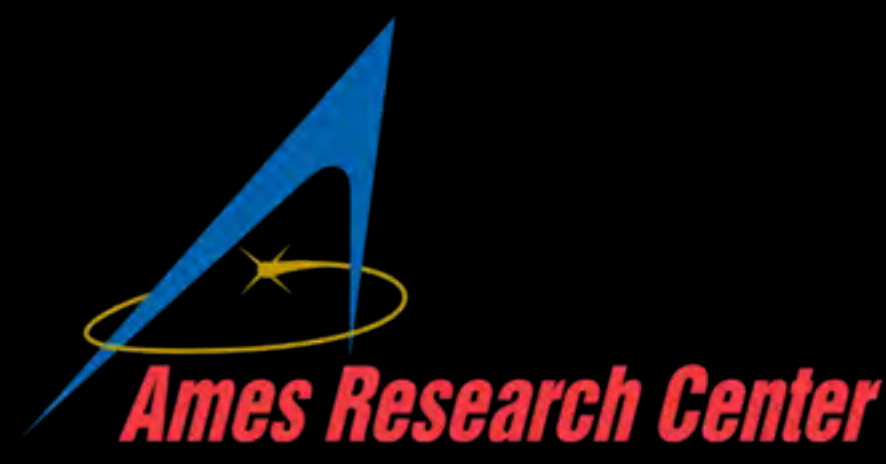
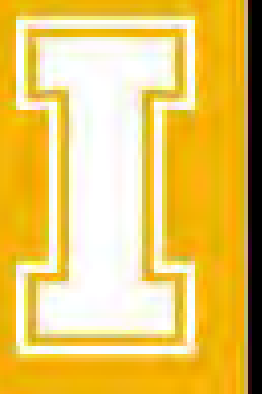




Low-Cost Satellite Communication for CubeSats



Team **TARDIGRADES**

Joseph Dennison (CE), Robert Goes (Math & CS), Cosette King (CS), Taegan Williams (CS)

Objective

To develop software, packet structure, and communication protocol for a microcontroller to establish a live connection via the Iridium Network for an upcoming TechEdSat mission.

Background

TechEdSat: The Technology Educational Satellite investigation employs small CubeSat spacecraft to evaluate, demonstrate, and validate new technologies

Iridium Core 9523: A consumer voice and data satellite transceiver module, the Core 9523 communicates with the Iridium satellite constellation and can establish a full internet connection to a ground network.

Types of Message Functionality:

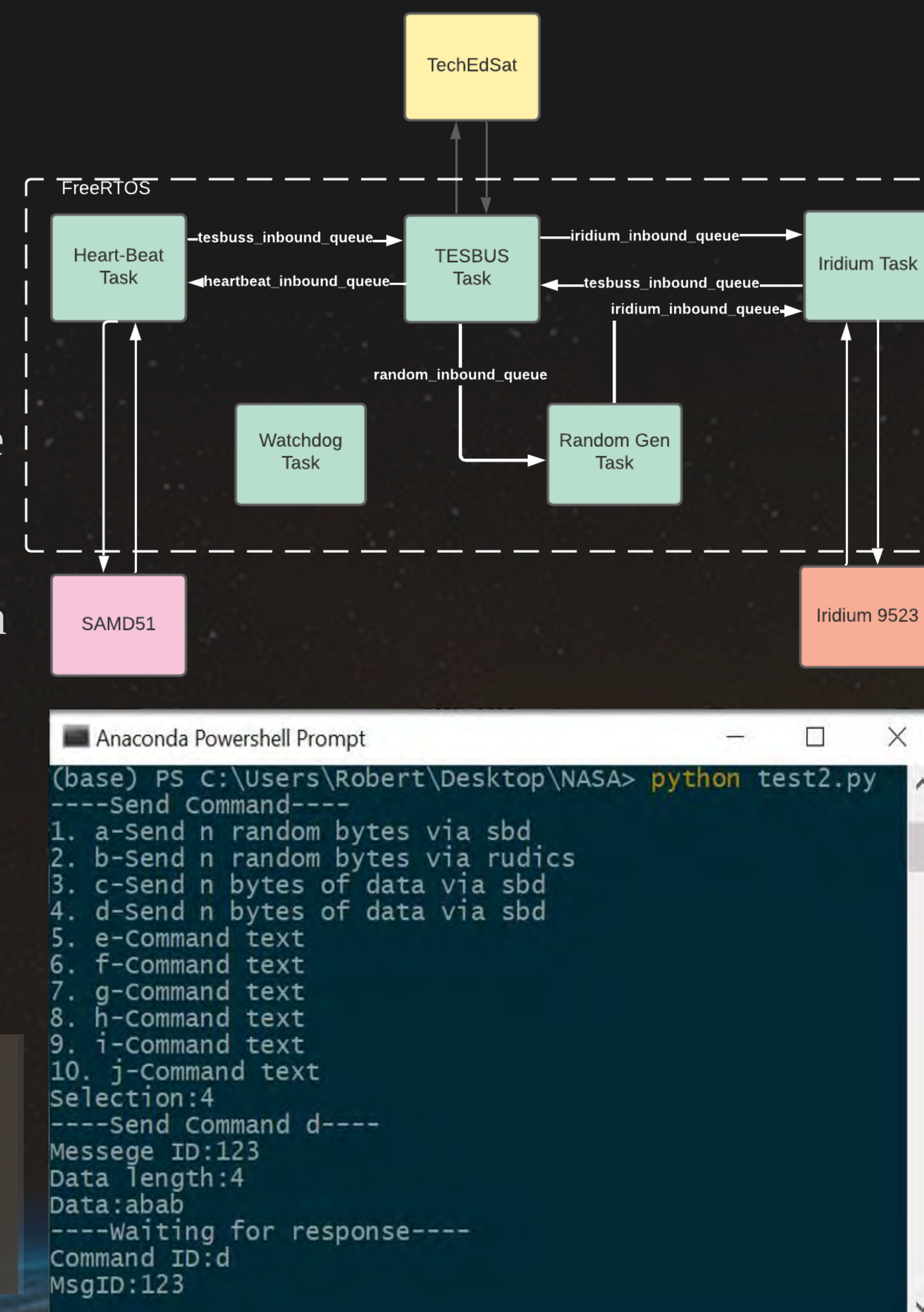
- SBD: Short Burst Data (Similar to SMS)
- RUDICS: Router-Based Unrestricted

Software: Satellite

- Separated into different tasks that will run continuously while the microcontroller is powered on.
- Communicates with the primary satellite computer via custom commands.
- Handles errors, such as overheating or dropped calls.
- Communicate with the Iridium 9523 in order to send SBD or RUDICS

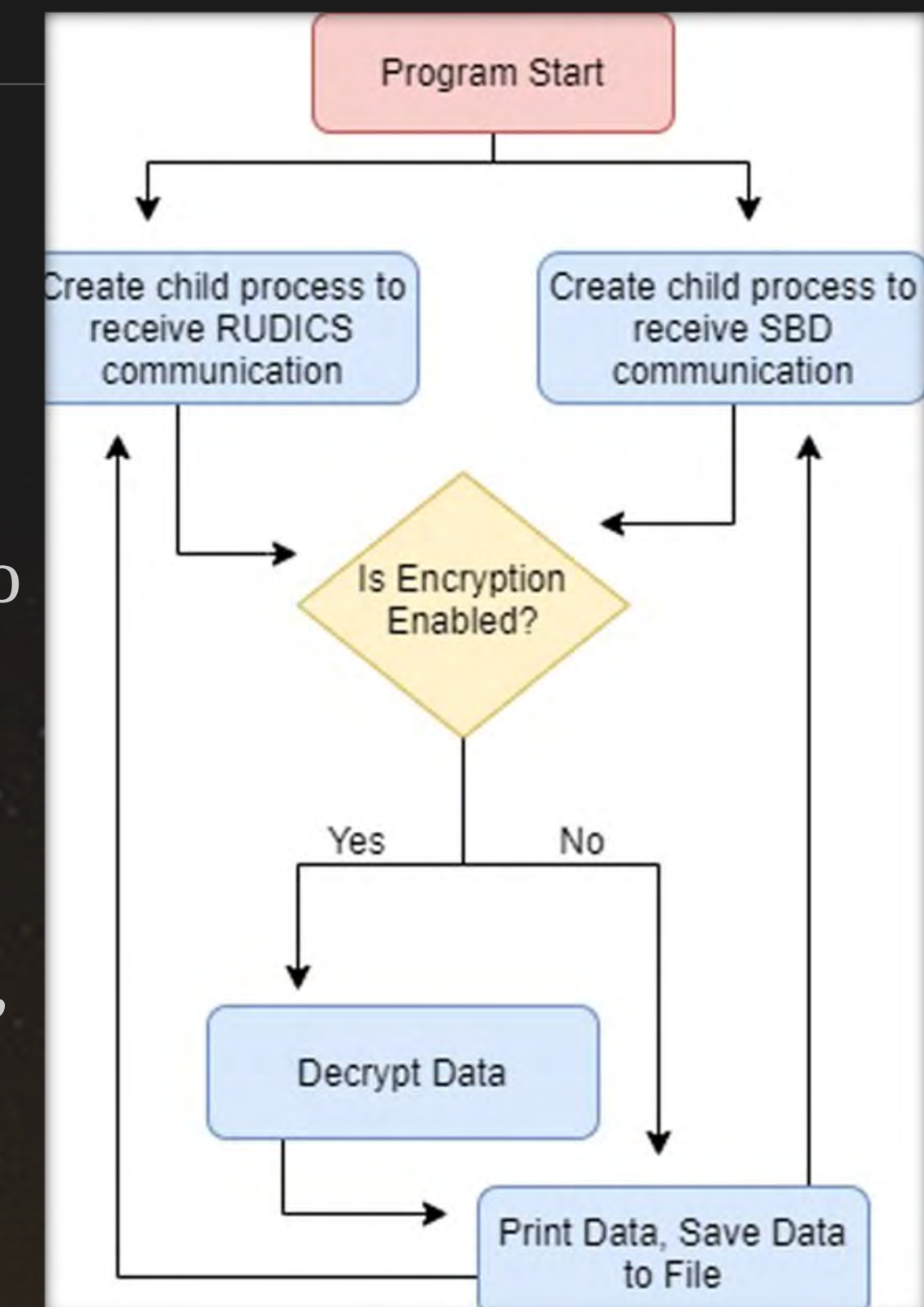
Testing Utility:

- Simple to use
- Sends commands
- Reads status info



Software: Ground

- The ground server will receive communication from the satellite.
- Digital Ocean, an American cloud infrastructure provider, is used to create our ground server. Our current setup is 1 GB memory and a 25 GB hard drive
- Details: uses AES 256 encryption, coded in python and has a firewall with active security measures to ensure integrity and availability. It has 1 address with 2 open ports but only 1



Recommendation for Adoption

- Receive, encrypt, and transmit mission data
- Send SBD packet with RUDICS checksums
- Initiate RUDICS call upon SDB reception

Validation

NASA requirement:	Achieved by:
Communication with primary satellite computer	Verifying TESBUS task is functioning
Verification of expected signal quality based on position	Sending current time in the message
Integrity of data transferred	Error detection byte within each message
Volume of data transferred	Sequential message IDs
Changing between SBD and RUDICS mode	Verifying TESBUS task is functioning

Value Proposition

The cost of satellite communication are normally in the tens of thousands of dollars. By switching to an off-the-shelf satellite network, the cost for future NASA satellite missions will be drastically reduced.

Design Requirements

Minimal Viable Product:

- Send status messages and be able to transmit with either SBD or RUDICS
- ### Other Board Functions:
- Be able to turn off and on at anytime
 - Sample temperature, voltage and current sensors every second



For more information, visit our wiki page!

Special Thanks

- NASA ARC: Marcus Murbach, Avery Brock and Alejandro Salas
- Lead Instructor: Dr. Feng Li
- Idaho Space Grant Consortium

