The Ground Station at the University of Colorado at Boulder

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Antenna on roof of DLC

The Ground Station at CU Boulder is the communication center for the CU CubeSat program and other satellite programs at CU.

http://spacegrant.colorado.edu/

Ground Station Information

Latitude	N 40 °1.00’
Longitude	W 105 ° 16.00’
Altitude	1655 m (5430 ft)
Station License	None
Operating Frequencies	2m and 70cm Amateur Band

Before moving to the Discovery Learning Center, the Ground Comm. station was located in the engineering center. When moved, many specifics on how the station was set up were lost.

In fall 2006, the Ground Comm. Team was created to bring the station back up to working order and to ensure that future teams could use the station. The station is continually changing, as it is not completely set up yet. There are still many things yet to be completed.

When finished, we hope to have the following capabilities;

- Fully automated transceiver. (A computer program will control all tuning and Doppler shift.)
- Lightning protected system, with grounding for the antenna and radio.
- A software TNC (which can do far more than a hardware TNC)
- Microwave communications ability in the 3.4 GHz range.
- Two computers for the ground station.

These goals will enable CU Space Grant to have one of the best ground communication stations.

Hardware

The SGGS has 2 antennas, one each for 2 meter and 70 centimeter communications. The 2 meter band antenna is a 22-element Yagi antenna. The 70 cm band antenna is a 38-element Yagi. They have 14 dBdc and 15.5 dBdc gain respectively. Both antennas have the ability to switch the polarization from LHCP (Left Hand Circular Polarization) to RHCP (Right Hand Circular Polarization). The transmit and receive antennas are mounted with their masts parallel to each other, at the top of a 35 foot tower on the 3rd floor roof of the DLC.

The actual station is on the 2nd level of the DLC. All lines are run through pipes connecting the roof to the ground station computer. The antennas are controlled by Yaesu G-5400B Azimuth/Elevation Rotators. The antenna controller is capable of elevation and azimuth control. It has elevation control from 0 to 180 degrees. Its azimuth control goes from -180 to 180 with North being 0 degrees.

Ground Station Components			
Item	**Manufacturer**	**Model**	**Feature**
2 meter antenna	Cushcraft Corp.	22XB 2m OSCAR Boomer	14 dBdc gain
70 centimeter antenna	Cushcraft Corp.	738XB 70 cm OSCAR Boomer	15.5 dBdc gain
Antenna rotator	Yeasu	G-550	Azimuth/Elevation
(2) Coaxial Cable (75-100 ft)	Carol	RG8/U	5.56 dB/ 100 ft at 440 MHz
LNA – mast mounted	Mirage		
(2) Control Cable	Superior Essex Marathon	CAT5E	Rotator Control Cable
Power Supply	Yaesu	FP-1023	23 amp, 13.8 V
Rotator Controller	Yaesu	G-5400B	Azimuth/Elevation rotator
Transceiver	Yeasu	FT-847	Sensitivity = 0.2 μV
PC	Custom HP		2.19 GHzm 512 RAM, Win XP
DAQ Device	LabJack	U12	Controller for rotator controller

TNC	Timewave	Pk-96	FSK Modualtion

The actual station is on the 2nd level of the DLC. All lines are run through the roof of the building to the radio and computer.

A Yeasu FT-847 Radio is used for communication. It has an adjustable Radio Frequency (RF) power output range from 5 watts RF to 50 watts RF in the 2 m and 70 cm bands. The transceiver is capable of simultaneous transmit and receive on separate bands, and has enough bandwidth to handle the 9600 baud data rate. It also has a CAT (Computer Aided Tuning) port that allows Doppler frequency corrections to be made by an outside device.

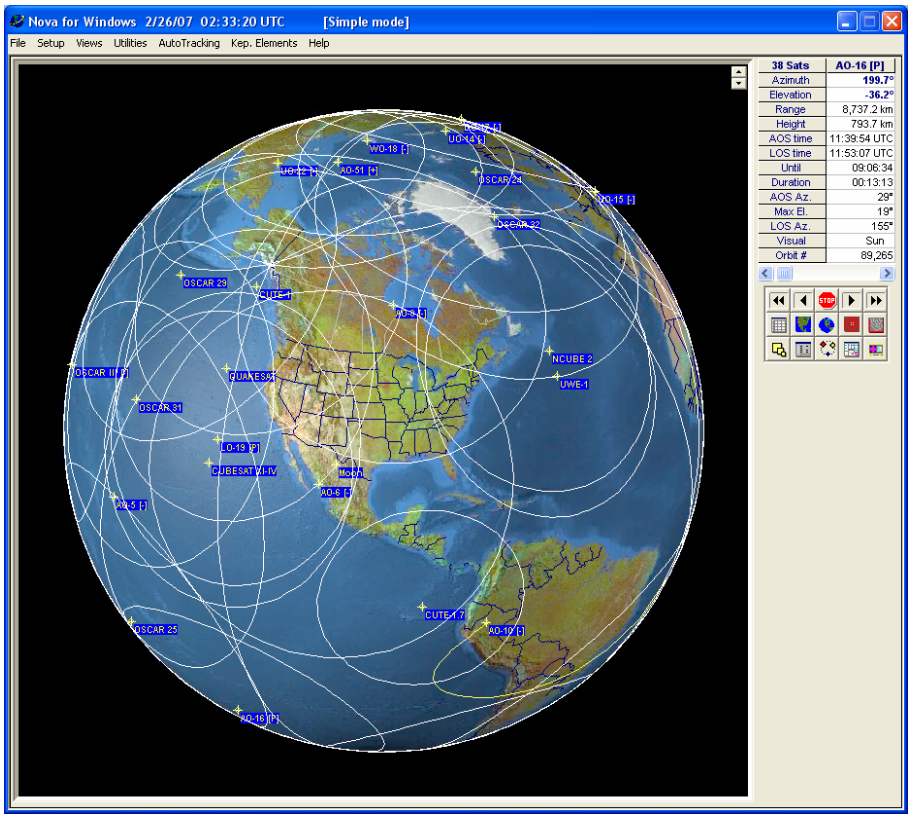
The TNC is used to convert audio frequency signals in the AX.25 format into a digital stream. The ground station Terminal Node Controller is a Timewave PK-96 .

Communication

Tracking satellites is controlled mainly by the computer and the software it runs. For tracking satellites, NSLA's Nova allows us to have an overall view of multiple satellites in the sky, controls the rotators and shows the flight path for any given satellite.

The rotators are controlled by Nova through the computer's USB port, into a LabJack, and then into the rotator control box. The LabJack is a device which allows us to use a USB port for the rotator control box.

Nova tracks the satellite and controls the antennas as the satellite passes over. In



Nova for Windows from NLSA.[1]

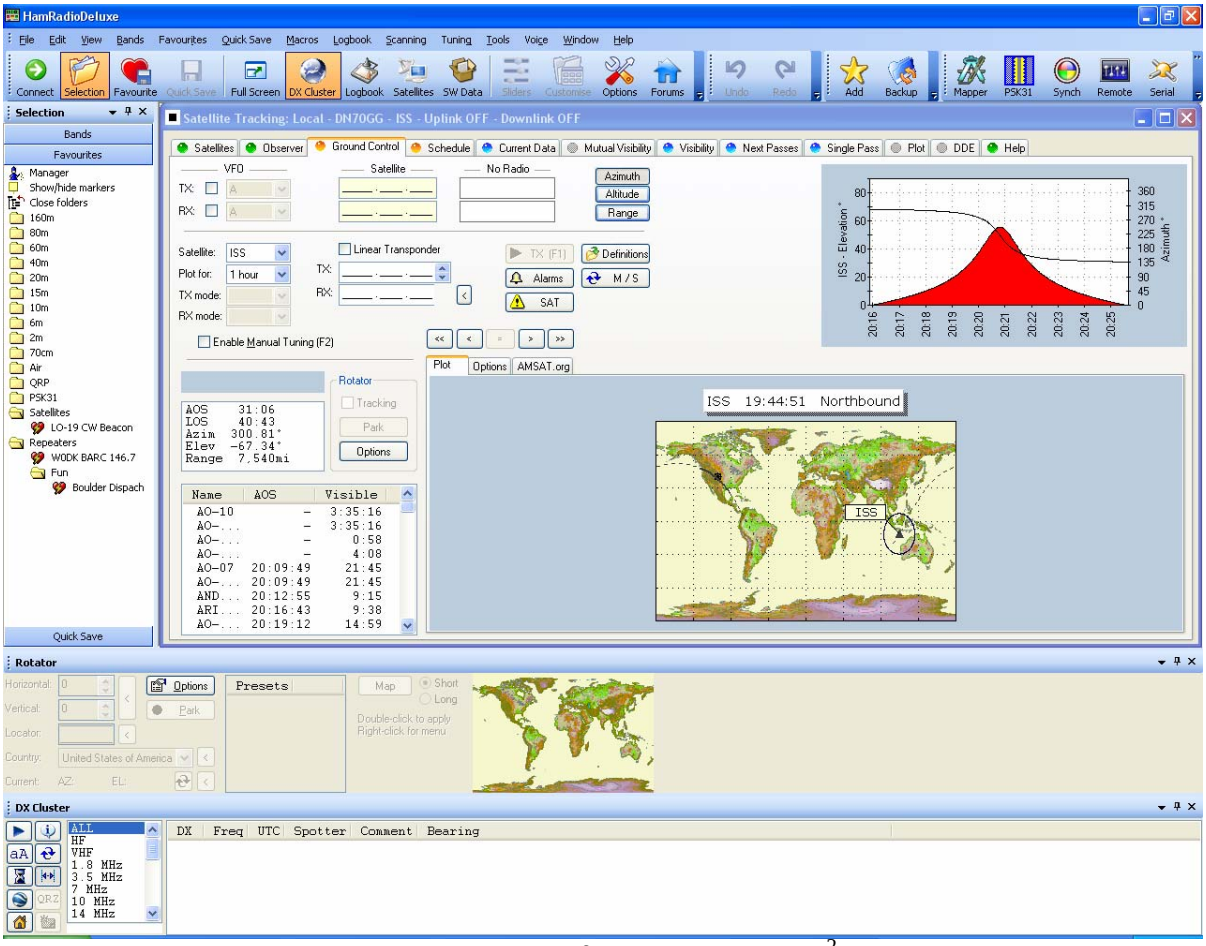
Nova, we can enter the Uplink and Downlink information to then calculate the correct Doppler shift.

Nova is a very good program due to its use of a great graphical interface, Keplerian elements downloaded from amsat.org, and smooth rotator control.

In addition to Nova, we also use Ham Radio Deluxe (HRD), which controls the radio's frequency setting automatically.

(Right now, we are in the process of getting these two programs to work together so that the ground station is completely automated.)

When HRD and NOVA are working together, the tracking of satellites will be fully automated. Both Nova and HRD are programs designed for tracking satellites. They are both updated from the AMSAT website with the information for nearly all amateur radio satellites.

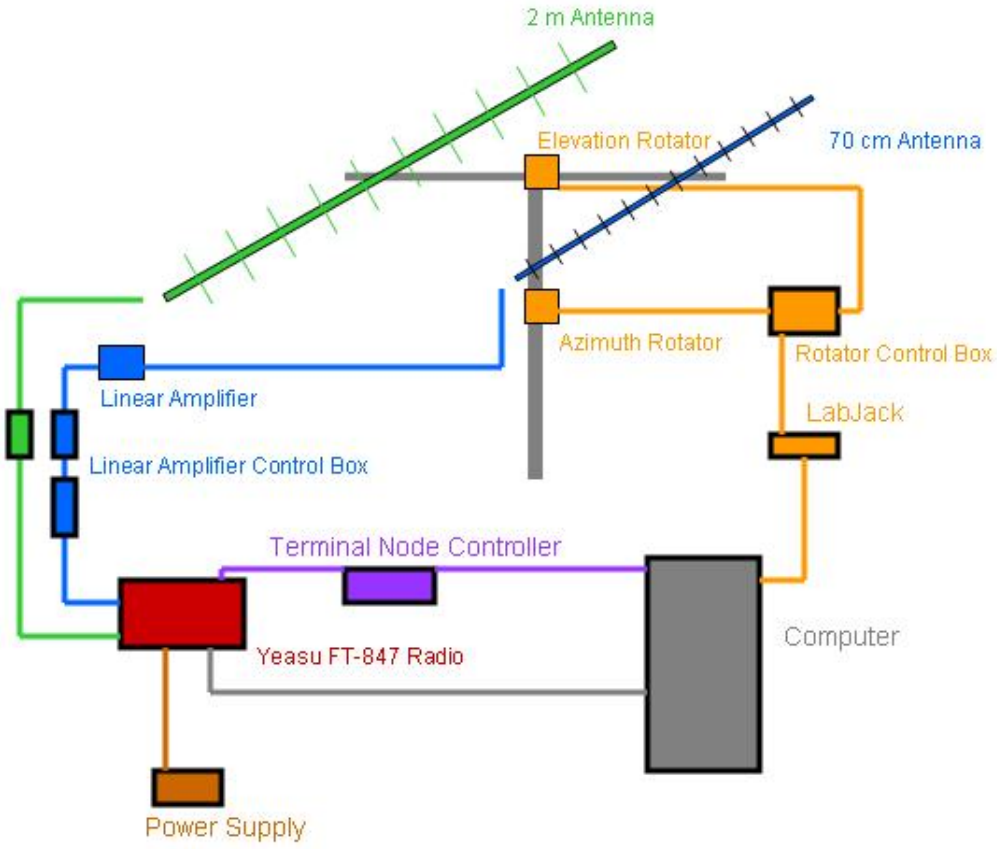


Ham Radio Deluxe from Simon Brown[2]

Signals picked up by the ground station radio are fed into a TNC. This TNC decodes them and then it is displayed in Window's HyperTerminal. This basic system will be used to test ground-to-satellite communications before software pertinent to the current satellite being constructed at CU is created and installed.

Conclusion

With in 2007, the ground station at CU boulder will be fully operational and able to contact various satellites.



Connection Diagram for Ground Station

[1] http://www.nlsa.com/
[2] http://hrd.ham-radio.ch/