POLYSAT

A University CubeSat Story

California Polytechnic State University, USA

PARIN PATEL

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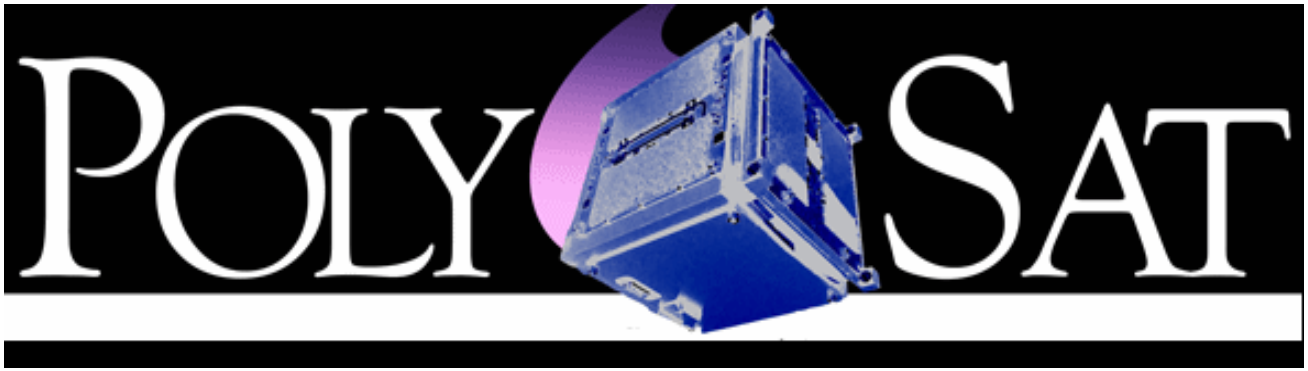
CubeSat Developer's Workshop

The Boeing Company, Huntington Beach California

April 20th 2007

PolySat

- Started in 1999 by a Multidisciplinary Team of Engineering Students
- Objective: Engineering Education
- Objective: Provide a reliable bus system to allow for flight qualification of a wide variety of small sensors and attitude control devices.



CP1

- Magnetorquer developed by Cal Poly
- Third party Sun Sensor

- DNEPR 1 launch failure: July 26th 2006
  - No in orbit operations

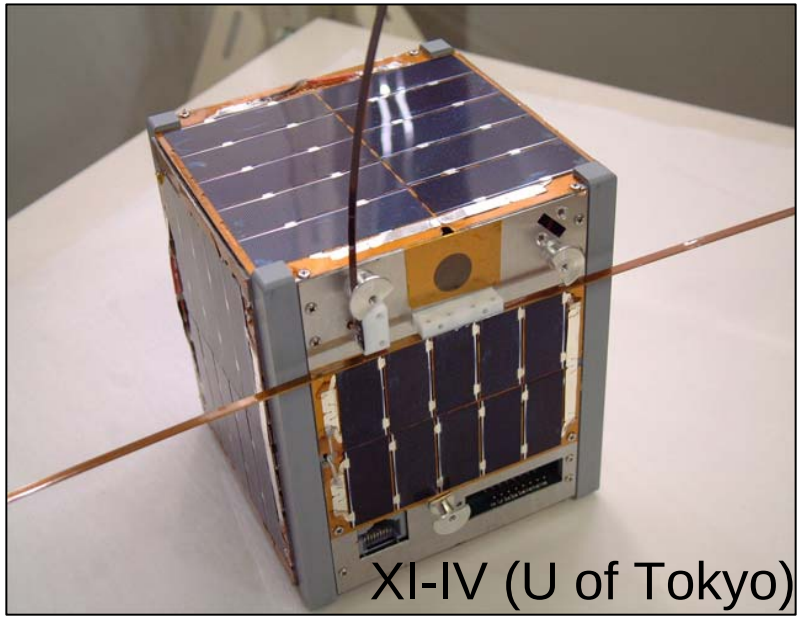
- Valuable lessons learned
  - CubeSat development: challenges & logistics
  - Non-Reoccurring Costs: Multiple Flight Units

Operations Experience

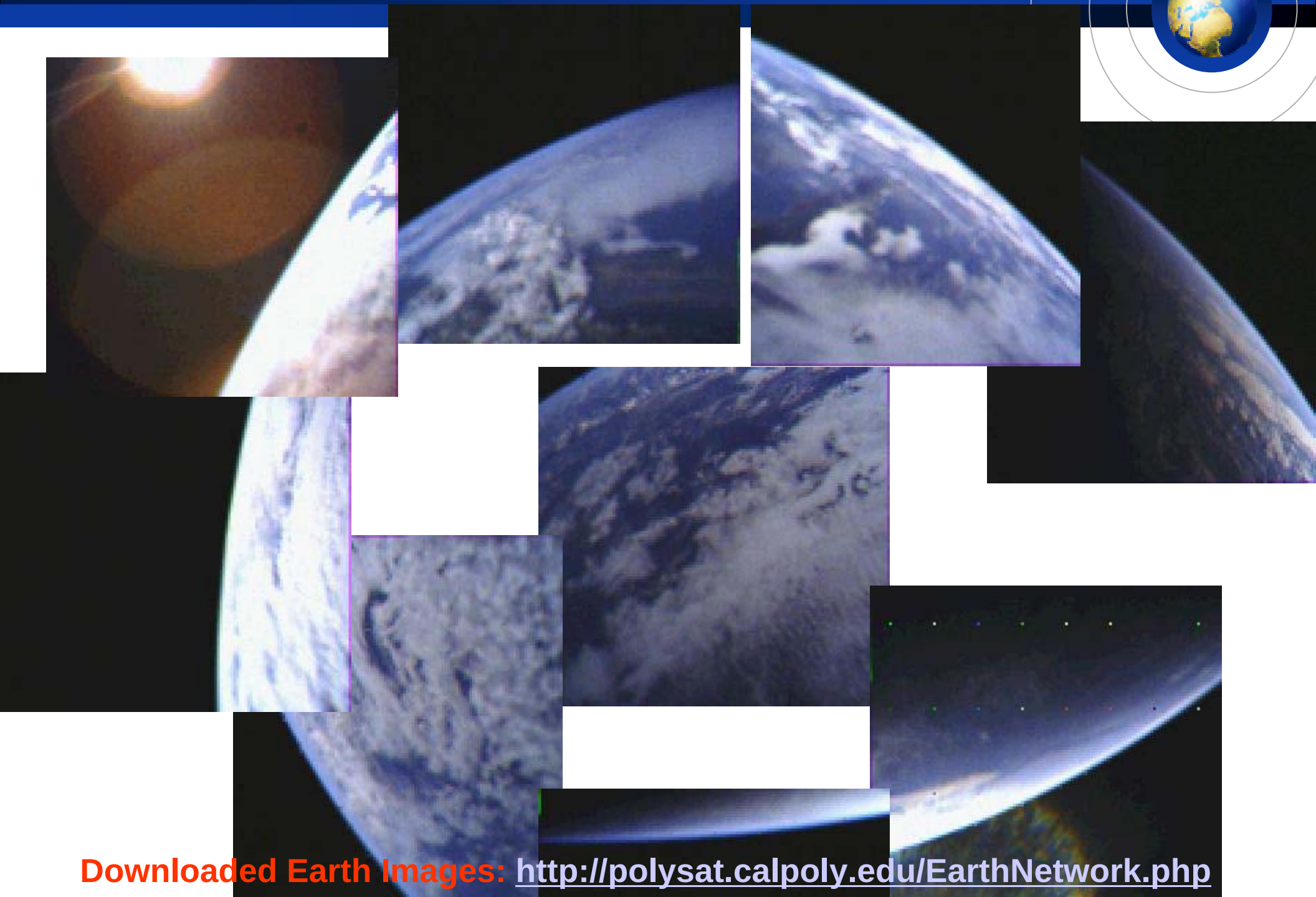
- Training Objectives
  - Successfully make contact with a CubeSat
  - Download and decode AX.25 digital data.
- Trans-Pacific Collaboration with University of Tokyo

- Autonomous Beacon
  - Locating the CubeSat after deployment
  - Acquisition of signal
  - Health status / contingency mode

- Normal CubeSat
  - 1/2 to 1 watt RF
- U of Tokyo (XI-IV)
  - Only 80 mW beacon: Morse Code
  - Comes in crystal clear!


XI-IV (U of Tokyo)

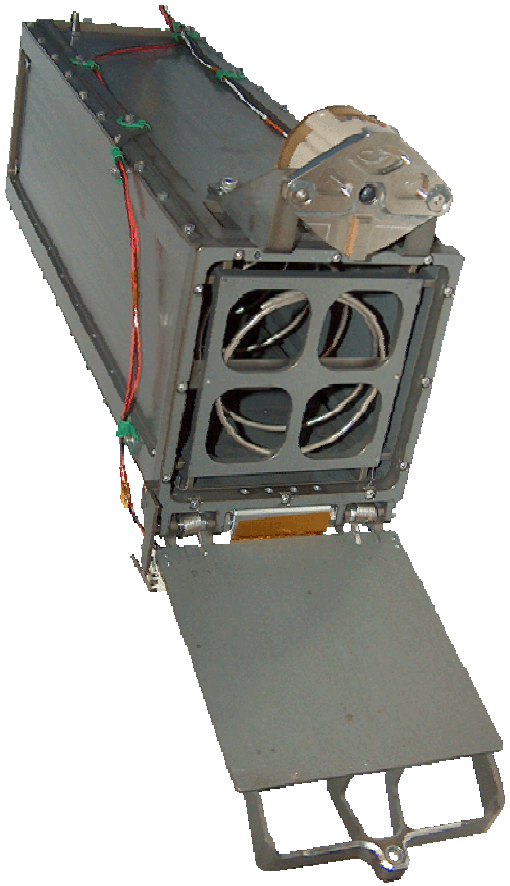
XI-IV Images

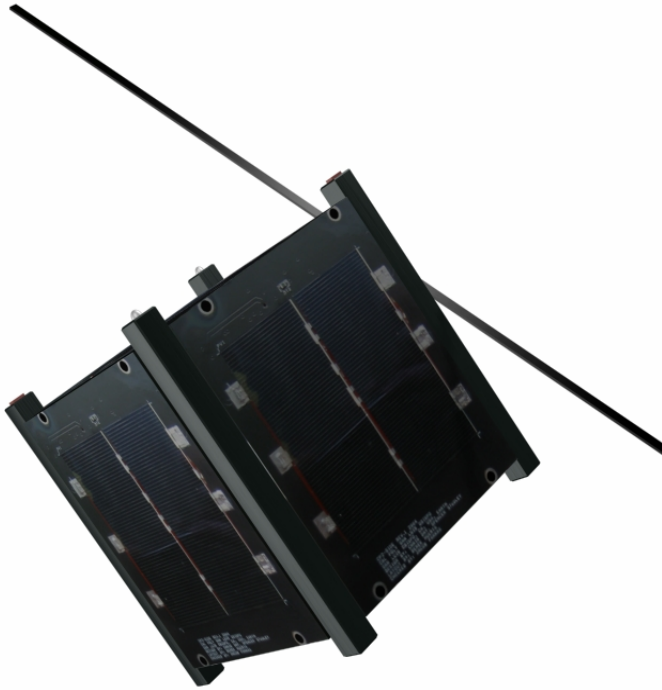


Downloaded Earth Images: http://polysat.calpoly.edu/EarthNetwork.php

Deployment to First Contact

- Launch
- P-POD deployment
- Antenna deployment
- First beacon
- First possible pass
- First contact





DNEPR 2 – April 17th 2007

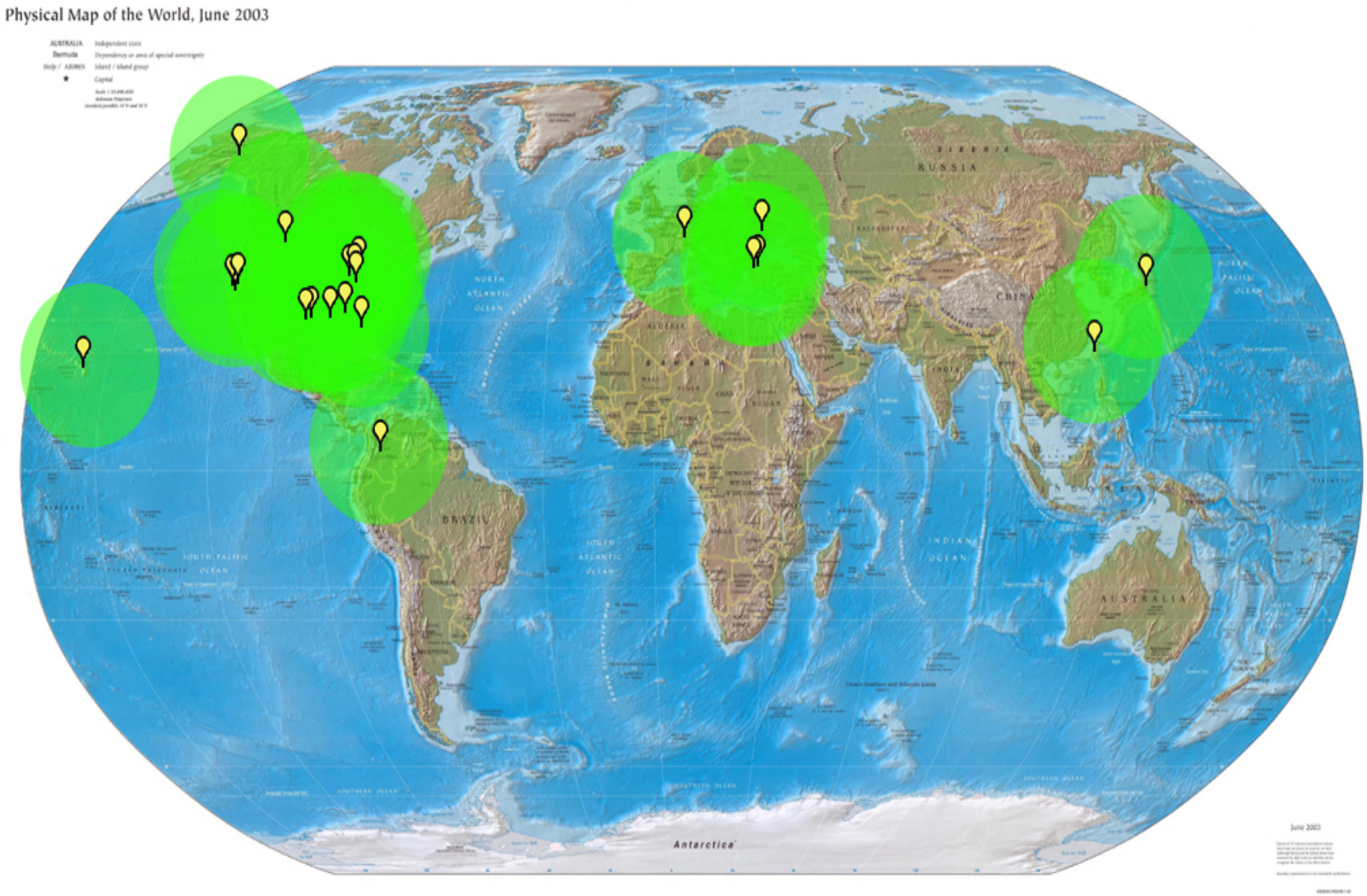
- CP2.1 manifested as CP4
  - Energy Storage and Dissipation Experiments
  - Test and Characterize CPBus

- CP3
  - Attitude Determination using a suite of sensors
  - Attitude Control using Magnetorquers in each side panel
  - Observation Imagers: lots of data to download!

Parallel Operations

- Yeasu FT-847 and Icom IC-910
- Yaesu G-5500
- MixW Software TNC
- Mac Doppler Pro for tracking

The Ground Station Network



GENSO Background

- Global Educational Network for Satellite Operators
- Originally started with the Japanese to combat interference
- Started under the International Space Education Board, a collaboration between CSA, ESA, JAXA, and NASA
- Approved on 5 October 2006 for 2 years
- Project to link low-cost earth stations

元素

Canada

esa

JAXA Japan Aerospace Exploration Agency

NASA National Aeronautics and Space Administration

genso

What is GENSO

- A system to link ground stations using the internet
- Only 1200/9600 baud data for now
- Three parts:
  - Central server
    - Authentication and registration
  - Mission Control Client
    - Scheduling of Ground Station Servers
    - 1 MCC per satellite developer
  - Ground Station Servers
    - Actual interface between rotors/radio and internet

Central Server

- 3 central servers located around the world
  - Europe
  - California (Cal Poly or SRI)
  - Japan
- Tasked with Authentication and Registration only
  - Registration of IP addresses of GSS and MCC
  - Statistics
- All other functions (scheduling, data transfer) will go peer-to-peer between Mission Control Clients and Ground Station Servers
  - This keeps the load off a single server when system scales up

Mission Control Client

- A program that runs on a personal computer that can control Ground Station Servers
- Uses the Central Servers to get IP addresses for individual GSS, then contacts the GSS's directly to:
  - Schedule an active session
  - Download decoded data
  - Control the radios and rotors to track a satellite during an active session
  - IRC Client ?
  - Skype Client?

Ground Station Server

- Compatible with a majority of ground stations currently operating
- “Passive” tracking:
  - Will continuously track all satellites it can decode
  - Will forward data on to MCC
- “Active” tracking:
  - Someone at a MCC is actively controlling the rotors and radio, looking at the decoded data, and listening to the audio
  - Must be scheduled prior to satellite pass and cleared with GSS
  - Requires offline interaction and parties that know each other
- Store audio/data locally and stream to MCC as bandwidth allows
- IRC and/or Skype client?

“Standard” Earth Station

- Icom IC-910 radio with computer interface
- M^2 OR2800P-DC for Azimuth and MT-1000 for elevation
- Symek TNC 31S
  - Possibly software in future
- Antennas:
  - 2MCP22 for 145 MHz
  - 436CP42UG for 437 MHz
  - 1 meter dish for S-band (downlink only)

CP3 and CP4 status

- CP4 (CP2.1)
  - Heard beacon most every pass at Cal Poly
  - In pre-ops mode, beacons every 5 minutes
  - Decoded data packet last night – cold with too much power
- CP3
  - Not heard from yet
  - Haven’t really tried
  - Only one left that hasn’t been heard from
- Due to downlink mode, we need good keps to decode packets
  - Space-Track still having trouble with 16 objects
  - Need more time

Questions?

Thanks!

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