

4 on 4

Phase 4 Update for Palomar Amateur Radio Club
November 4, 2015

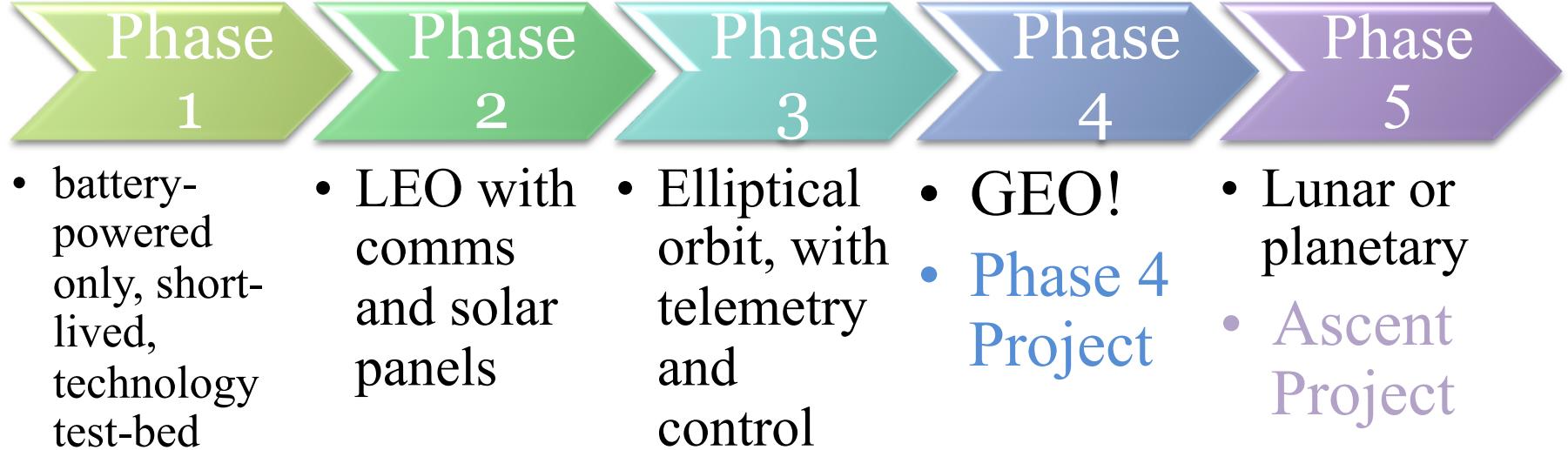


Phase 4

- A digital microwave geosynchronous amateur radio satellite service system made possible by a partnership between Virginia Tech, AMSAT, and Millennium Space Systems.



The AMSAT Phase System Explained



Phase 4 – Not Just a Satellite Project

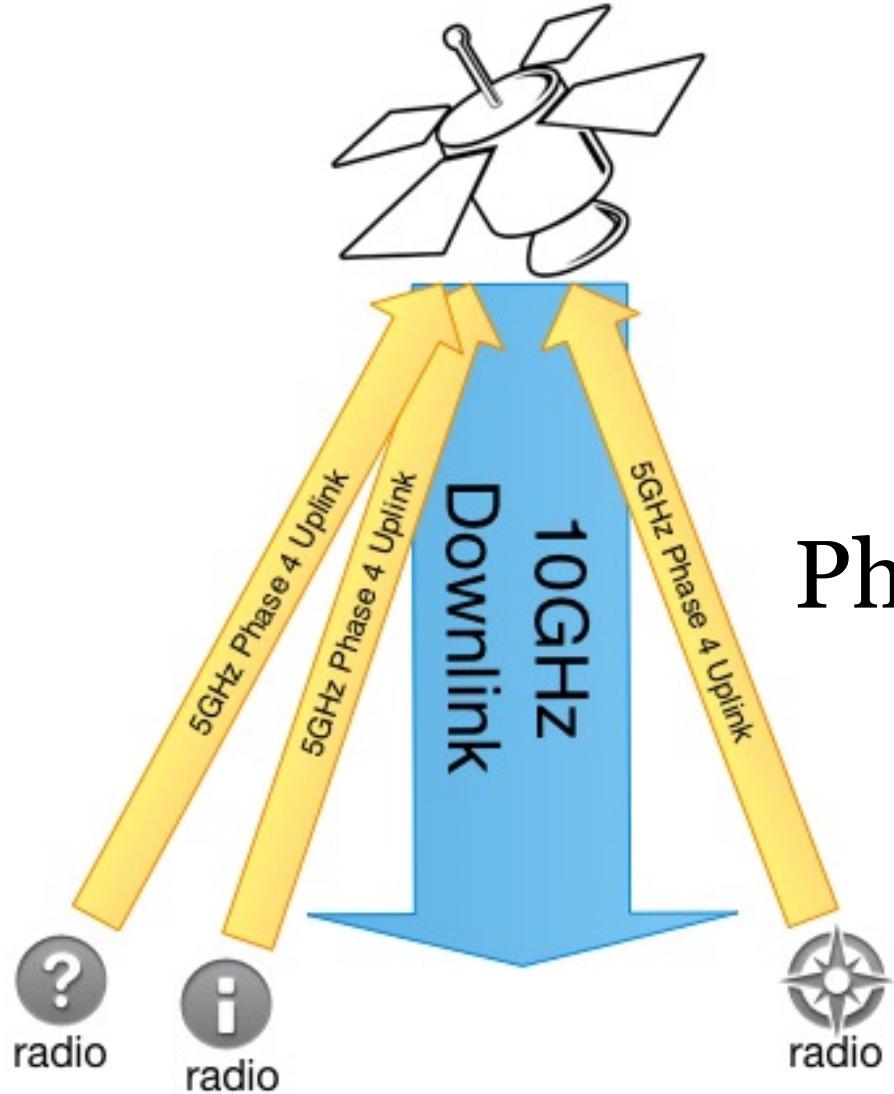
Satellite Service

This mission (Phase 4b) is funded for three years, and could last for ten. The satellite may be placed in a parking orbit. We are hoping to build upon this mission in order to have our own geosynchronous satellite(s) with longer missions.

Phase 4a is a AMSAT-DN project.

Terrestrial Service

Using the launch as a motivator, we will create ground stations and equipment that will live on past the satellite mission. Terrestrial service is built-in from the beginning. The system will be fun, useful, reconfigurable, powerful, and will make getting on the microwave bands much easier and much more accessible than they have been in the recent past. Use them or lose them!

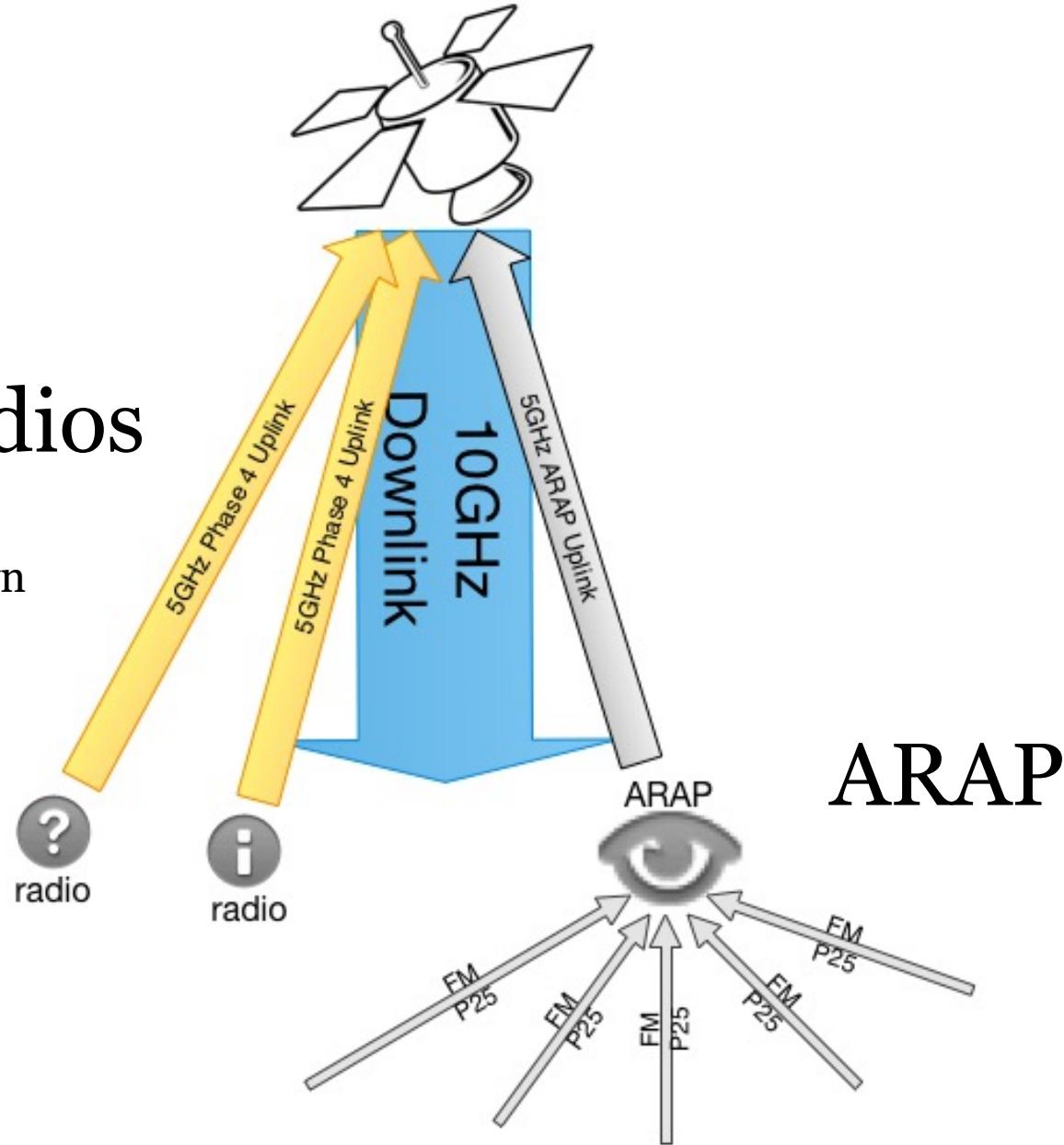


Phase 4 radios

5.645-5.655 GHz up
10.45-10.46 GHz down

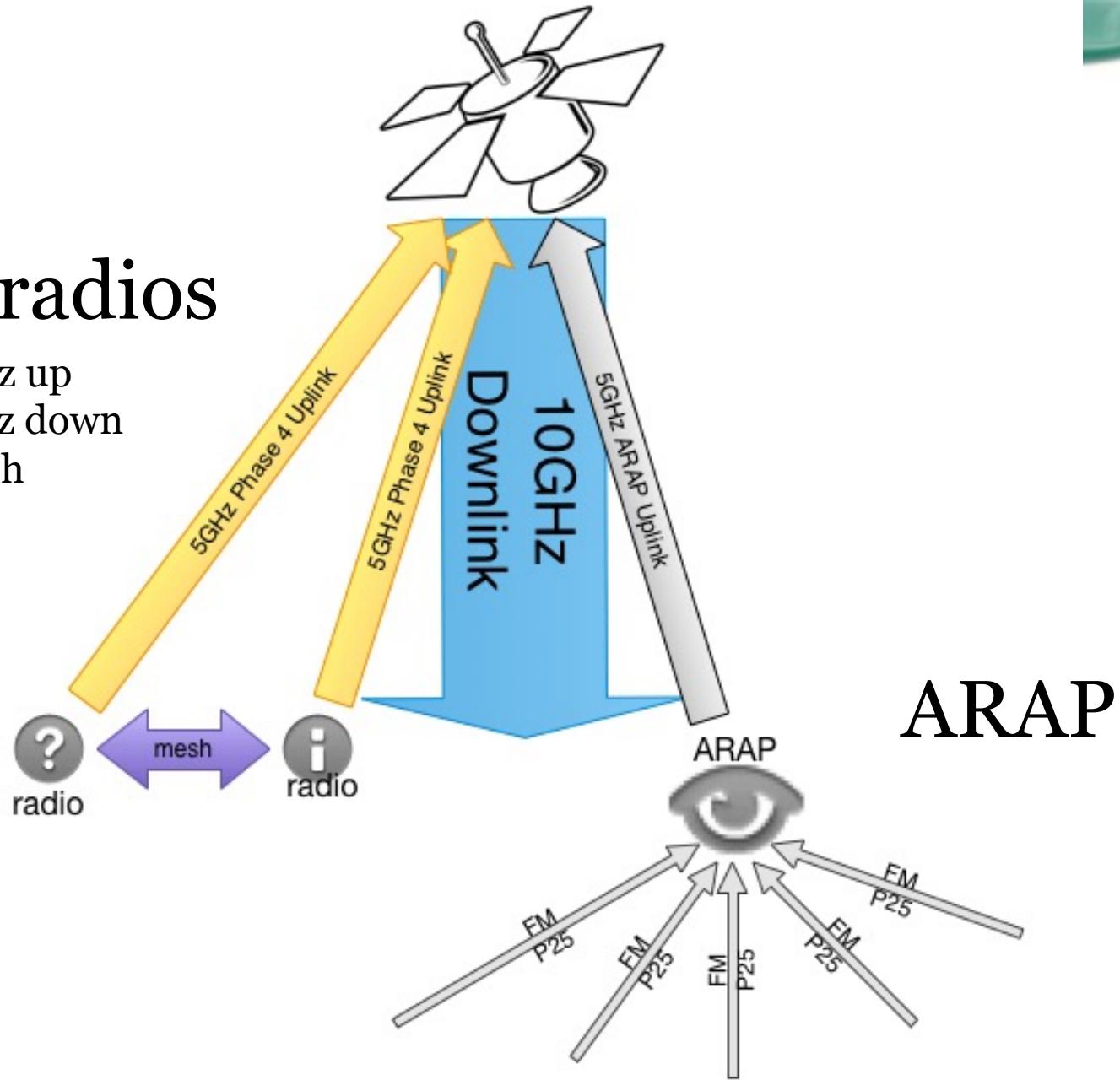
Phase 4 radios

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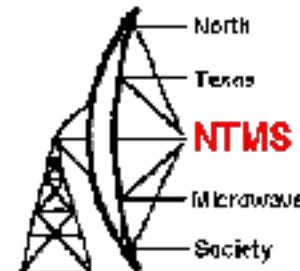
Phase 4 radios

5.645-5.655 GHz up
10.45-10.46 GHz down
5 GHz local mesh



Who else is directly supporting this project?

- Palomar Amateur Radio Club, Escondido Amateur Radio Society, Dixon Lake Recreation Area, Rincon Research, North Texas Microwave Society, Federal Emergency Management Agency, Ettus Research, Hume Center at VT, Amateur Radio Relay League...



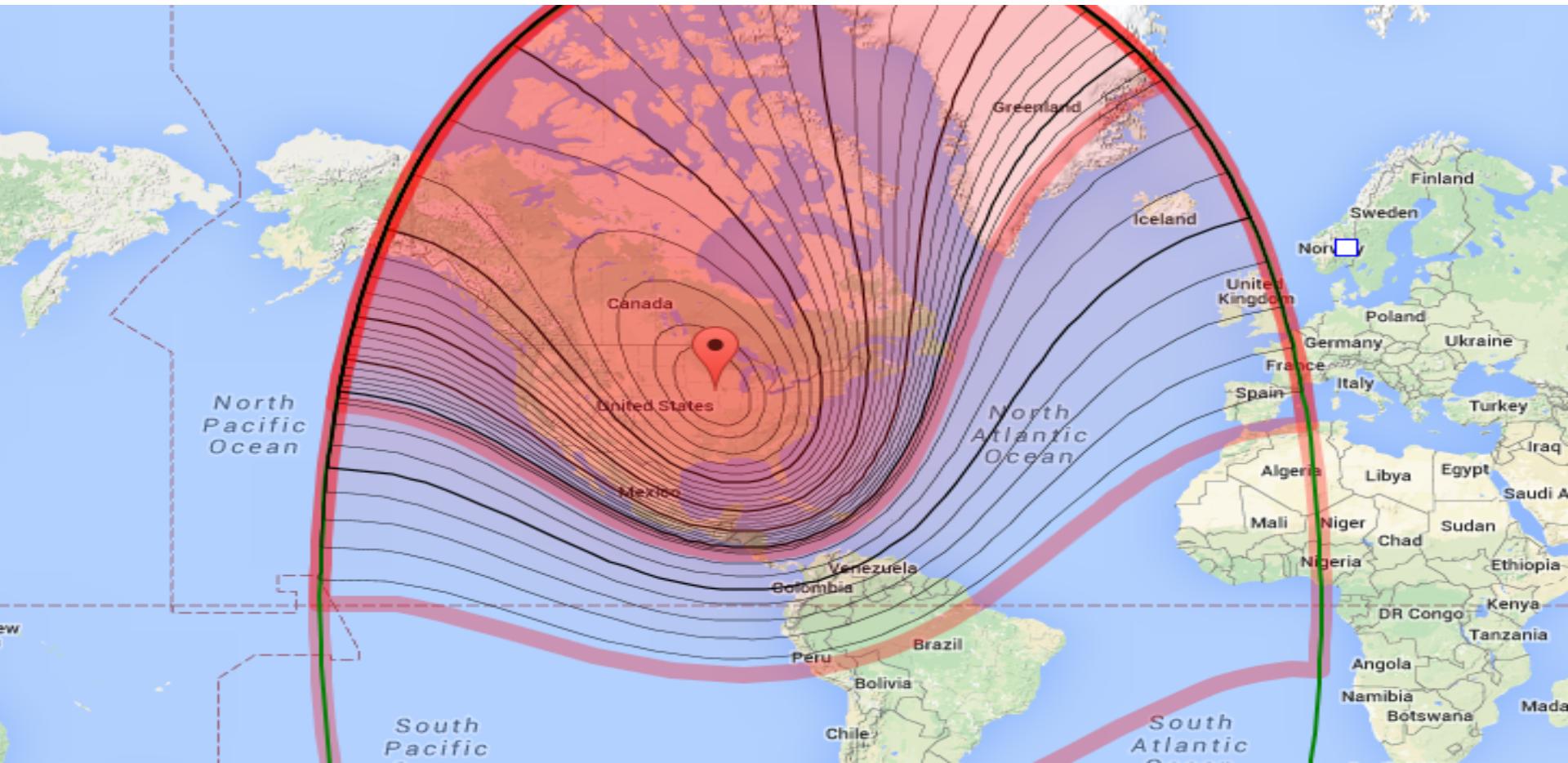
And lots of volunteers!



Current Status

- We have a growing team of 40 volunteers/employees
- A \$100,000+ rideshare payload study at MSS is underway
- We are expecting a late 2016 or early 2017 launch
- We will have 100 watts of power from the spacecraft
- We will enjoy access to the coldplate
- We can use several external areas on the spacecraft for antennas
- We do not have to control the spacecraft
- Ground station development is completely open source
- Space segment development is ITAR controlled

Possible Satellite Footprint – 74° W



Wide Field of View Connections

MSS

- Jeff Ward K8KA
 - University of Surrey
 - AMSAT
 - TAPR

Air Force

- Col Fred Kennedy
 - University of Surrey

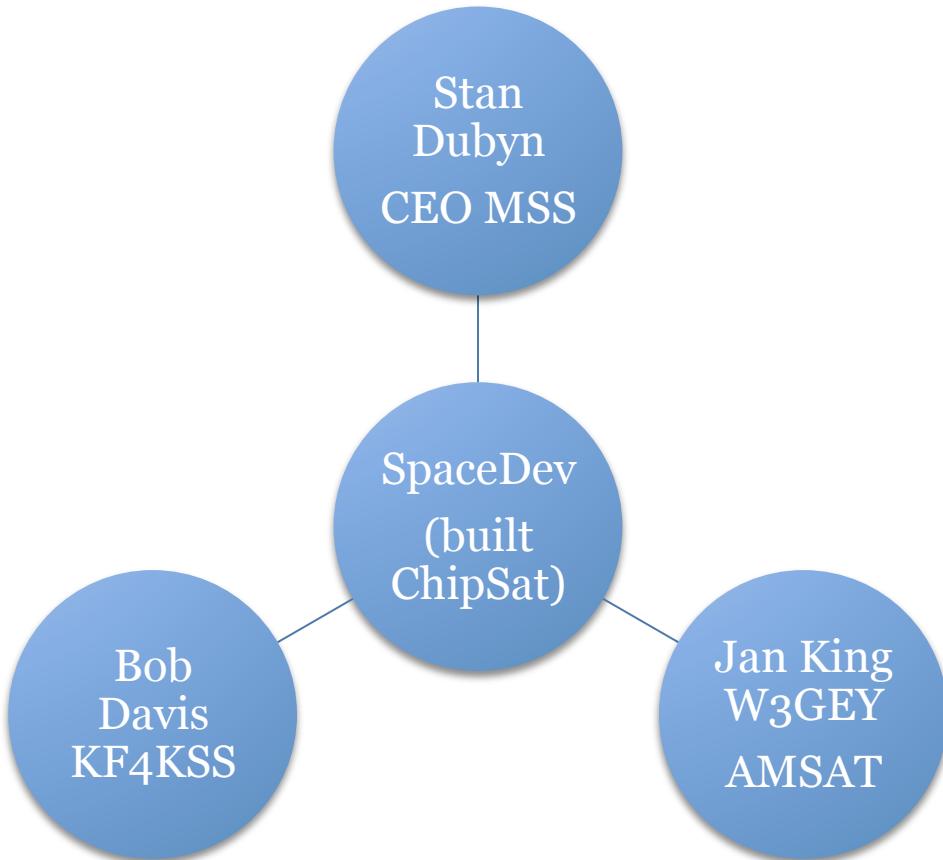
The diagram illustrates the 'Wide Field of View Connections'. In the center is a large blue circle containing the acronym 'WFOV'. Two grey arrows point towards this central circle from two separate blue rounded rectangular boxes. The left box is labeled 'MSS' and contains a bulleted list with 'Jeff Ward K8KA' at the top, followed by three items: 'University of Surrey', 'AMSAT', and 'TAPR'. The right box is labeled 'Air Force' and contains a bulleted list with 'Col Fred Kennedy' at the top, followed by one item: 'University of Surrey'. Both boxes have a slight shadow and rounded corners.

WFOV

 MILLENNIUM
SPACE SYSTEMS

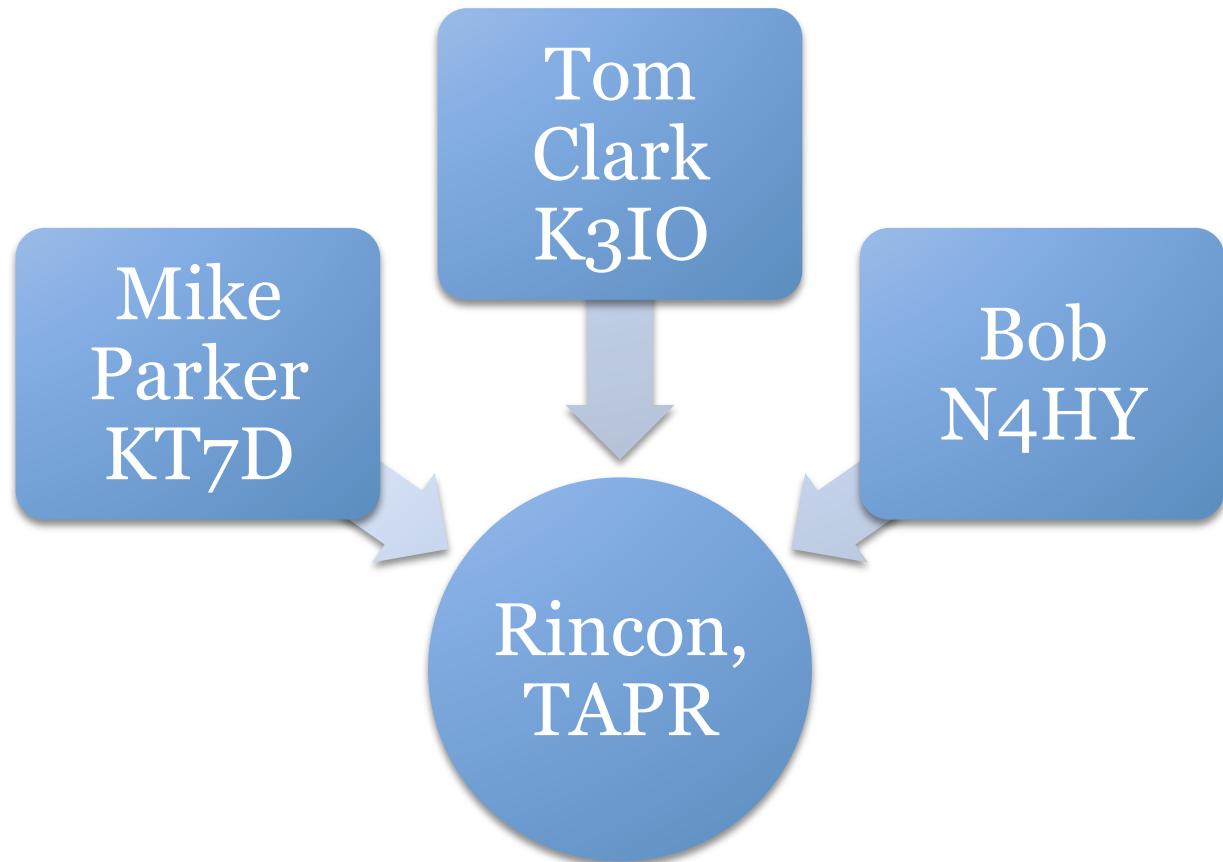


Millennium Space Connections ...are actually SpaceDev Connections



Rincon, TAPR, and the LPFE

- Rincon has donated their LPFE (similar to USRP E310) for the Phase 4 spacecraft.
- It's on the internet via VPN for programming.
- Rincon will also donate an LPFE for Phase 3E.



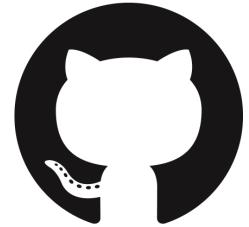
Issues and Resolutions

- International Traffic in Arms Regulations directly affects this project
- What and how did it impact the project?
 - Time wasted, stress increased, harsh and unnecessary limits on human resources
- Splitting up the project into **Ground** and **Space** allowed for open source development of the ground station while enabling the space segment development to continue to comply with ITAR.
- Teams are now separate and communicate through the Air Interface Document, which defines the radio link between satellite and stations on the ground.

Phase 4 Top-level Team Structure

Phase 4
Space Team

<https://github.com/phase4ground>



Common
Air
Interface



Phase 4 Ground Team

Phase 4 Ground Team Structure



It's All About The Team

RF Hardware

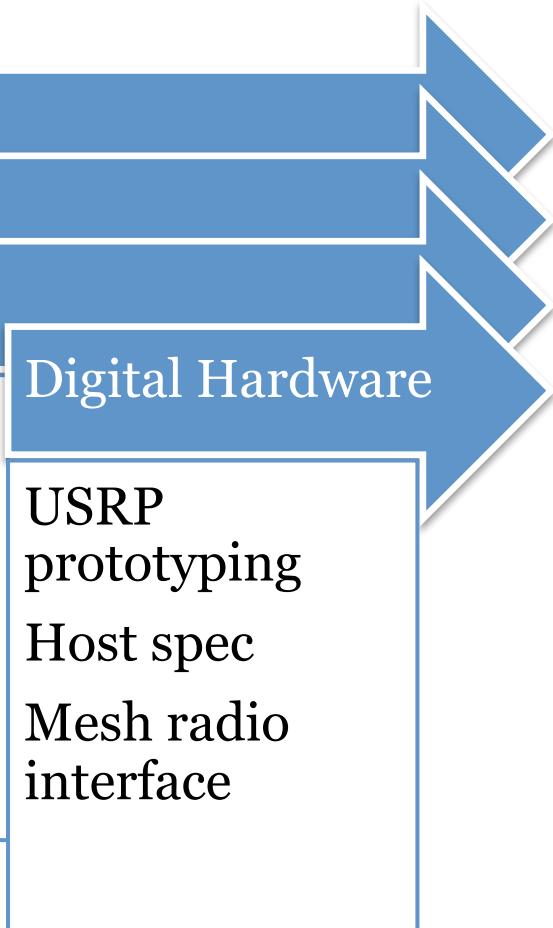
5GHz link
10GHz link
Antennas

Applications

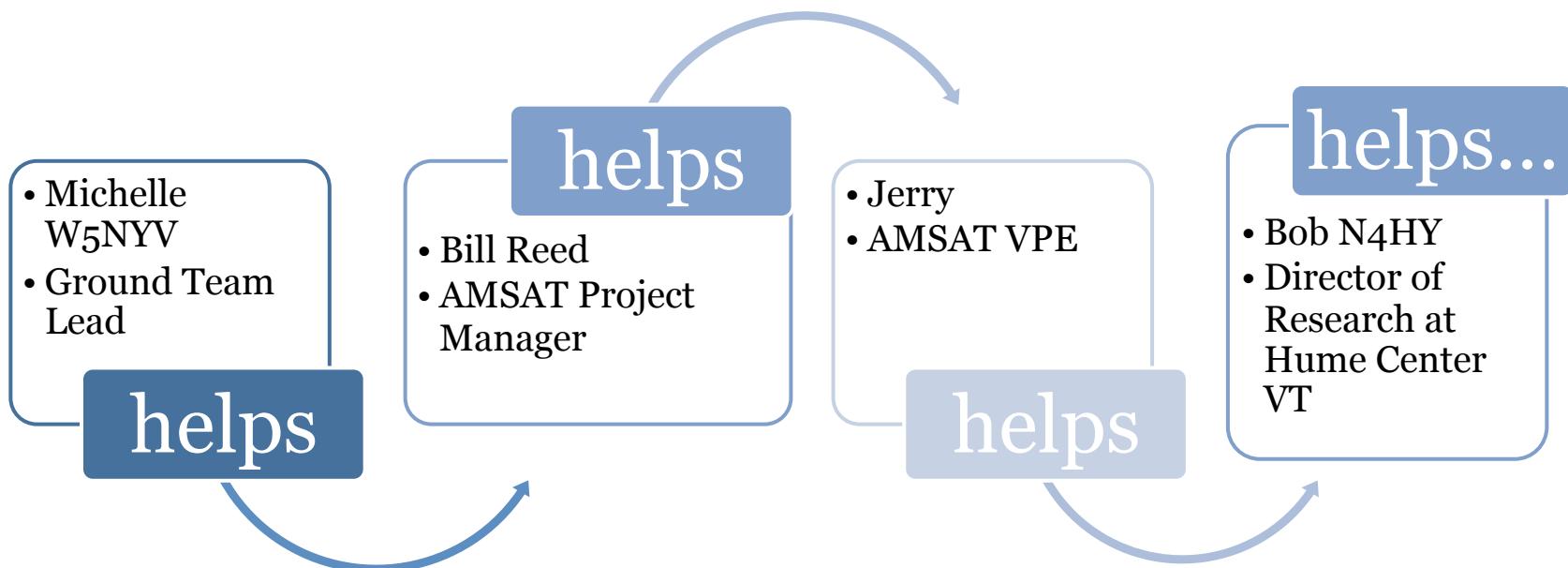
QSO party
SatChat 1k
EmComm
Stereo Field
FractalQSL

Servers

Xmpp
YAWS
Authentication

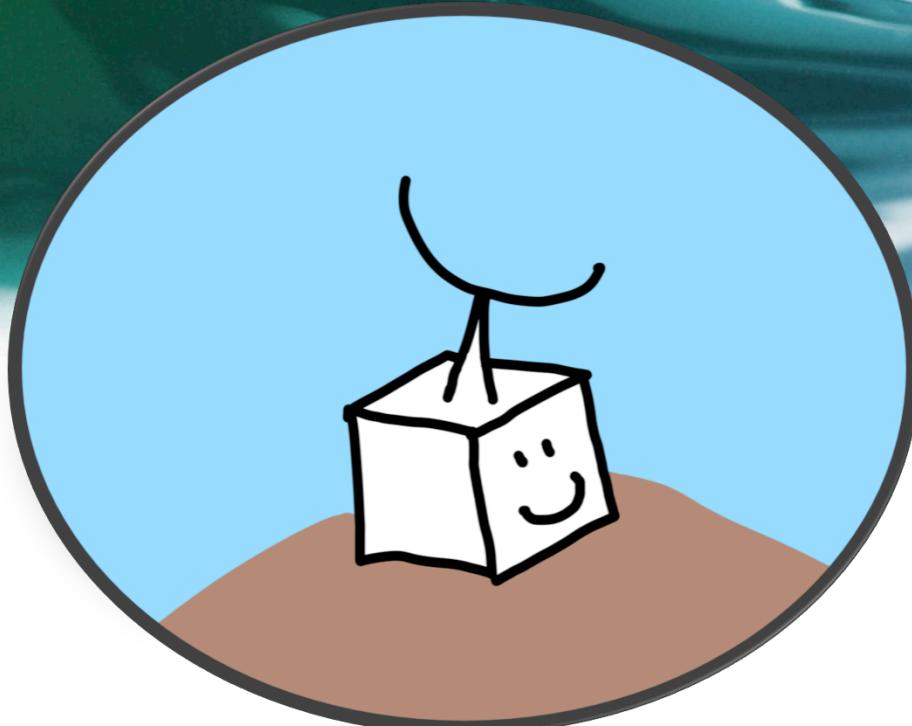


Phase 4 Ground Leadership Supports the Team



Development System

- **Groundsat**
- **ARAP**
- **User Terminals**



Groundsat



Groundsat sites are planned in four US locations with a variety of weather and geography.

Phase 4 Groundsats (proposed) ★

Groundsat Systems in the Phase 4 Network. Used for Phase 4 Development, these systems continue to operate terrestrially.
75 views

All changes saved in Drive

Add layer Share

San Diego System Individual styles PARC Groundsat Dixon ARAP

Maryland System Individual styles Maryland Groundsat

Virginia Tech System Individual styles Virginia Polytechnic Institut...

North Texas Microwave Society S... Individual styles North Texas Microwave Soci...

Base map

The map displays the following state abbreviations and names: ID, WY, SD, MN, WI, MI, NY, PA, NJ, DE, MD, VA, NC, SC, GA, FL, OK, KS, MO, IL, IN, OH, KY, TN, AL, MS, LA, TX, CO, UT, NV, AZ, NM, CHIHUAHUA, SONORA, COAHUILA, N.L., BAJA CALIFORNIA, BAJA CALIFORNIA SUR, SINALOA, DURANGO, TAMAULIPAS, MEXICO, and THE BAHAMAS. The map also shows the Great Lakes: Michigan, Huron, Erie, and Superior.

USRP* X310 and 10MHz – 6GHz RF daughter cards.
This will simulate the FDMA demodulator and TDM modulator functions provided by the satellite.

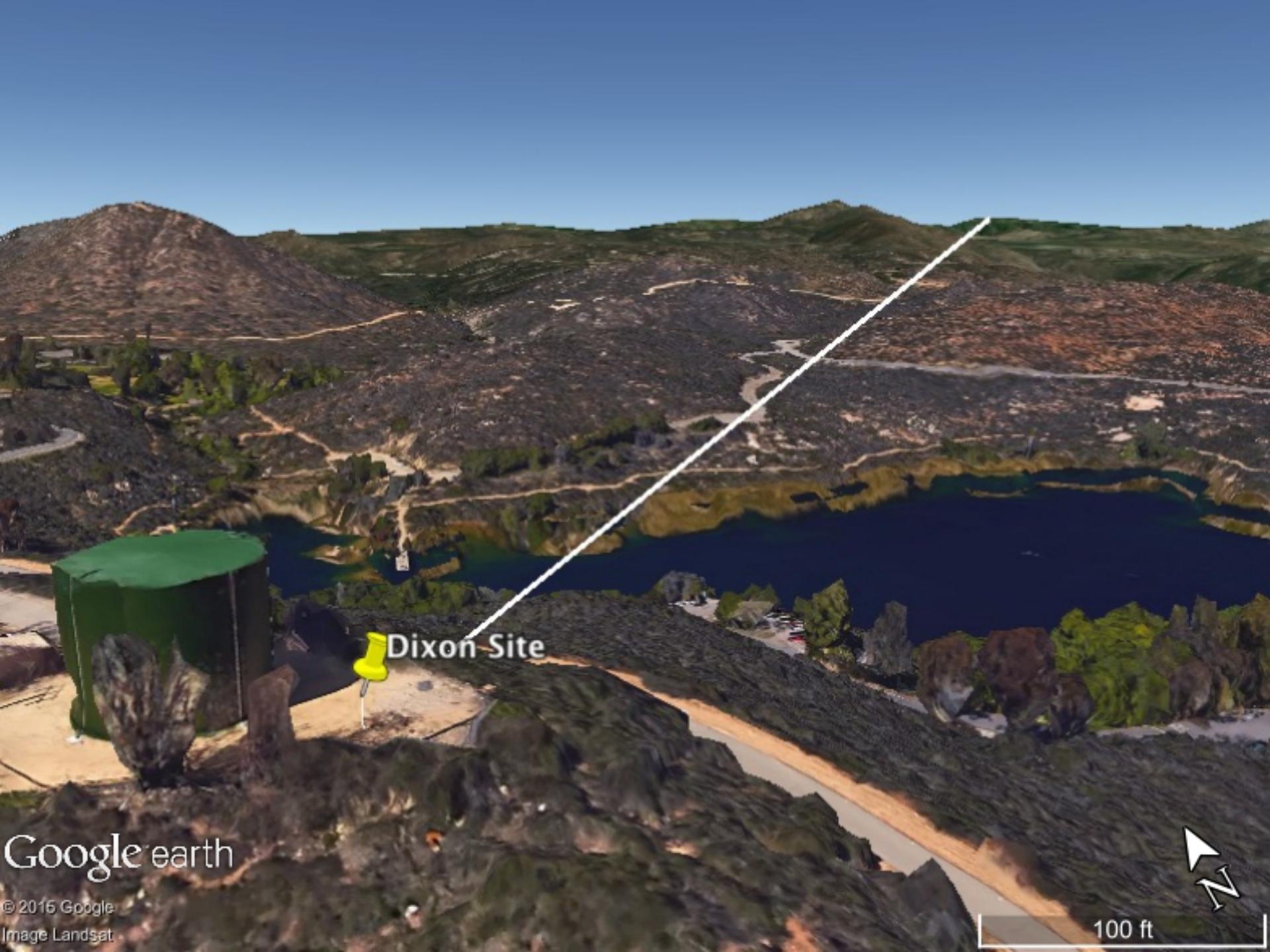


***Universal Software Radio Peripheral**

A R A P
イ M ヲク ヲ A キエイシニアエクク
ヲ ウ D イ C ヲク
ケ T ョ I E エク
エ E イ O ク S
コ U キ R ク S

Amateur Radio Access Points

- Amateur Radio Access Points (ARAPs) **aggregate radio traffic and send it to the satellite.** They are powerful mobile stations that can provide emergency communications out of an affected area to either a satellite or Groundsat.
- The goal is for emergency or credentialed personnel to **use their own radio gear.**
- During a communications emergency, **shared secrets** allow for control of access to the satellite uplink.



Google earth

© 2016 Google
Image Landsat

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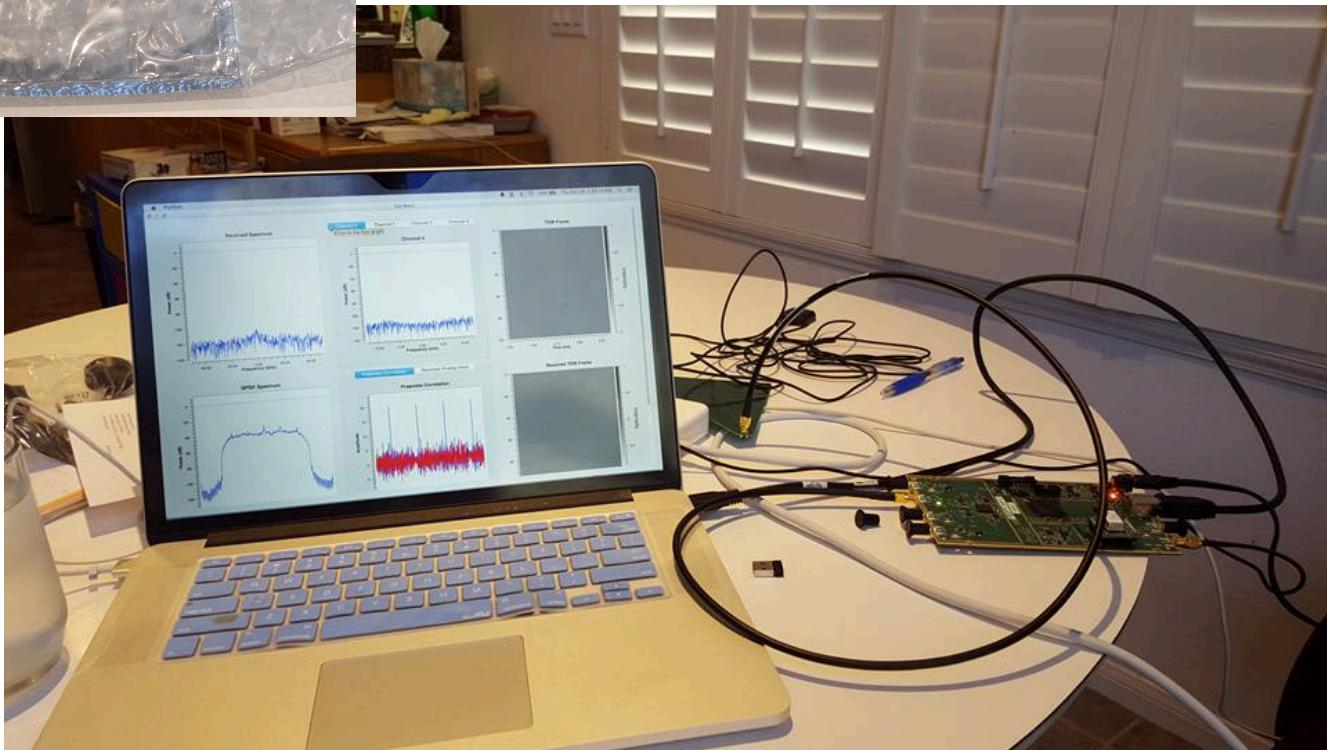
100 ft



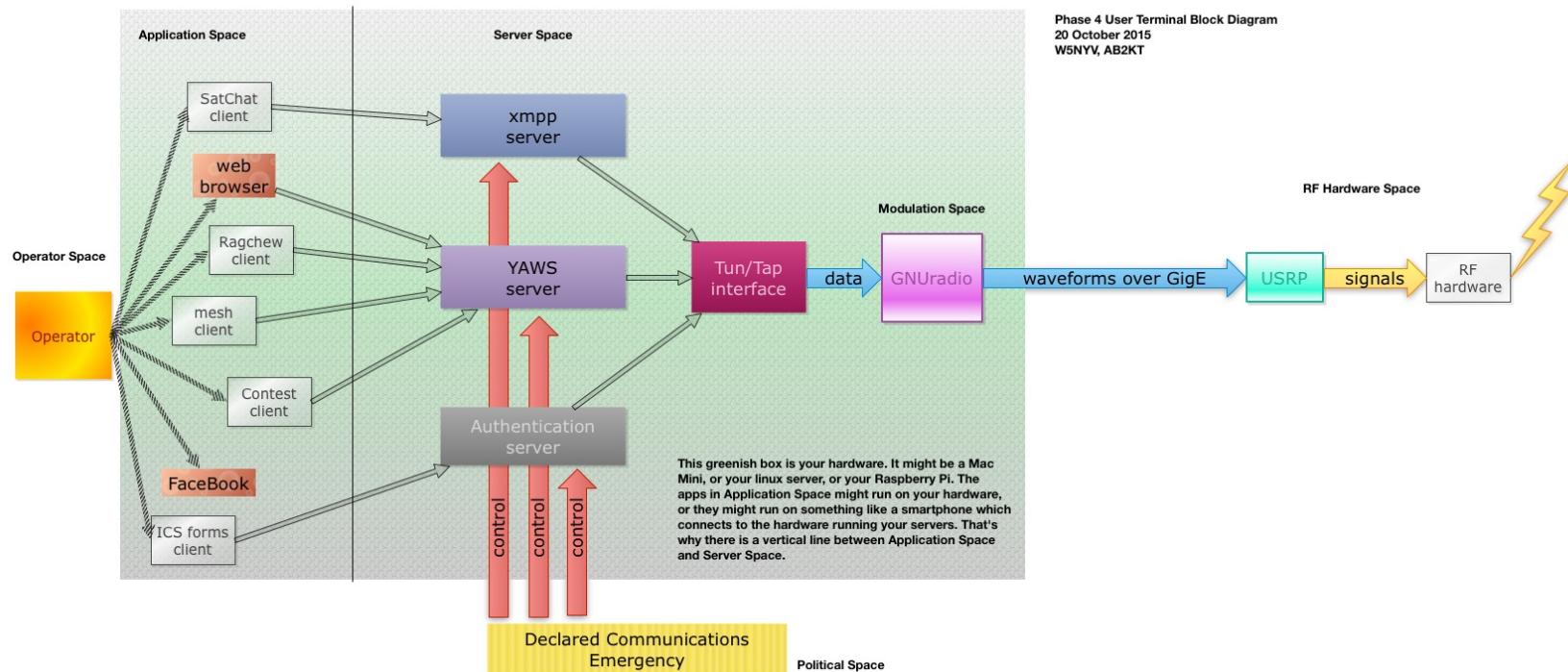
USRP B210 set up to demonstrate an ARAP collecting local FM traffic.

First demonstration was made at the AMSAT Symposium on 18 October 2015.

At left is same code running in San Diego on 30 October 2015.

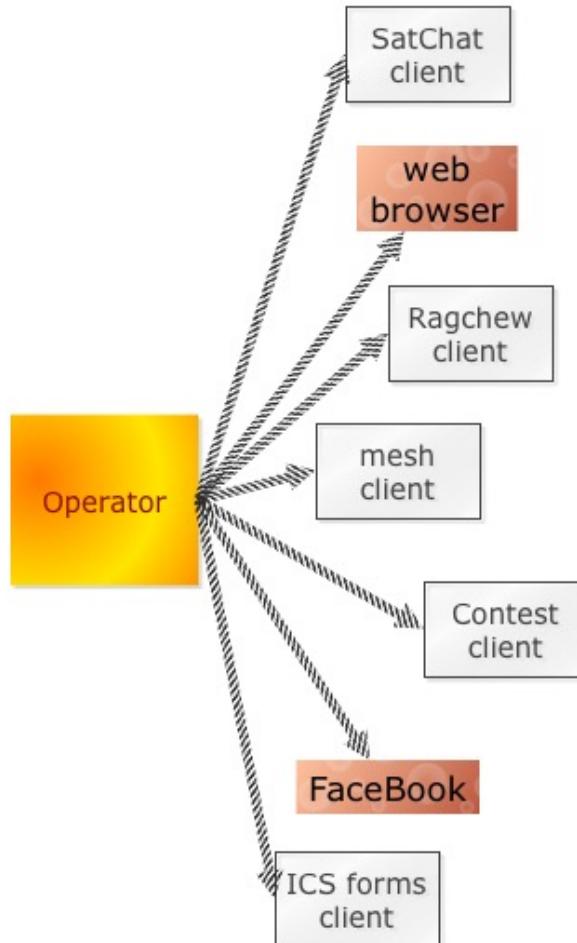


User Terminals... are still a block diagram

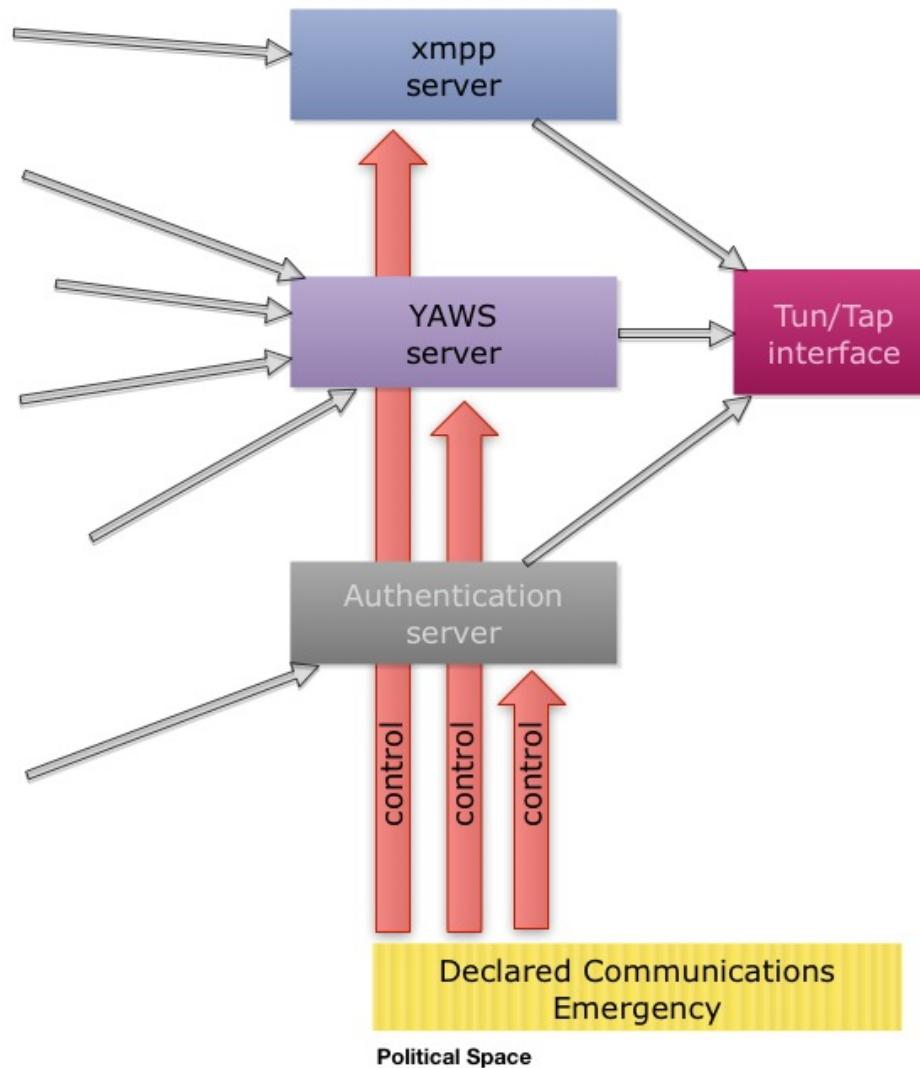


Application Space

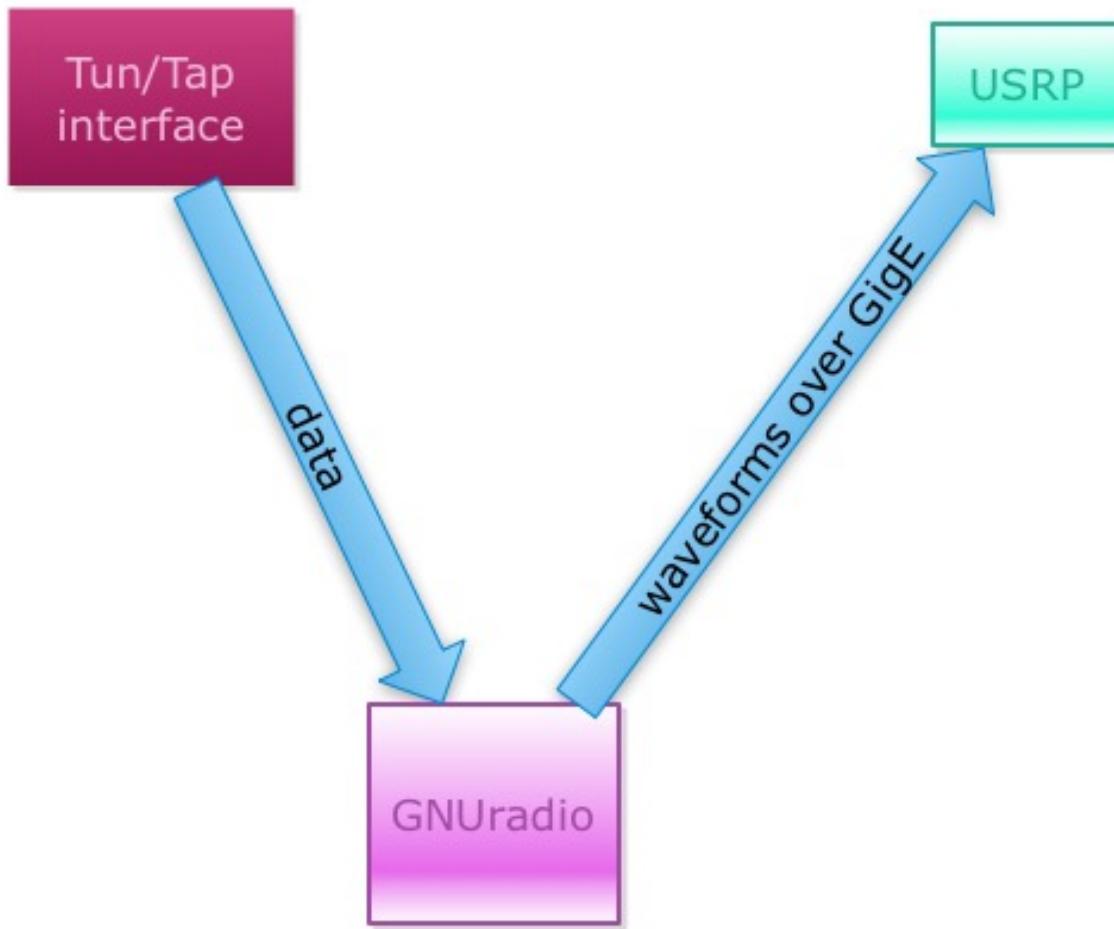
But, we have a great block diagram that has survived its first review.



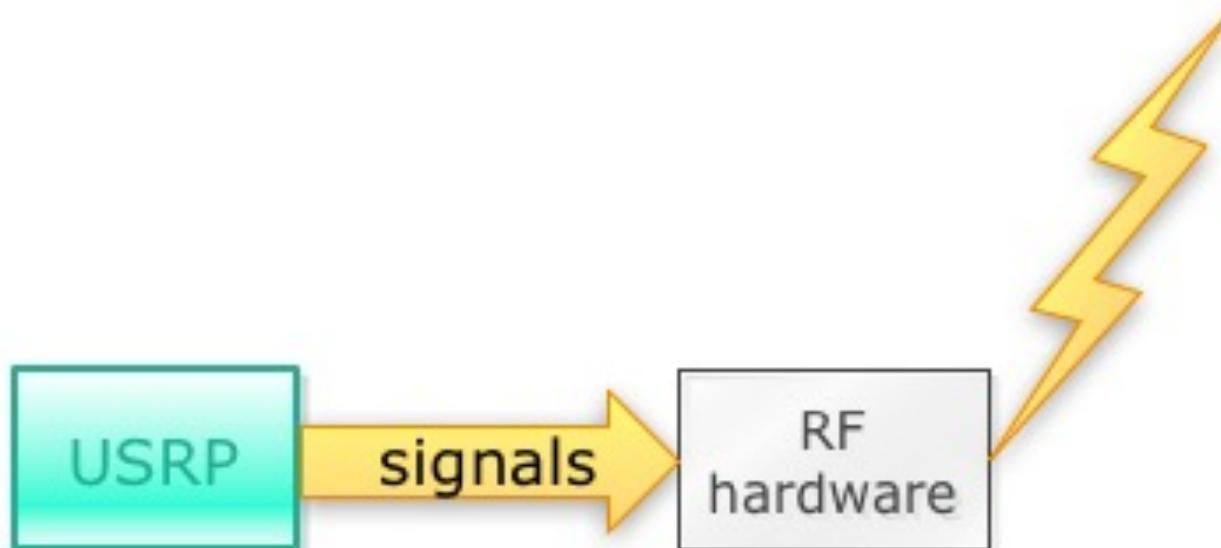
Server Space



Modulation Space



RF Hardware Space



Contact Phase 4 Ground

- <https://github.com/phase4ground> (team of 15 not visible)
- phase4@amsat.org (apply for membership to this address, open to both US and non-US citizens)
- Contact Michelle w5nyv@yahoo.com for more information.

Contact Phase 4 Space

- Due to ITAR, both the repository and the mailing list are closed, invite-only, and restricted to US citizens only.
- Contact Jerry Buxton vpe@amsat.org for more information.

NOTICE

**COMPLAINT
DEPARTMENT**



100 MILES

Complaints Lead:
N6KI

NOTICE

com
DEP
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