Bridging the Gap: Collaboration Using Nanosat and CubeSat Platforms Through The Texas 2 STEP (2 Satellite Targeting Experimental Platform) Mission

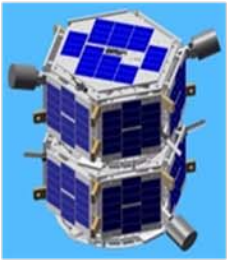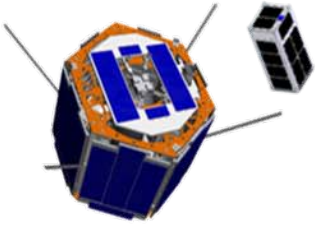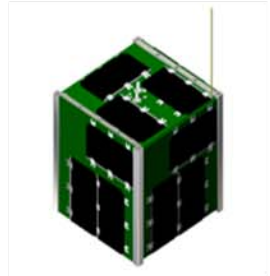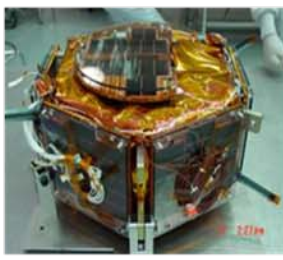Cinnamon Wright, Dax Garner, Jessica Williams, Henri Kjellberg, E. Glenn Lightsey
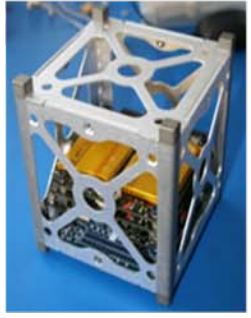
THE UNIVERSITY OF TEXAS AT AUSTIN

OVERVIEW

- Background
  - UT Satellite Programs
- Picosatellite Programs
  - CubeSat
  - PARADIGM
- Satellite Design Laboratory Collaboration
- Nanosatellite Programs
  - Texas 2 STEP
  - Texas 2 STEP Vehicles
  - Chaser Spacecraft
  - Target Spacecraft
  - ARTEMIS vs. 2 STEP Design
- Nanosat and CubeSat Cooperation
  - Texas 2 STEP Separation System
  - Microgravity Experiment
  - SHOT Collaboration
- Benefits
- Considerations
- Future Program Plans

BACKGROUND (UT SATELLITE PROGRAMS)

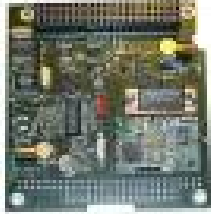|	Nanosatellites		Picosatellites	
	FASTRAC	Texas 2-STEP	PARADIGM	CubeSat
Design				
Hardware				

CUBESAT

Blackfin/Tinyboards
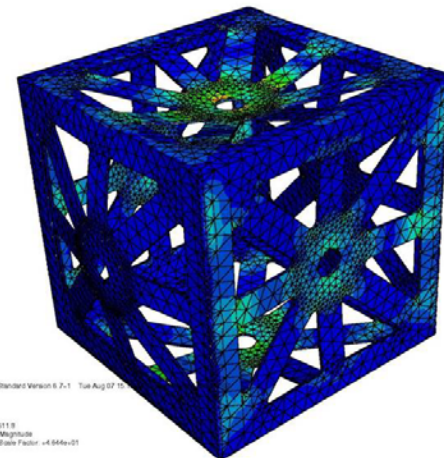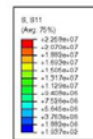
StenSat RX/TX

Dipole antenna

Clyde Space 3U regulation board
LiPo Batteries

Spectrolab ITJ Solar Cells

- Original Bus Design
- Missions
    - Wireless Communication
    - Re-usable plug-and-play bus design using LabVIEW Embedded RTOS
    - Increase the TRL of components for PARADIGM, 2 STEP, and FASTRAC
    - Led the cooperation effort of Satellite Programs.

PARADIGM

- NASA sponsored
- Working with A&M
- First Mission: Downlink 2 orbits worth of GPS data from the Dragon
- Last Mission: Rendezvous and docking
- 5"x 5"x 5" form factor

Mission 1:

Launch

Jettison from STS-127
Vehicles Immediately Separate

Stabilization & Charge Time

Systems Check

Acquire Mated GPS Data
for Baseline

Downlink GPS Data
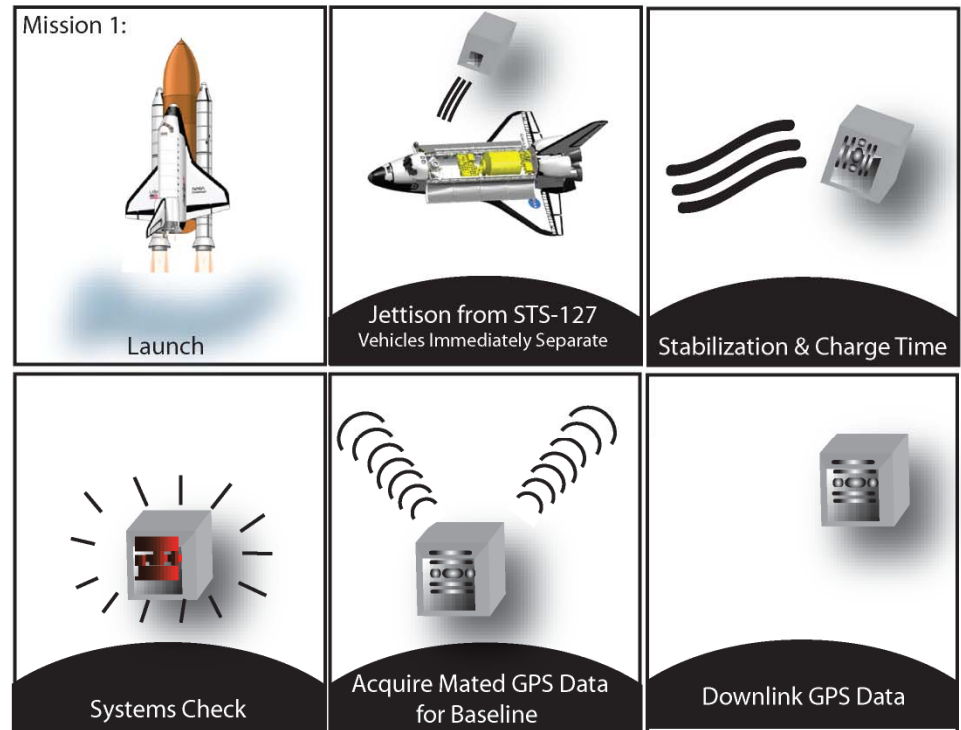
PARADIGM ADAPTATION

- Utilized much of CubeSat design
- Linux Embedded
- Dragon Receiver
- New custom CDH Board

TEXAS 2 STEP

❶ Launch/Orbital Insertion	❷ LV Separation	❸ Checkout
$T_0 \approx 0:00$	$T_{LVsep} \approx T_0 + min$ *Uplink* *Downlink*	$T_{Health} \approx days$
❹ Chaser/Target Sep.	❺ Drift	❻ Initiate Rendezvous
$T_{C/Tsep} \approx T_{LVsep} + days$ *Xlink* *Xlink*	$T_{drift} \approx 1\ hr$ ~3 km	$T_{ren} \approx T_{C/Tsep} + 1\ hr$
❼ Controlled Return	❽ Proximity Operations	❾ End of Mission
$T_{ret} \approx 1\ hr$	$T_{prox} \approx 1\ day$ (Until depletion of power or fuel supply) ~150 m	$T_{end} \approx T_0 + 6\ months\ min.$
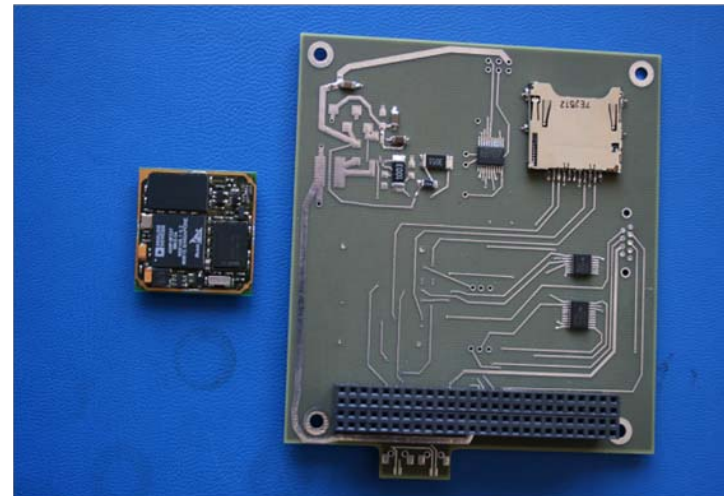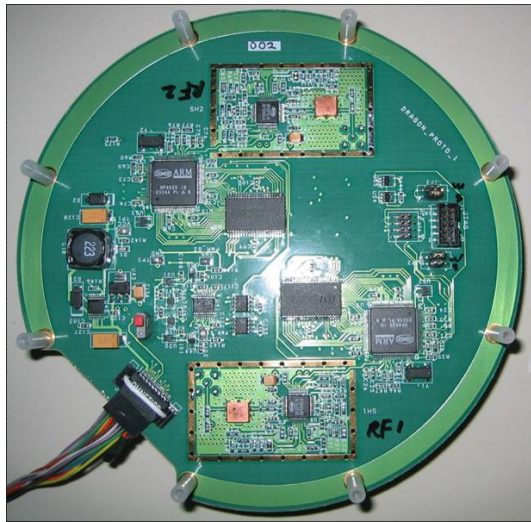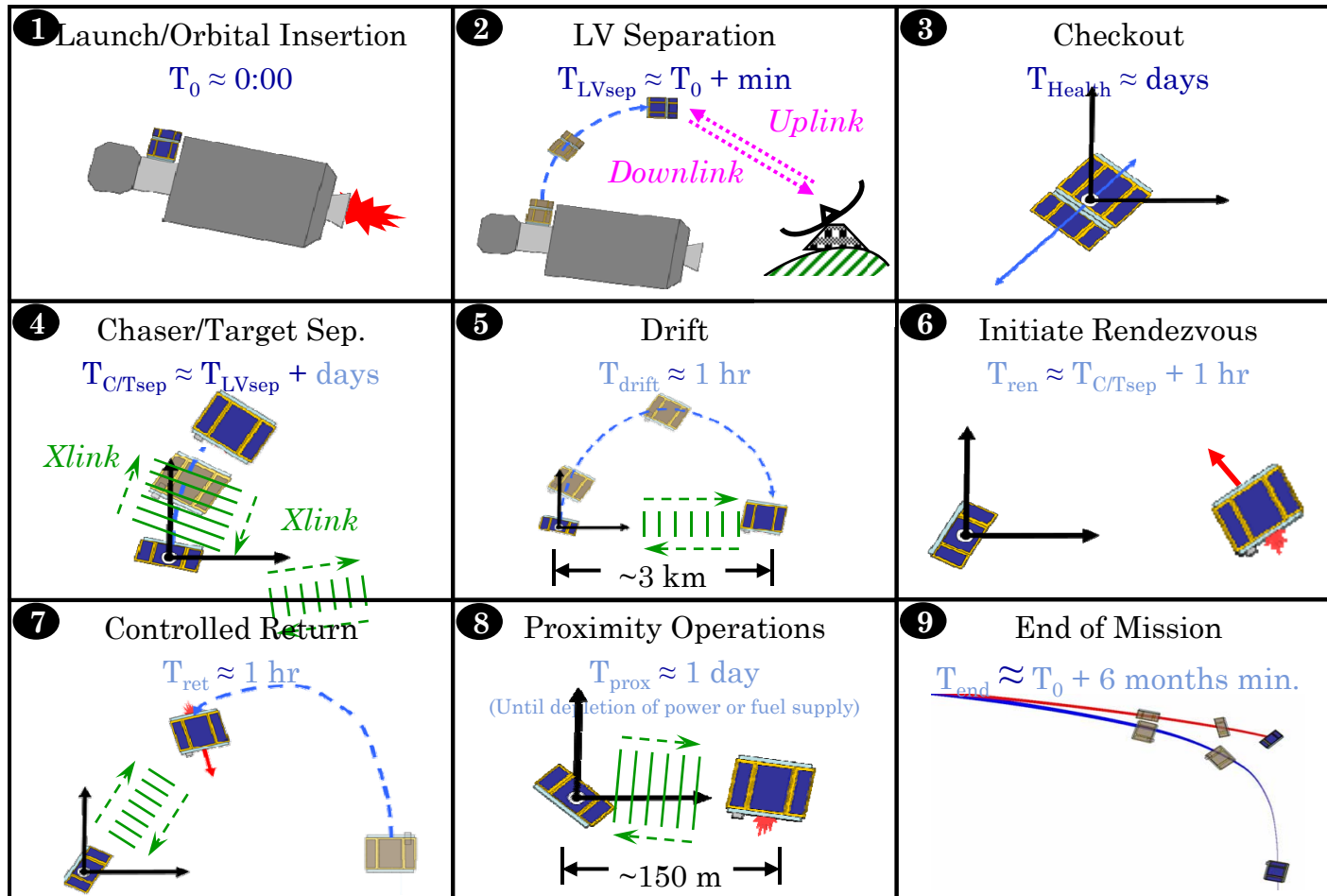
2 STEP Vehicles

And the Adoption of a 3 Unit CubeSat for the Target

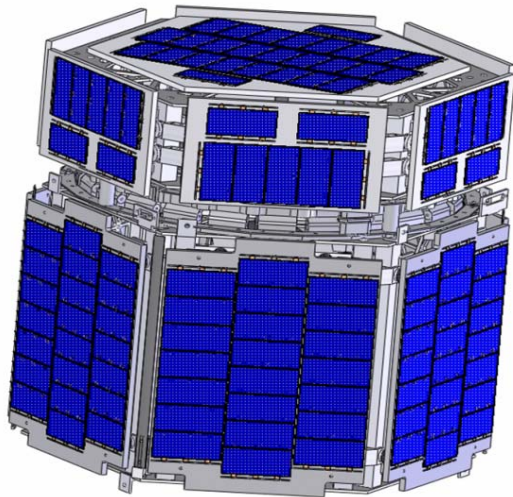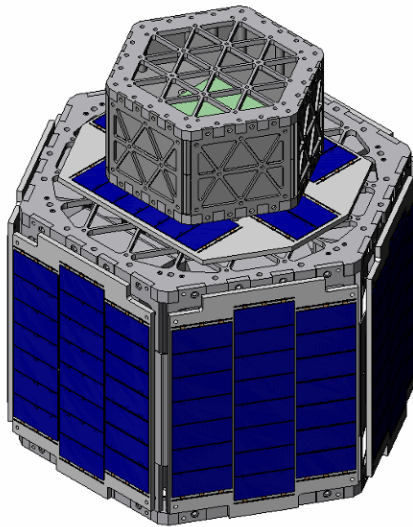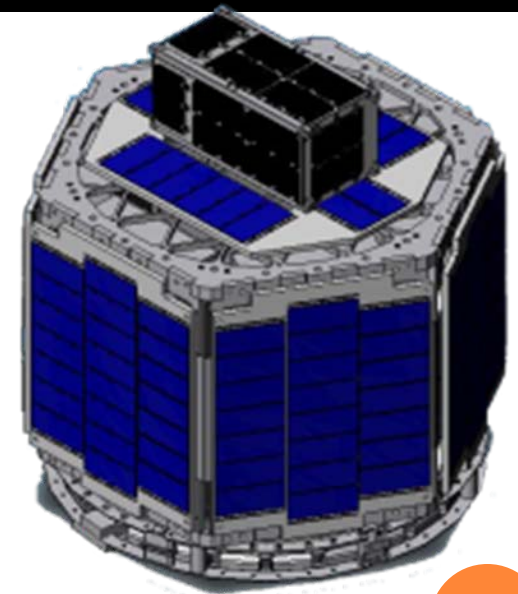| Original ARTEMIS Chaser/Target Design	Final ARTEMIS Chaser/Target Design	Texas 2 STEP Chaser/Target Design

Texas 2 STEP Chaser

- R-134A Propulsion
- Bluetooth Verification
- Stensat radio
- Arcom VIPER
- Ampro Littleboard 800
- QNX Operating System

Texas 2 STEP Target

- Inherited mostly from CubeSat and PARADIGM
- Adheres to UNP and CubeSat standards
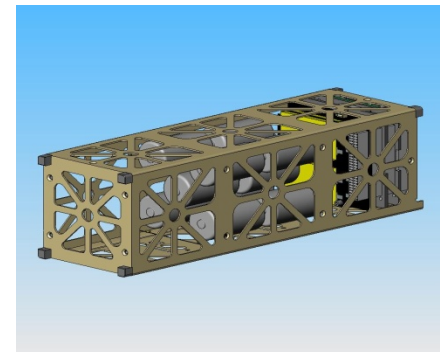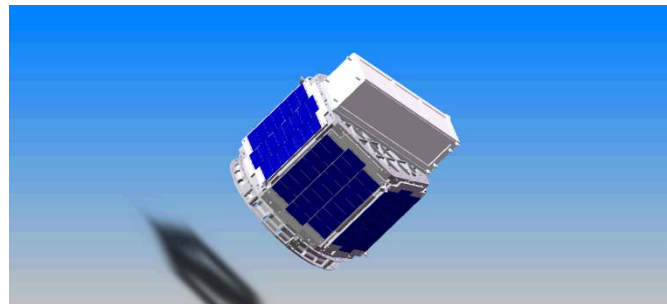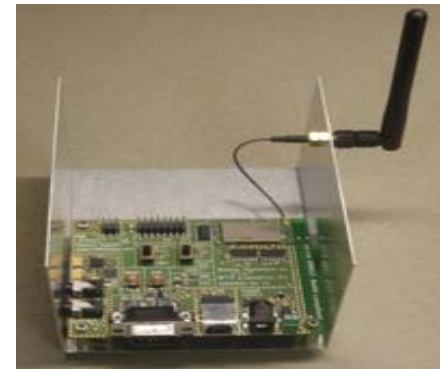
TEXAS 2 STEP GNC

- Chaser GNC Design
  - Optical Energy Sun Sensor
  - Orion GPS
  - Honeywell HMC2003T Magnetometer
  - MicroStrain 3DM-GX2
  - R-134A Cold Gas Propulsion System
- Target GNC
  - Orion GPS
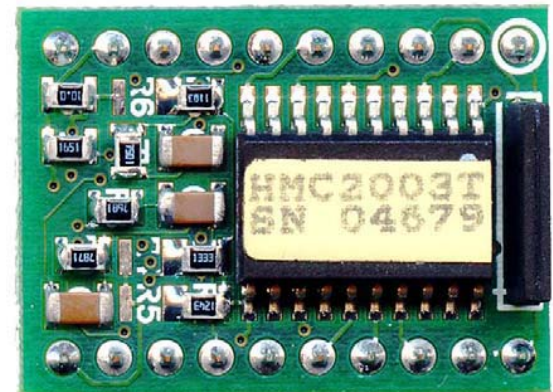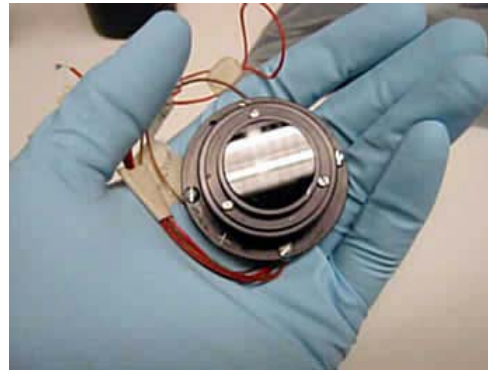
Satellite Design Laboratory Collaboration

- Began in 2007
- Similar challenges.
- COTS for small low-cost satellites limited.
- Re-using satellite bus solutions.
- Ground Station
- Facilities

Nanosat and CubeSat Cooperation

- Texas 2 STEP Separation System
- Microgravity Experiment
- SHOT II Workshop

TEXAS 2 STEP SEPARATION SYSTEM AND MICROGRAVITY EXPERIMENT

- Cal Poly's P-POD Deployer

SHOT Collaboration

- UNP5 Balloon Launch
- Tested components which will go on all 3 satellites
- Power systems
- Bluetooth verification
- Communication
- Software

Benefits

- Eliminate the need for duplicate system design.
- Design -to- fabrication time shrinks.
- Team cooperation and support.

Considerations

- CubeSat standard hardware does not always meet the University Nanosatellite Program Standards.
- It is more difficult to design something more universal.
- Need to examine new technologies still exists.

FUTURE PROGRAMS

- Now have heritage from FASTRAC, ARTEMIS, CubeSat, PARADIGM, and TEXAS 2 STEP
- Advantages of previous bus designs.
- Advantages of easily adaptable CubeSat standards.

THANK YOU!

Advisors

- Dr. E. Glenn Lightsey
- Dr. Robert H. Bishop
- Dr. Sean Buckley
- Dr. Matthew Hall
- Lisa Guerra
- Dr. Cesar Ocampo

REFERENCES

- Toorian, Armen, et al. "CubeSats As Responsive Satellites." AIAA Proceedings, Long Beach, California, August 30, 2005.

- "Pumpkin CubeSat Kit™." Pumpkin, Inc. http://www.cubesatkit.com, accessed, May 2008.

- "1U CubeSat Power Datasheet." Clyde Space Ltd. http://www.clyde-space.com accessed, June 2008.

- "Poly Picosatellite Orbital Deployer Mk III ICD" California Polytechic University http://cubesat.atl.calpoly.edu/media/P-POD%20Mk%20III%20ICD.pdf accessed, June 2008.

- "IMI-101™ Miniature 3-Axis Reaction Wheel Product Specification." IntelliTech Microsystems, Inc. Autonomous Vehicle Technologies. http://www.imicro.biz space.html accessed, June 2008.

- *"MTi Miniature Attitude and Heading Reference System" XSENS Motion Technologies.* http://www.xsens.com accessed, June 2008.

- "Sun Sensors" Optical Enegy Technologies Inc. http://www.opticalenergy.com accessed, June 2008.

- *"Three Axis Magnetic Sensor Hybrid" Honeywell.* http://www.ssec.honeywell.com/magnetic/datasheets/hmc2003.pdf accessed, June 2008.