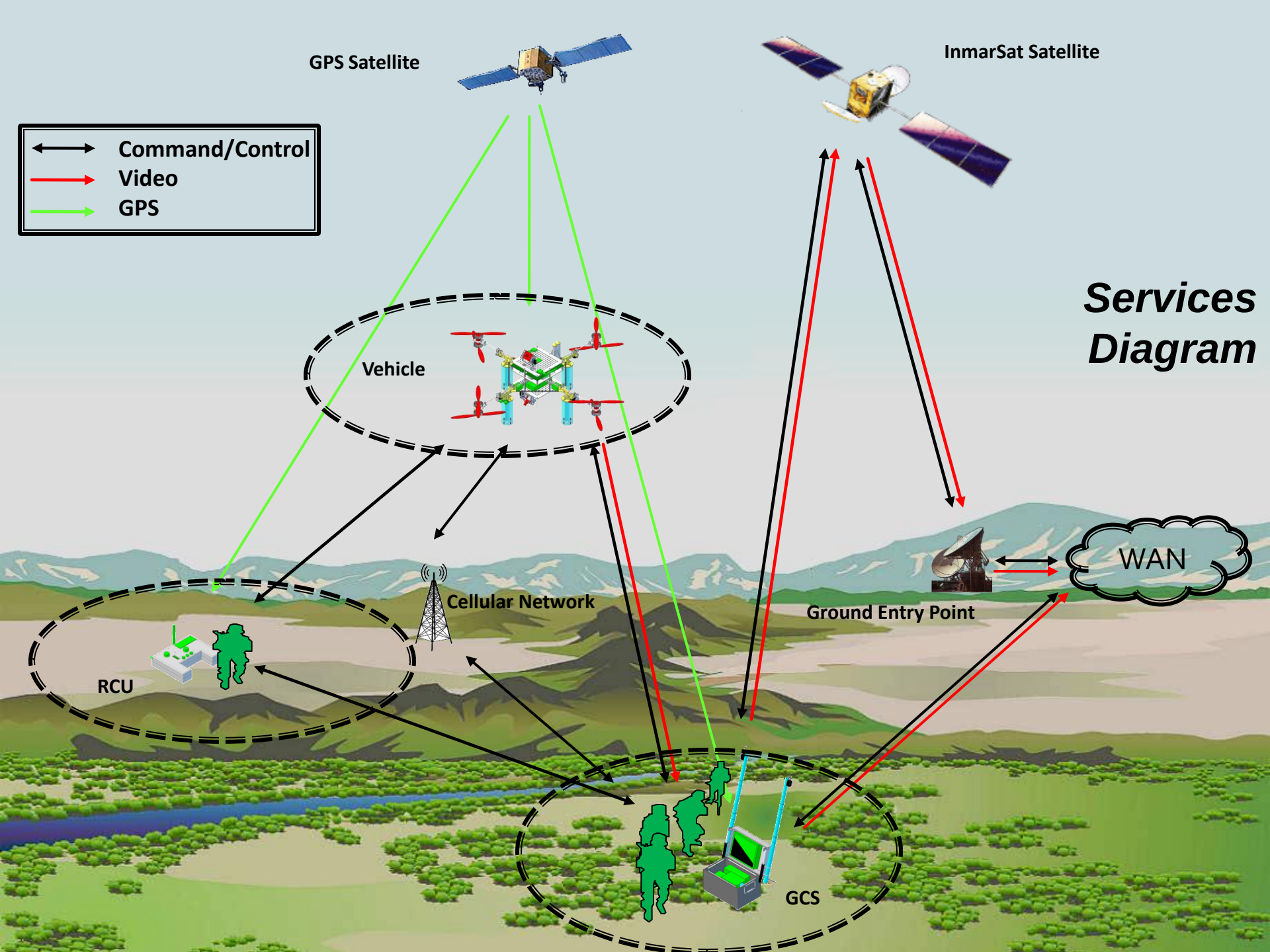
Capabilities - Planned	
Manual Control via RCU or GCS	Simple Calibration and Testing via Test-Stand
Limited Autonomous Navigation via RCU	Error Display on RCU and GCS
Extended Autonomous Navigation via GCS	Force-Feedback on RCU
Automatic Takeoff, Hover and Landing	Vehicle Health Reporting

Capabilities - Future	
Real-Time Video Transmission to GCS	Image Capture
Wireless airborne programming	Advanced Hover modes
Vehicle Status Audio via RCU	Extended Range
Configurable Payloads	Terrain Following
Extended Flight Duration	Obstacle Avoidance
Swarm Autonomy	Vehicle Status - Audio

Technologies

Technologies - Planned	
Command/Control Network Monitoring	Inertial Navigation Unit (INU) w/ Altitude and Heading Reference System (AHRS)
Power Management	Primary/Secondary Controller Implementation
Waypoint Navigation	Communications Protocol

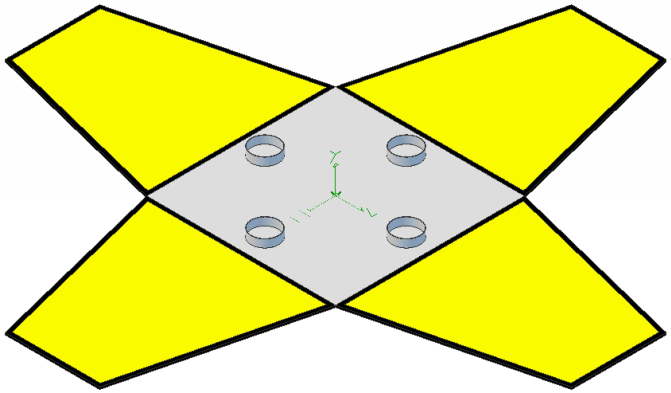
Technologies - Future	
3d Feedback	Audio Commands
Automatic Landing Pad	Cellular Network
Cel-Phone Control	Co-Axial Rotors
Data Storage	GCS Interface (MATLAB)
JAUS Interoperability	Motor Heat Dissipation
R/C Control	RCU Testing Software
Recovery System	Tilt Rotors
Satellite Communications	Simultaneous Localization and Mapping (SLAM)
Target Detection	Wireless Charging


GPS Satellite
InmarSat Satellite
Command/Control
Video
GPS
Vehicle
Services
Diagram
Cellular Network
WAN
Ground Entry Point
RCU
GCS

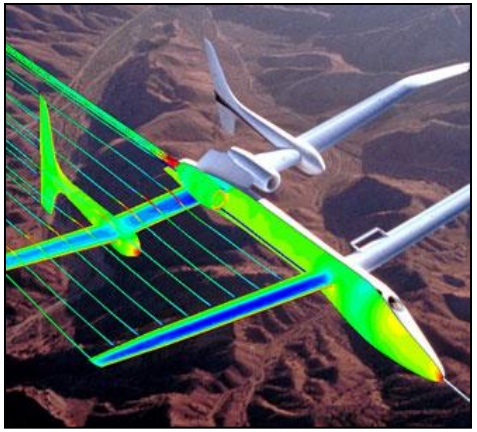
System Specifications

- Range: ~1.5 km LOS (~3km with Xbee Mesh Network)
- Duration:
  - Vehicle: ~12 min (100% Throttle) , ~20 min (Hover)
  - RCU: ~4-6 hrs
  - GCS: ~4-6 hrs (including field charging Vehicle)
- Speed: ~2 - 4 kph
- Weight: ~5.5 lbs
- Size: 48" x 48" x 10.5"
- Propeller Rotation: Max: 3,000 RPM
- Vertical Thrust: ~7.8 lbs

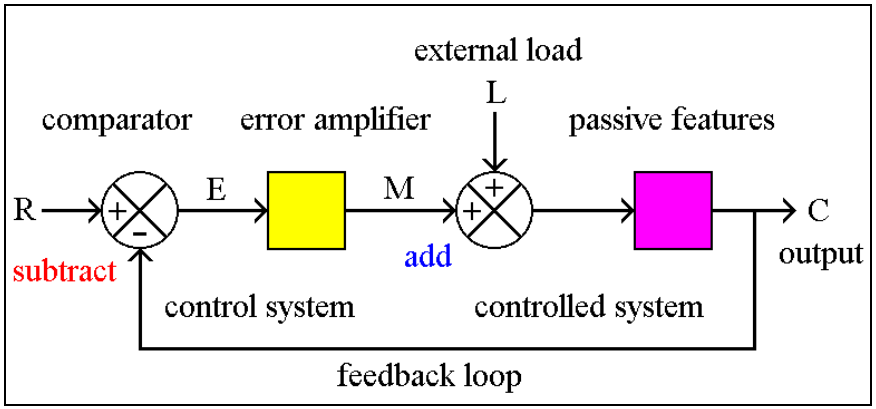
Senior Design Proposals



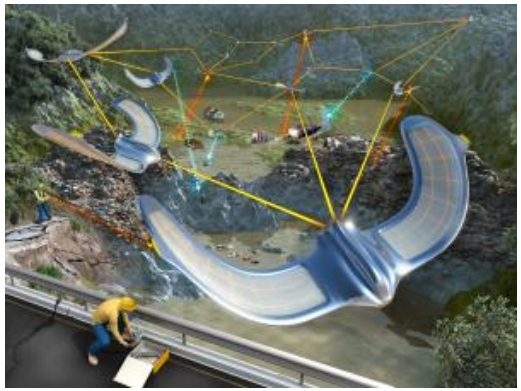
Automatic Landing Pad



Aerodynamic Analysis



Control System Design



Swarm Autonomy

Questions?

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