



Software Defined Ground Stations

James Cutler

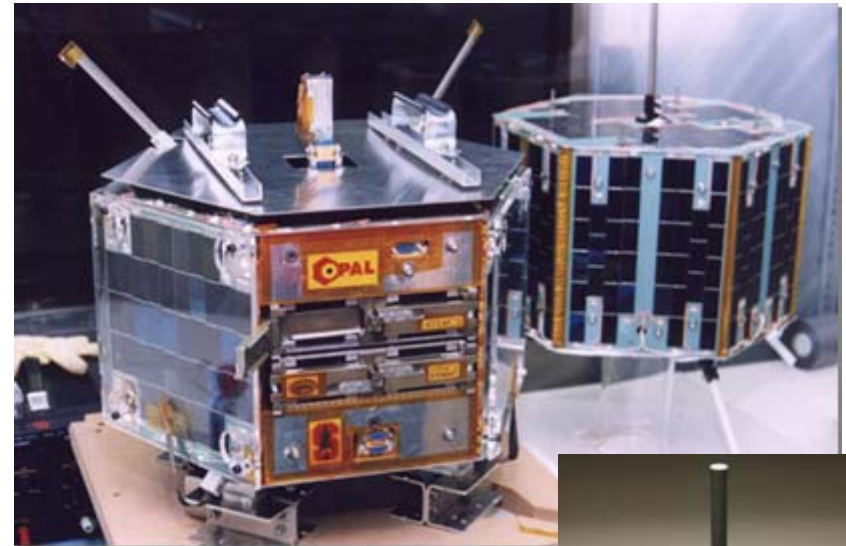
Space and Systems Development Laboratory

Space And Systems Development Laboratory

- SSDL History
 - Established ~ 1994
 - Four quarter class--AA236

- Missions
 - Sapphire, Opal, QuakeSat-1, Genesat, MAST, BioLaunch, Antarctic weather stations

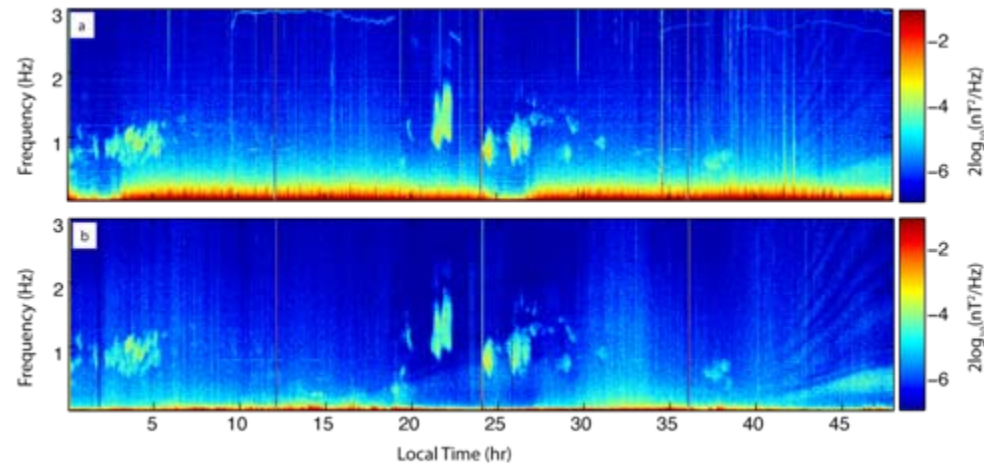
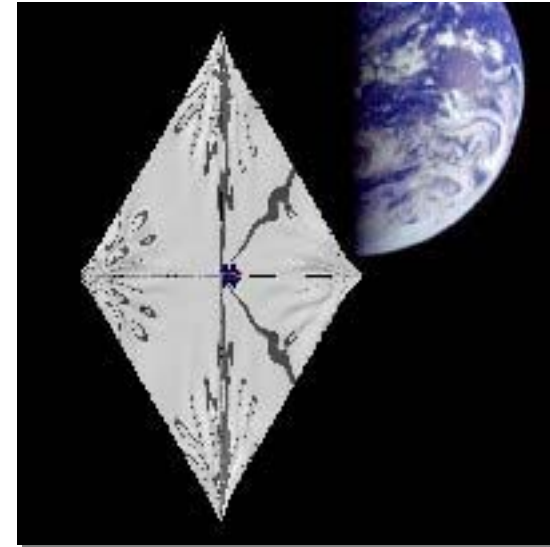
- Student demographics:
 - ~400 students throughout the years
 - A mixture of industry and Stanford





SSDL Research

- Communication systems
 - Global ground station networks
 - Flight radios
 - Deployable antennas
- Space science
 - Ground: ULF magnetometers
 - Space: plasma wave sensors
- Solar sails
 - A nanosatellite that sails
 - Control, orbits, materials, mission architecture
 - Sail or antenna?
- Lunar X





Ground Station Birthing/Growing Pains

How long have we been using AFSK/FSK 1200/9600 communication systems?

Goal: Enhance communication capabilities...

1. Reducing the monolithic, stovepipe, hardware centric nature of current systems.
2. Enable customization and optimization of ground station functionality.





Communications Costs

Network	Data Amount	Bit Rate	Estimated Integration Cost	Estimated Transfer Cost
TDRSS	1GB	100Kbps	Unknown	\$17,300
TDRSS	1GB	3Mbps	Unknown	\$577
Commercial	1GB	100Kbps	\$150K	\$48,900
Commercial	1GB	3Mbps	\$150K	\$1,650
Web servers	1GB	100Mbps	\$100-\$200	\$0.10-\$6.50

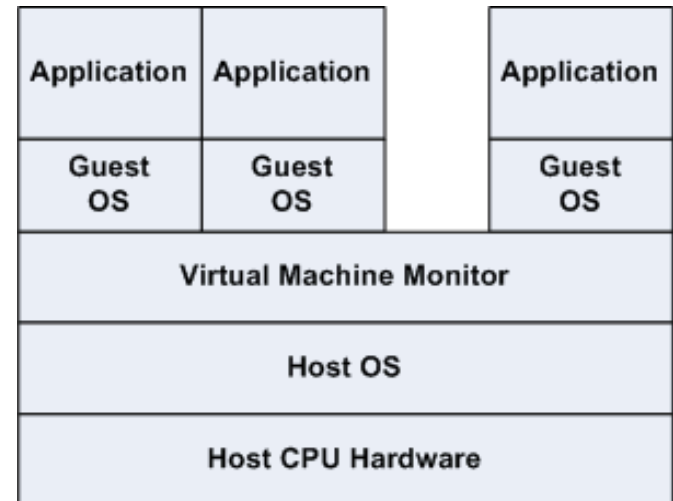
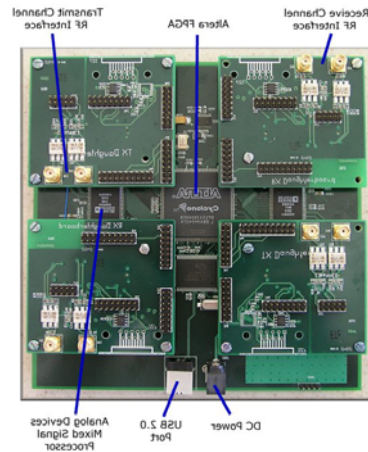
- Provide a parallel track in standardization
 - Standardized ground interface
 - Flexible application level support

- Promote innovation through a software interface
 - High to low level customization
 - Mission experimentation

Objectives

1) Architect a low-cost ground station based on software-defined radios.

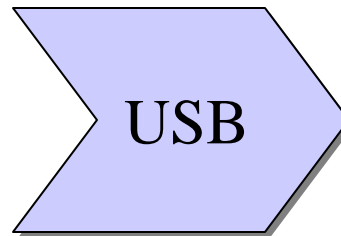
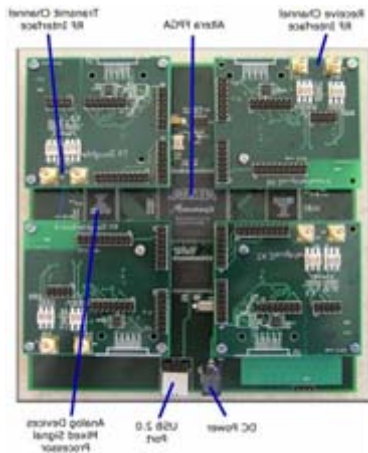
2) Extend a ground station's core capabilities to include virtual machine execution



3) Combine 1 and 2 to develop a software-defined ground station (SDGS).

Prototype Work

USRP/GNUradio

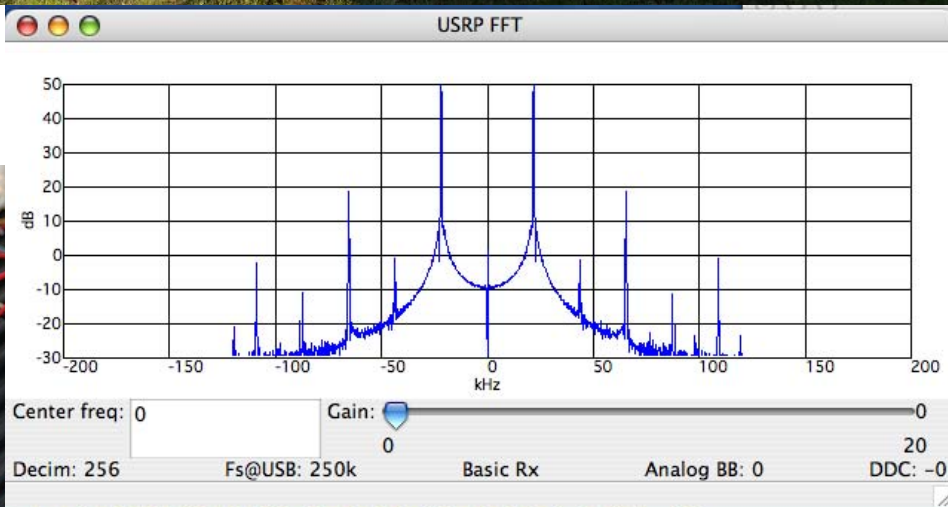


- MacOS X
 - Vmware
 - Linux/Fedora VM
 - Slow GUIs



- Fedora 8
 - Running native
 - No VMs

Field Work



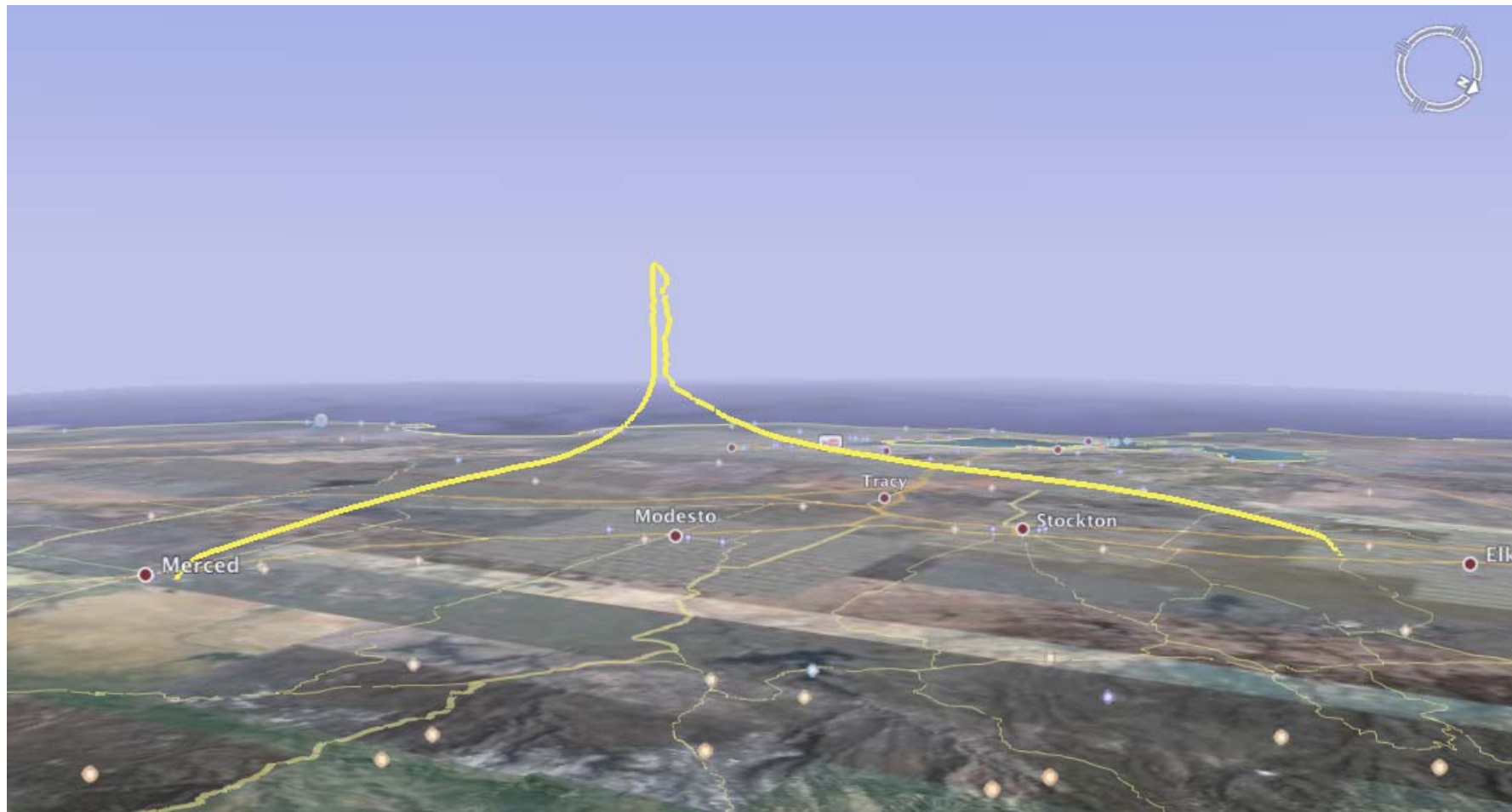


Easy Recovery





2008 Flight



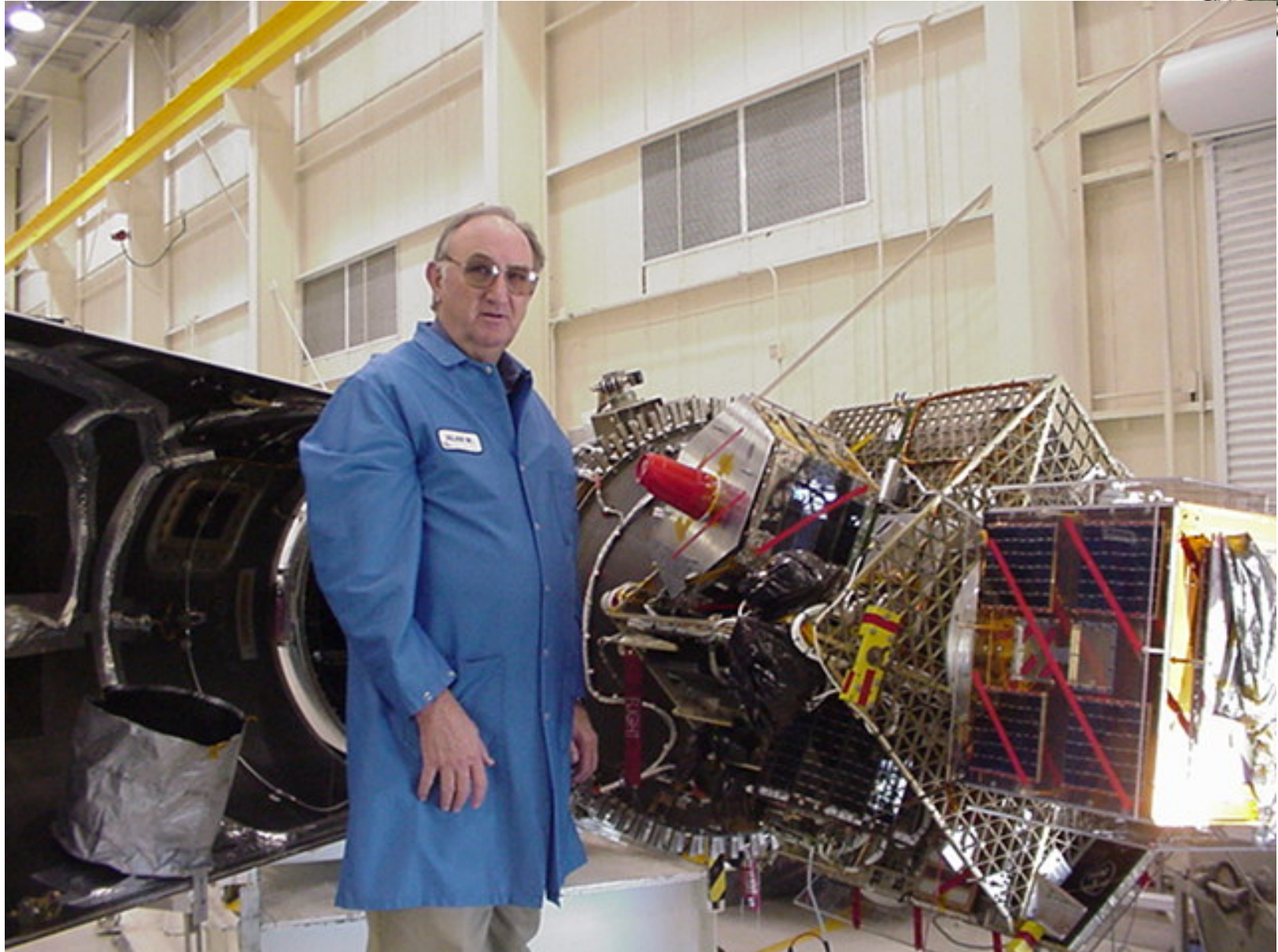


Next Steps For SDGS

- How fast can we push the SDGS?
- Integration into ground station code
 - Mercury, GENSO, etc
- Network accessible GNUradio components
- Advanced VMs for SDGS
 - FEC, BPSK, etc.
- Publish a reference station specification
 - Building a reference station
- This summer in Utah...
 - SDGS progress
 - Flight radio progress

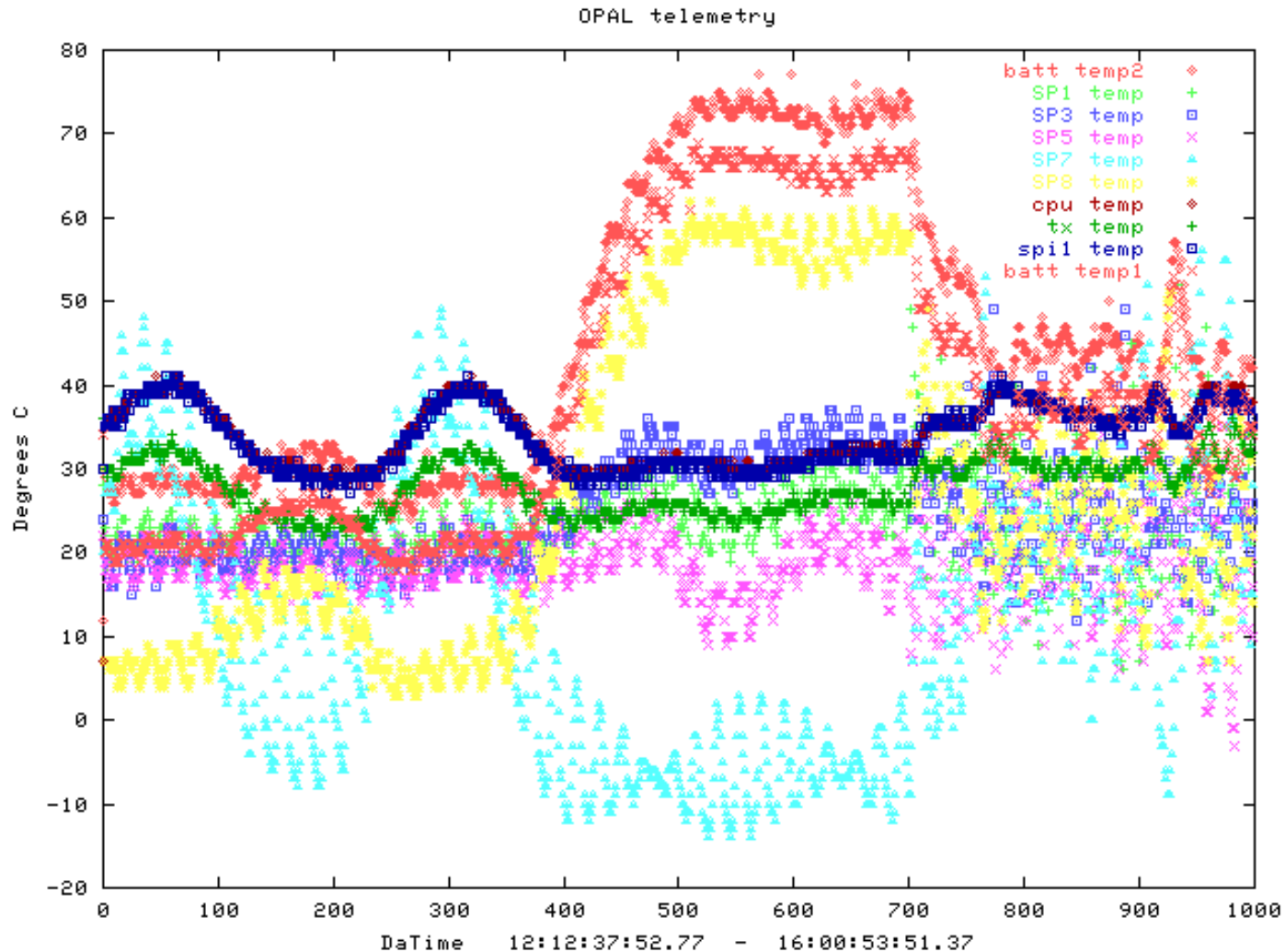


Extra Slides



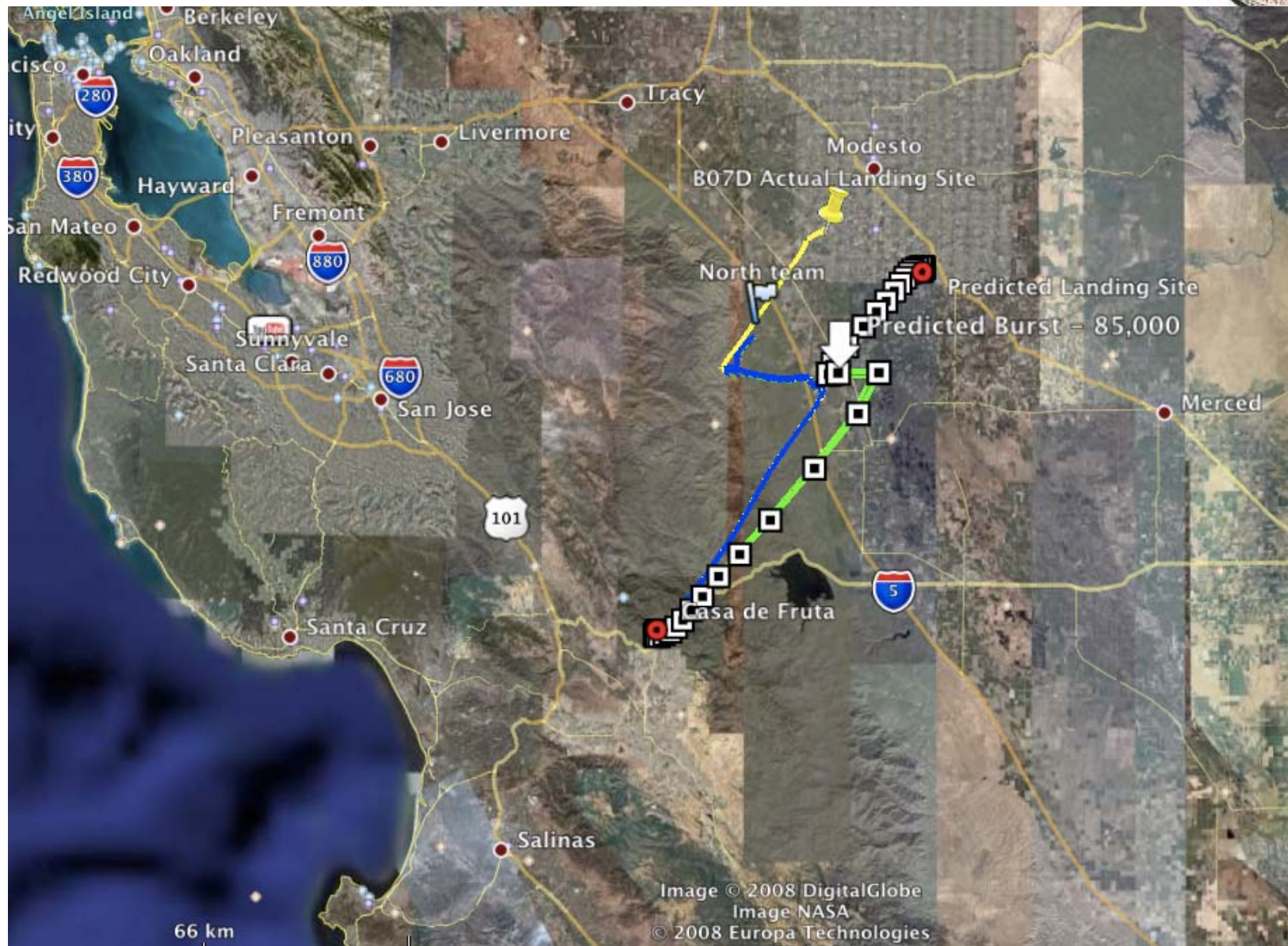


OPAL Thermal Anomaly



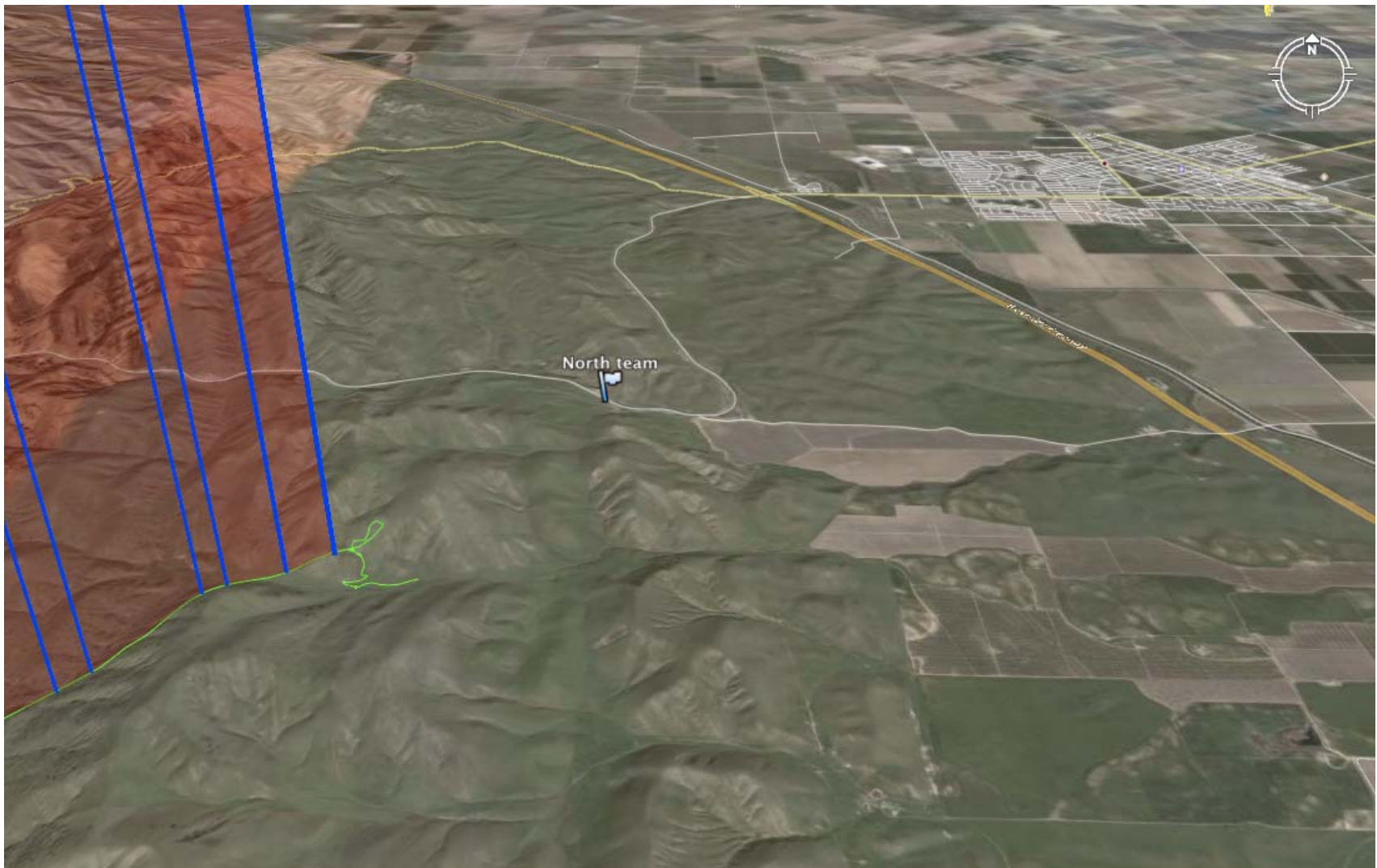








A Hike





Bees





Cows







