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THE TRAILBLAZER™ CLASS OF LOW COST SPACE VEHICLE

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THE TRAILBLAZER™ CLASS OF LOW COST SPACE VEHICLE

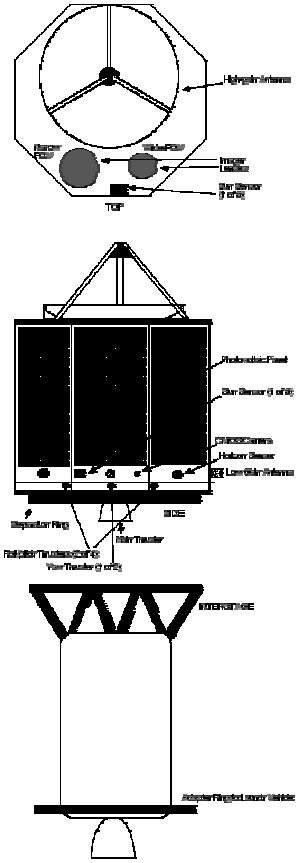
- Overview
- Spacecraft Architecture
- Development Approach
- Applications
- Summary

Overview

- History
  - Originally developed for *TrailBlazer*™ lunar orbiter mission by TransOrbital, Inc.
  - Lunar mission scheduled to occur within a year
  - Design adaptable to a range of missions
- General Design Factors
  - Sufficient power independent of spacecraft orientation
  - Symmetric design
  - No gimbals required for sensors, antennas, solar panels
  - Dependence on off-the-shelf components
  - Adaptable to a range of launch vehicles

TrailBlazer™ Microspacecraft

- Microspacecraft Bus:
  - 90 cm long x 93 cm diameter
  - 101 kg fueled
  - Photovoltaic power, Li-ion battery
  - 3-Axis stabilized operation with thermal stabilization roll for cruise
  - Sun, Horizon, & star field sensors, IMU
  - S-band telemetry & telecommand
  - Hydrogen Peroxide maneuvering & on-board propulsion



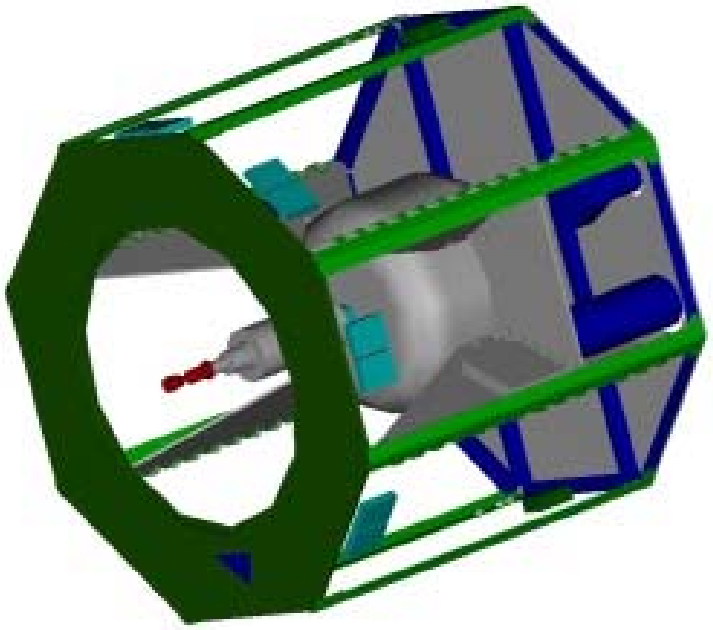
TrailBlazer™ Microspacecraft

- Payload:
  - 2 high-resolution cameras with data processing computer and storage
  - X-band RF system and high-gain antenna
  - Radiometer for Far-Side Radio Observatory RFI study (International Academy of Astronautics)
  - Inert cargo carriage

TrailBlazer Structural Test Article, in vibration testing, Yuzhnoye Design Office, Ukraine

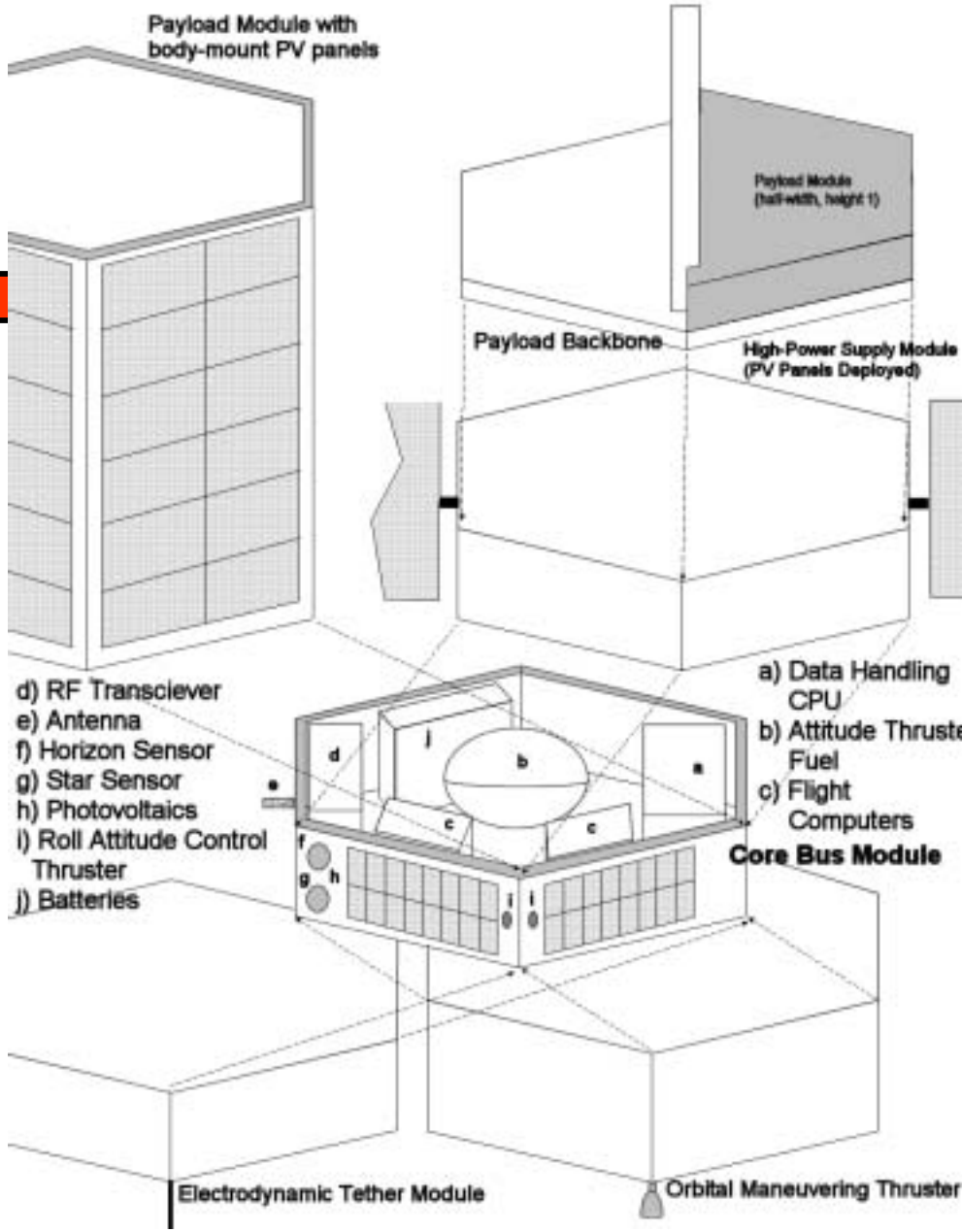
TrailBlazer™ Microspacecraft

- Design Features
  - Bus functions concentrated on rear bulkhead
  - Payload functions concentrated on front bulkhead
  - Launch on Russian *Dnepr*



TrailBlazer™ Multi-purpose Bus

- Base microspacecraft bus
- Add-on power, payload, & propulsion modules
- Extensive use of COTS components and standardized interfaces

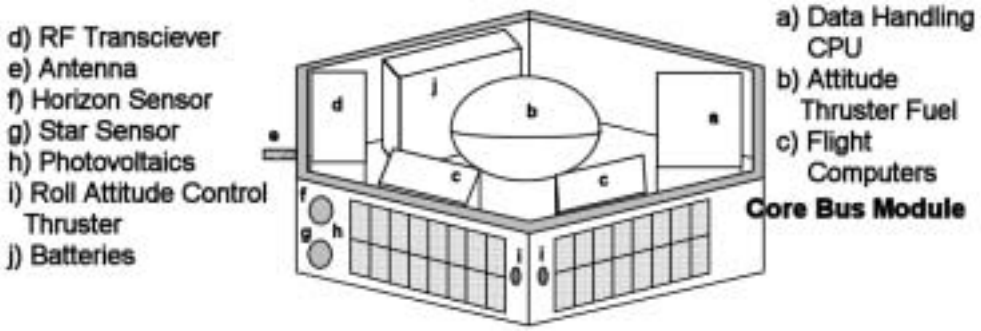


TrailBlazer™ Multi-purpose Bus

- Standardized, modular architecture based on TrailBlazer™ Spacecraft
  - Base bus module
    - Common attachments for power, propulsion, other general-purpose functions
    - Pre-tested and stored
  - Payload modules
    - Standardized attachment, packaging, interconnection format
    - Standardized modules also (e.g., optical)
    - Pre-tested and stored
  - Advantages of Standardization and Repetitive Production
    - Improved reliability
    - Results in less overall spacecraft testing time and cost

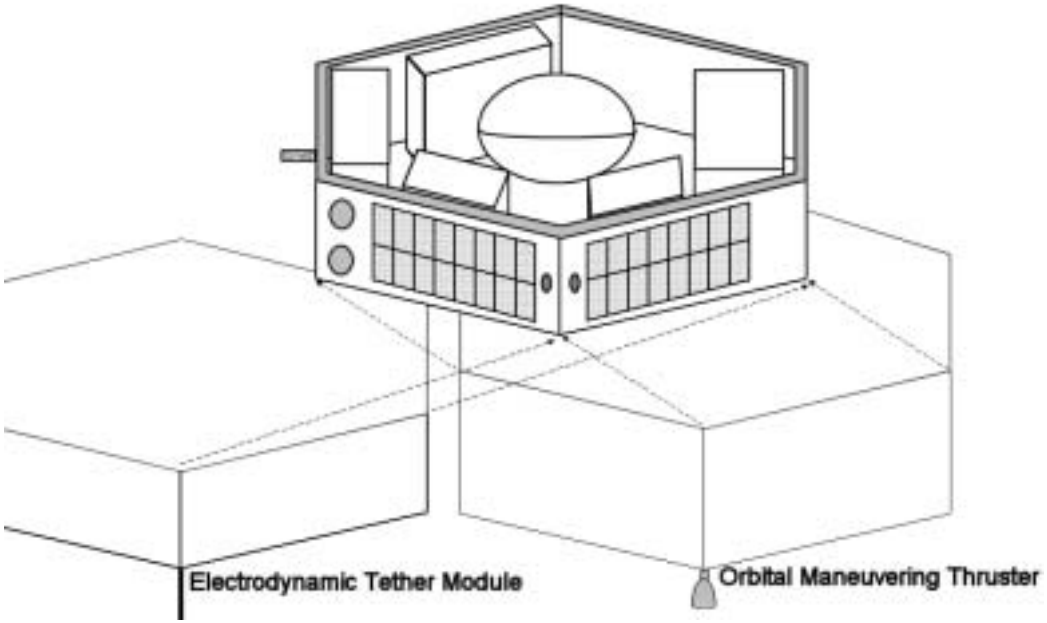
Development Approach

- Modular Architecture
  - "Pizza box" module in base of spacecraft
    - Flight control computers
    - Attitude control and navigation sensors
      - Optical Sun and horizon sensors
      - Inertial measurement unit
    - Attitude control systems
      - Thrusters and/or
      - Reaction wheels
    - Data handling computers
    - Telemetry transceivers and antennas
    - Power storage and handling
    - Sufficient photovoltaic capability to maintain emergency and long on-orbit storage capability



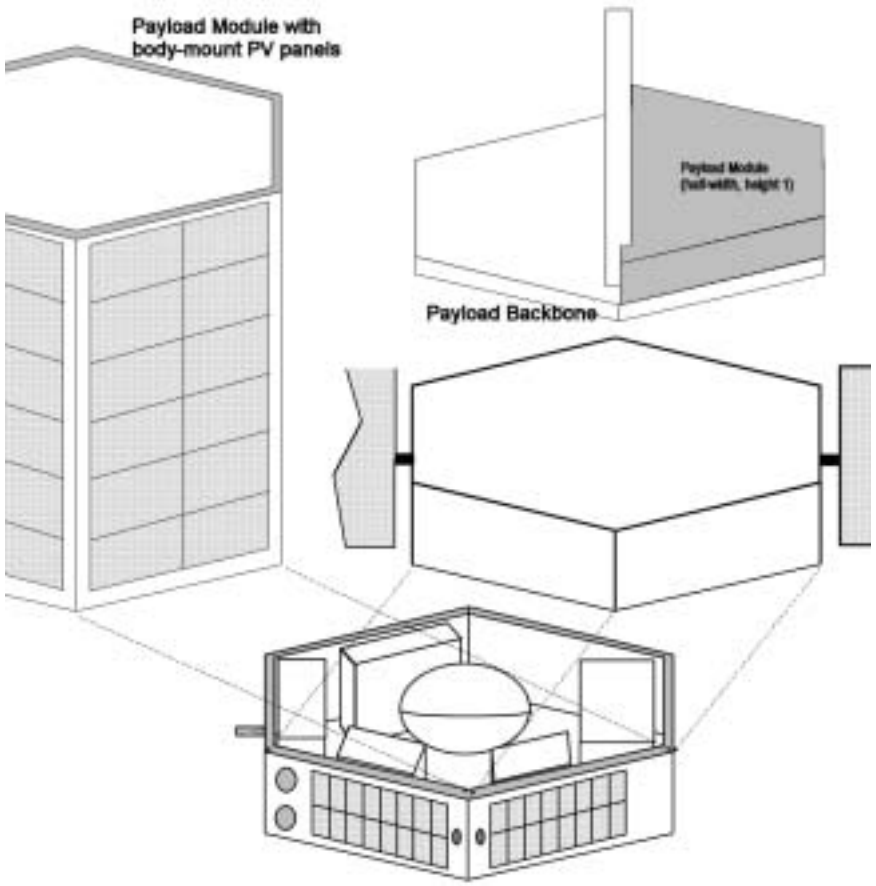
Modular Architecture (Cont'd)

- Variations possible to accommodate different missions
  - Orbital maneuvering/adjustment modules can attach to the rear of the base bus module
    - Gravity stabilization tethers or booms
    - Electrodynamic tethers
    - Mono- or bi-propellant thrusters



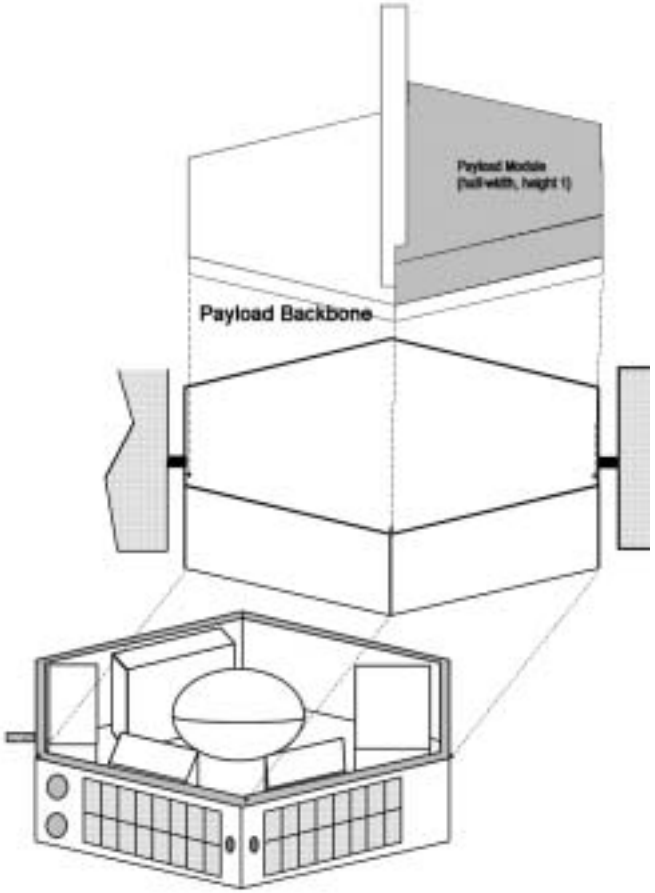
Modular Architecture (Cont'd)

- Power and Payload modules attach to the front face of base module
  - Wrap-around PV panels (like TrailBlazer™) enclose payload
  - Deployable Photovoltaic Panel module sits under payload



Modular Architecture (Cont'd)

- "Building brick approach to payload modules
  - Payload can occupy entire hexagonal volume **OR**
  - "Backbone" module - vertical strut for mounting modular payload "blocks", such as
    - Deployable solar panels to increase power from the 100 – 200 watts available from wrap-around panels
    - High-bit-rate transmitter
    - Manipulator arm
    - Sensors



Modular Architecture (Cont'd)

- Standardized interfaces for payload, power, and propulsion modules
  - 28 VDC spacecraft power bus
  - Commercial standard data buses
    - Low bit-rate (< 1 Mbit/sec) – For transmitting telecommand and telemetry among spacecraft components
      - CANbus[1]: Widespread hardware and software support
    - High bit-rate – For handling data from sensors
      - SpaceWire: variation on IEEE 1355 (100 Mbit/sec)
      - Fiber-Optic Data Bus Standard (1 Gbit/sec)
  - Standardized data interface formats
    - "Plug-and-Play" a key capability for both low cost and reliability
    - Consultative Committee for Space Data Systems standards used for telecommand/telemetry formatting

[1]CANBus is a trademark of Robert Bosch

Modular Architecture (Cont'd)

- Standardized interfaces for payload, power, and propulsion modules (cont'd)
  - Standardized mechanical, electrical, data, and thermal interfaces between modules.

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Applications

- Governmental/NASA
  - Discovery and Explorer class of missions
  - Target of opportunity missions (e.g., newly discovered near-Earth asteroids)
  - Military telecommunications and remote sensing missions
    - Cluster formation constellations
    - Rapid-Response launches
- Commercial
  - Communications
  - Inexpensive remote sensing
  - Component flight testing
  - Macro-spacecraft inspection and maintenance

Summary

- Responsive and low cost spacecraft driven by
  - Standard bus module based on TrailBlazer™ design
  - Capability for rapid assembly and configuration
    - Standardized interfaces
    - Modular components
  - Ease of customization