Optimizing the Small Satellite Platform
for Compelling Technology Demonstrations:
Bandit/Akoya Proximity Operations and Rapid Integration

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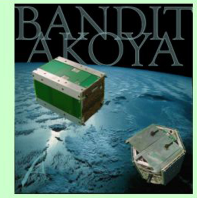
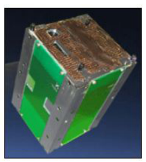


Small satellites have the potential to advance space technology at a fraction of the cost and time of traditional large-scale spacecraft. Unfortunately, due to the volume constraint of miniaturized satellites, microscale spacecraft often lack the payload and bus space to support complex missions.

Bandit/Akoya utilizes **distributed** design with a **plug-and-play** platform to perform **proximity operations** and **rapid integration** of two microscale vehicles and a host - *all under 35 kg and $70,000*.

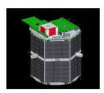
Students are directly responsible for *all* program elements.

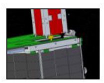
Bandit: The Free-Flyer
3kg, 12 x 12 x 18 cm (less than a triple CubeSat)



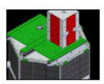
Primary
Proximity operations of a microscale free-flyer relative to a host spacecraft.

Extended
Repeatable docking, 6DOF control, visual navigation, autonomous flight





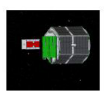
Short- to long-range, short-duration sorties
Small (3 kg), inexpensive ($15,000)

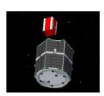


Akoya: The Host
29kg, 40h x 42d cm

Primary
Support Bandit.

Extended
Demonstrate RI&T with modularized subsystems, distributed C&DH, and standard power/data protocol.

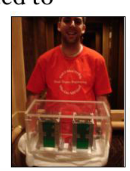




Stationary, long-duration mission
"Large" (29 kg), still inexpensive ($39,000)

Long-term survival functions are distributed to Akoya, such that Bandit is dominated by **mission-specific subsystems.**

By offloading subsystems, Bandit is **small**, **maneuverable**, and **expendable**.

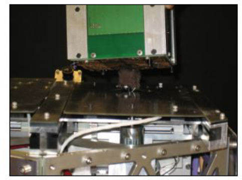


Fractionation:
Sharing Subsystems

Bandit's long-term needs are distributed to a Dock on Akoya. Bandit is **structurally decoupled**, but **dependent** on Akoya for survival and Mission Success.

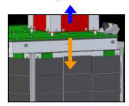
Station-keeping: Repeatable Soft-Docking

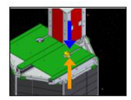
Bandit docks with **Velcro**!
Yes, it's low-tech! It's also:
- *Simple*
- *Strong (one hook hold 0.5 N)*
- *Repeatable*
- *Soft*
- *Extremely error-tolerant…*

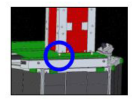


Power Charging

…And **electrically-conductive**.
- Bandit charges continuously and automatically while docked.
- Full charge in 2 hours, lasts 30 minutes


Detach


Redock


Charge

Complex Processing

Complex computing - image processing, autonomous algorithms - is performed on Akoya.

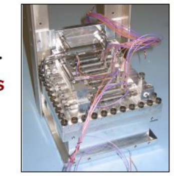
Communications Hub

Akoya is the **relay station** between Ground and Bandit. Bandit only needs **minimal cross-link** chip radios/antennas.

Prox Ops Design Features

80% of Bandit's volume is dedicated to **mission-specific subsystems**.

Akoya hosts multiple payloads.
Bandit-2 is a complete **on-orbit spare**.



Self-Propelling 6DOF Thrusters

Eight solenoid valves at compound 45° angles for uncoupled 6DOF actuation. Propulsion tank holds 12 m/s ΔV of R-134a ("Dust Off").

Blended Navigation Sensing

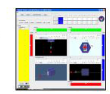
Primary Sensors:
- Roll rate gyros
- MEMS 3-axis accelerometer

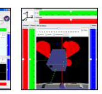
Secondary Sensors:
- Image processing
- IR range finder

When you lack the brawn *and* the brain…
- Bandit is too small and too slow for commercial accelerometers. (Nano-g resolution for a 10 minute sortie.)
- Bandit's processing is not fast enough for real-time video.

Just throw everything you've got at it…
- Slow/accurate secondary sensors refresh fast/inaccurate inertial sensors at 1/4 Hz and provide visual verification of position.

Or get out fast.
- Mission-critical sorties last < 4 minutes.



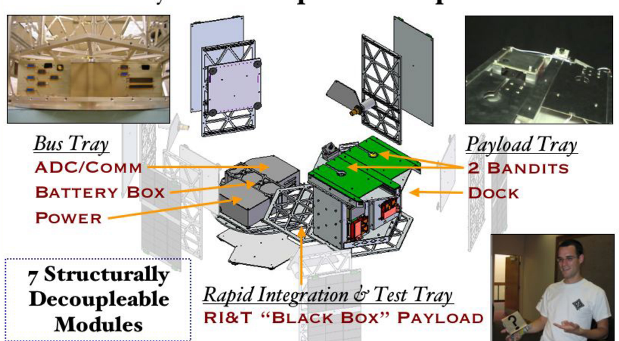


Visual Inspection & Autonomous Flight

- Bandit observes an **LED array** to determine pose.
- **3D computer estimator** visualizes real-time and simulated telemetry on the ground, including correction for sensor lag.
- Near-dock sorties fire thrusters on timer; complex sorties use adaptable **way-point or task-based algorithms**.

Modularity: Distributed C&DH

Akoya is a fully-customizable support bus, with **modularized plug-and-play** subsystems standardized by a **common power/data protocol**.

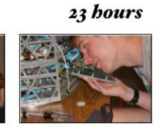


7 Structurally Decoupleable Modules

Each subsystem is controlled by its own **microprocessor** and conforms to the **standard power / data** Emerald Data Protocol. Elements can be inserted or removed **without interfering** with other components.

dCDH allows ease of testing and component swapping. Not just "rapid," but *immediate* integration:

20th Annual Small Sat	NanoSat-4 FCR
WU/SCU "Black Box" Swap #1 ***10 minutes***	WU/SCU "Black Box" Swap #2 ***2 minutes****
WU/SCU Inter-Sat Integration ***30 minutes***	WU Protoflight Final Integration ***23 hours***



** Because the embedded systems engineer was distracted by the pretty box.*

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