Dependable Multiprocessor (DM) Implementation for Nano-satellite and CubeSat Applications

(Challenging Packaging for High Performance Embedded Computing)

Précis

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Overview

- Space applications have been, and will continue to be, subject to severe size, weight, and power constraints

- The need for/use of high performance embedded computing in space exacerbates the size, weight, and power problems

- Flying high performance embedded computing in nano-satellite and CubeSat applications presents unique problems which require unique solutions

- Small, light-weight, low power, COTS Computer-on-Module (COM), e.g., Gumstix, technologies are potential solutions to the size, weight, and power problems

- Platform- and technology-independent Dependable Multiprocessor Middleware (DMM) allows COMs to be used in nano-satellite and Cubesat applications

Size and Weight Challenges

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- **CubeSats are flown in various sizes**
  - 1U and 3U CubeSats are the most popular
  - 6U and 12U CubeSats are on the drawing boards

- **1U and 3U CubeSats are launched from P-PODs (Poly-Picosatellite Orbital Deployers)**

- **A P-POD can launch three (3) 1U CubeSats, one (1) 1U and one (1) 2U CubeSat, or one (1) 3U CubeSat**

Prototype CubeSat Launcher and CubeSat Models *
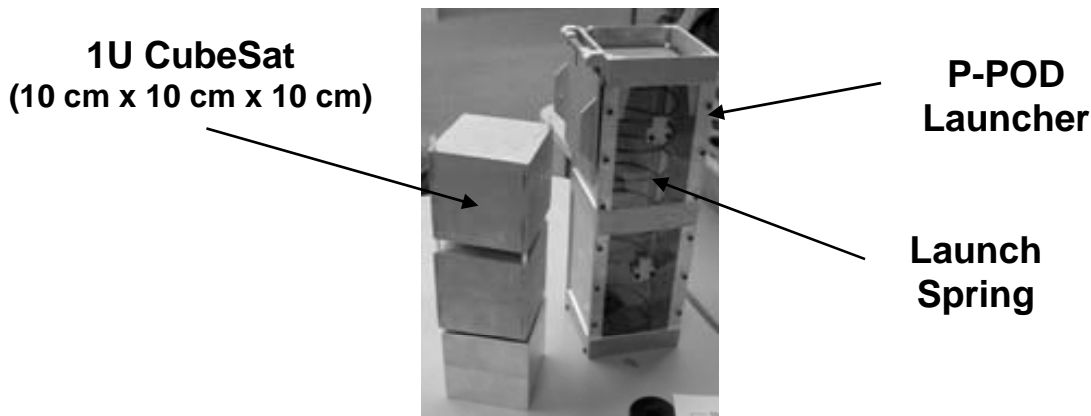
P-POD After CubeSat Ejection ^

1U CubeSat
**(10 cm x 10 cm x 10 cm)**

P-POD Launcher

Launch Spring

* Excerpted from "CubeSat: The Development and Launch Support Infrastructure for Eighteen Different Satellite Customers on One Launch," Jordi Puig-Suari, Clark Turner, & Robert J. Twiggs, California Polytechnic University, 15th Annual Utah State University Conference on Small Satellites

^ Excerpted from Nanosatellite Separation Proposal, "Nanosatellite Separation Experiment Using a P-POD Deployment Mechanism," John Sangree, the University of Texas at Austin, circa 2007

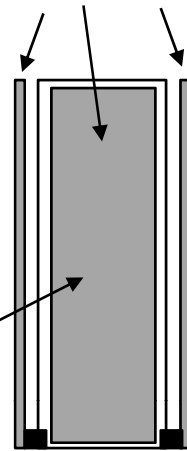# Power Challenges – Generation & Dissipation
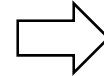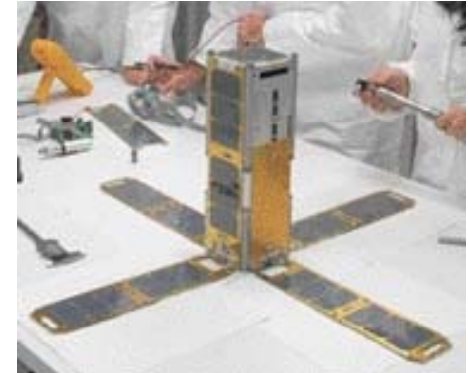
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Axial View of P-POD Launcher

Solar Panels

3U CubeSat with Hinged Solar Panels Deployed
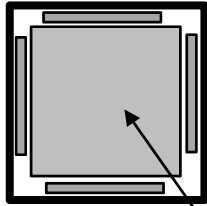
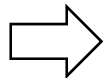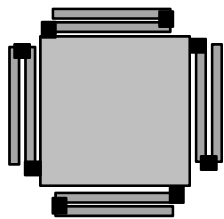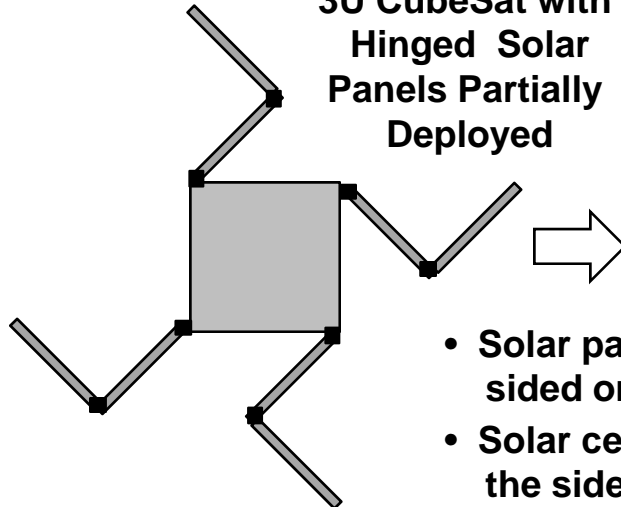**3U CubeSat with Hinged Solar Panels Folded**
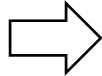
Hinges

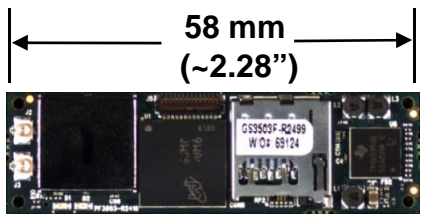**3U CubeSat with Hinged Solar Panels Partially Deployed**

3U CubeSat with Hinged Solar Panels Fully Deployed

- Solar panels can be one-sided or two-sided
- Solar cells can also cover the sides of the CubeSat

Example: Gumstix™ Computer on Module (COM) - A Small, Light-Weight, Low-Power Processing Solution *

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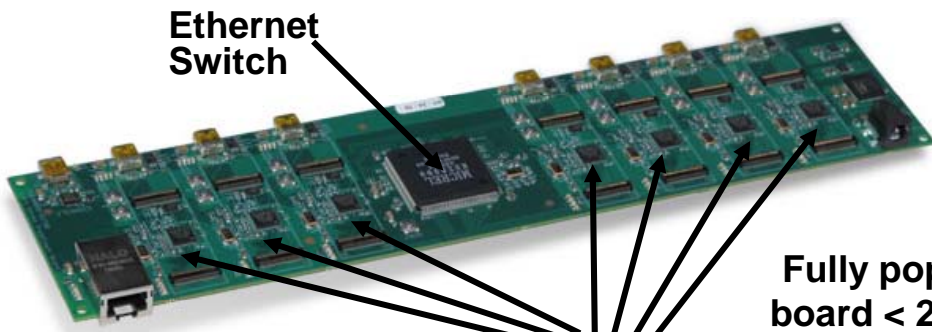
Gumstix Processor Module:

58 mm (~2.28")

17 mm (~0.67")

~1600 DMIPS
OMAP 3503 Application
Processor with ARM
Cortex -AP8 CPU
256 MBytes RAM
256 MBytes Flash

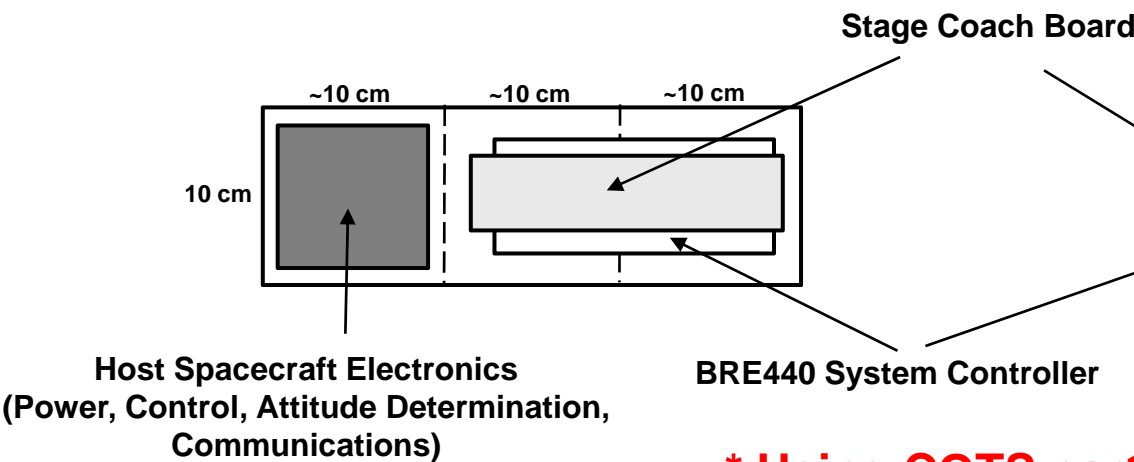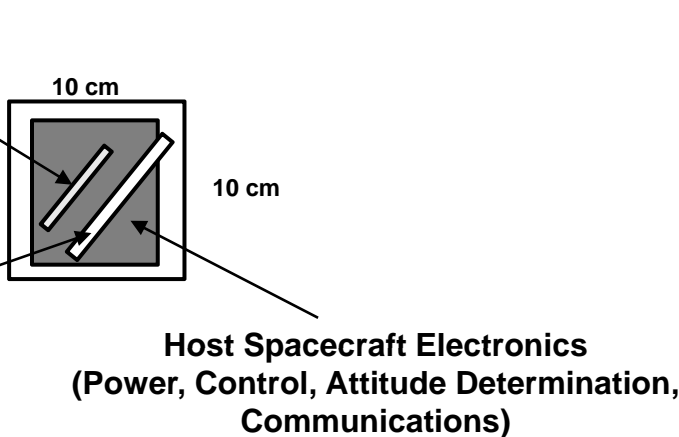## Gumstix Cluster: Seven (7) Gumstix Modules on "Stage Coach" Expansion Board

Ethernet Switch

Gumstix Module Locations

Fully populated board < 20 Watts

CubeSat Side View

Stage Coach Board

~10 cm   ~10 cm   ~10 cm

10 cm

Host Spacecraft Electronics
(Power, Control, Attitude Determination,
Communications)

BRE440 System Controller

CubeSat Axial View

10 cm

10 cm

Host Spacecraft Electronics
(Power, Control, Attitude Determination,
Communications)

* Using COTS parts