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 1	Phase 2	Phase 3	Phase 4	Phase 5
• battery-powered only, short-lived, technology test-bed	• LEO with comms and solar panels	• Elliptical orbit, with telemetry and control	• GEO! • Phase 4 Project	• Lunar or planetary • Ascent Project

Phase 4 – Not Just a Satellite Project

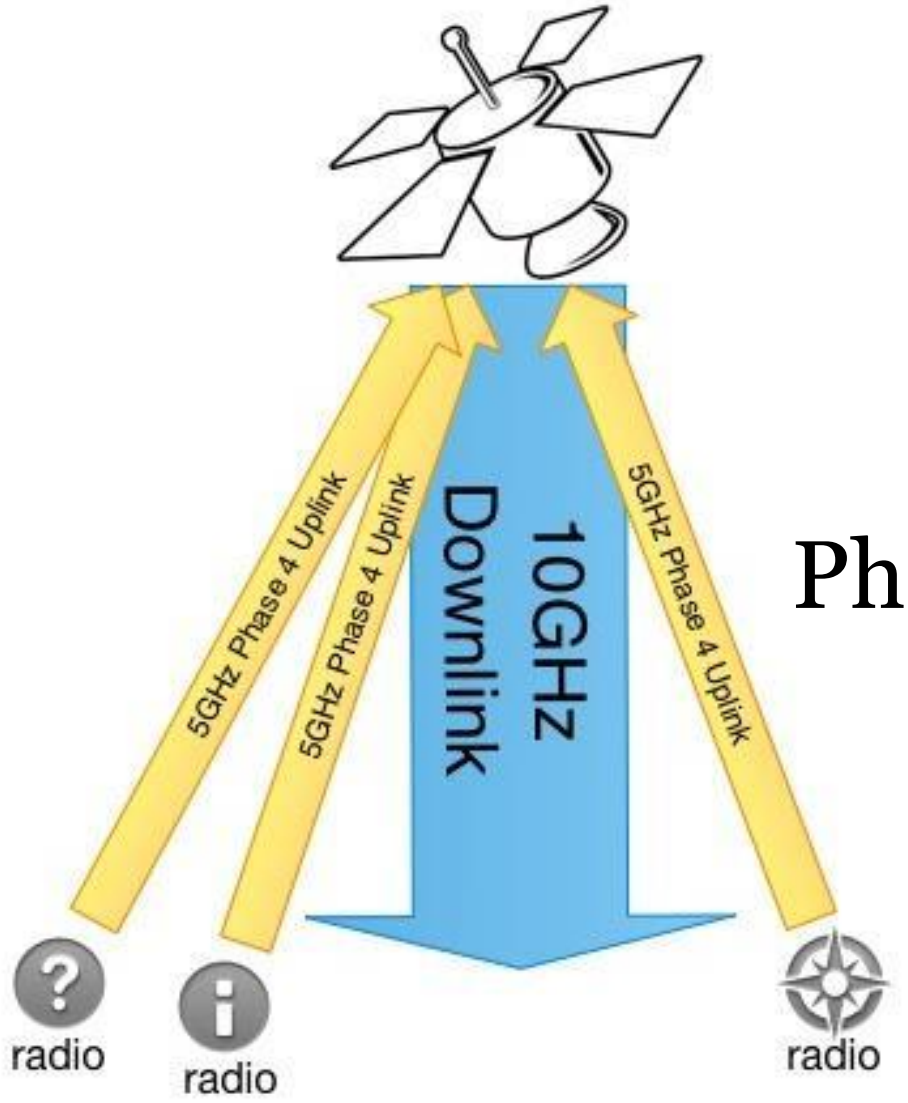
Satellite Service

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

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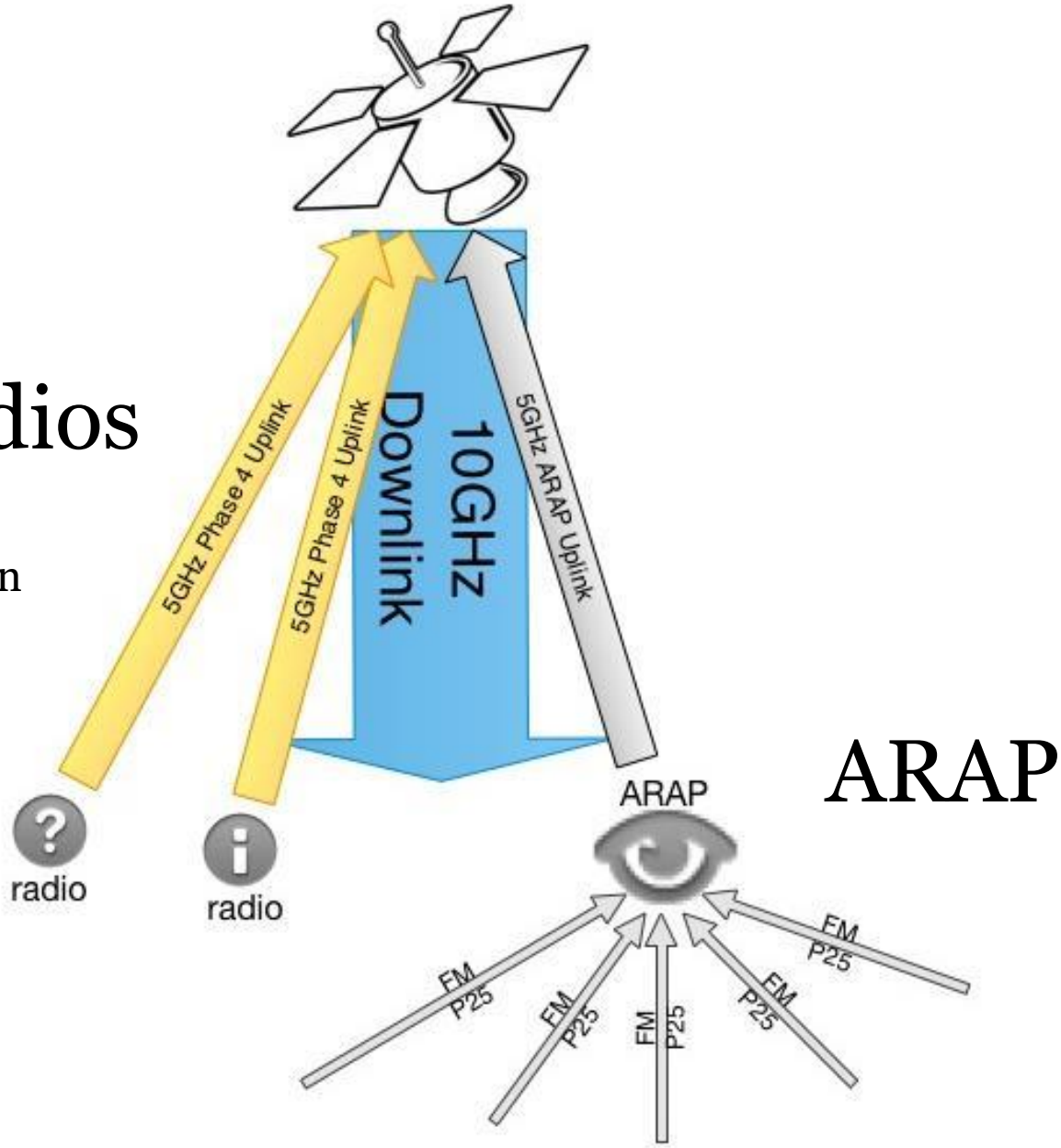
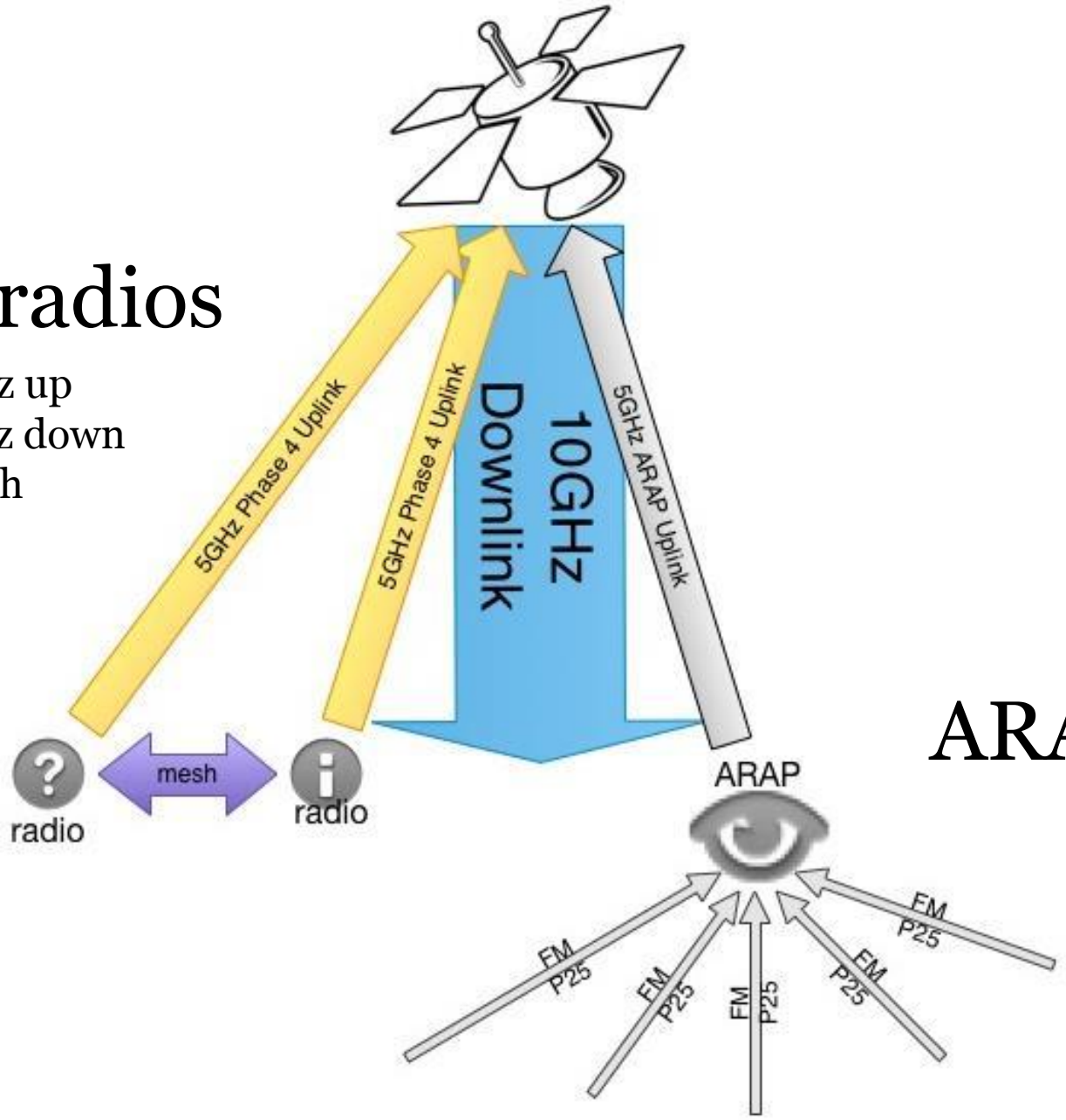


ARAP

Phase 4 radios

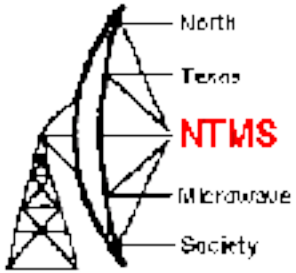
5.645-5.655 GHz up
10.45-10.46 GHz down
5 GHz local mesh



ARAP

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…

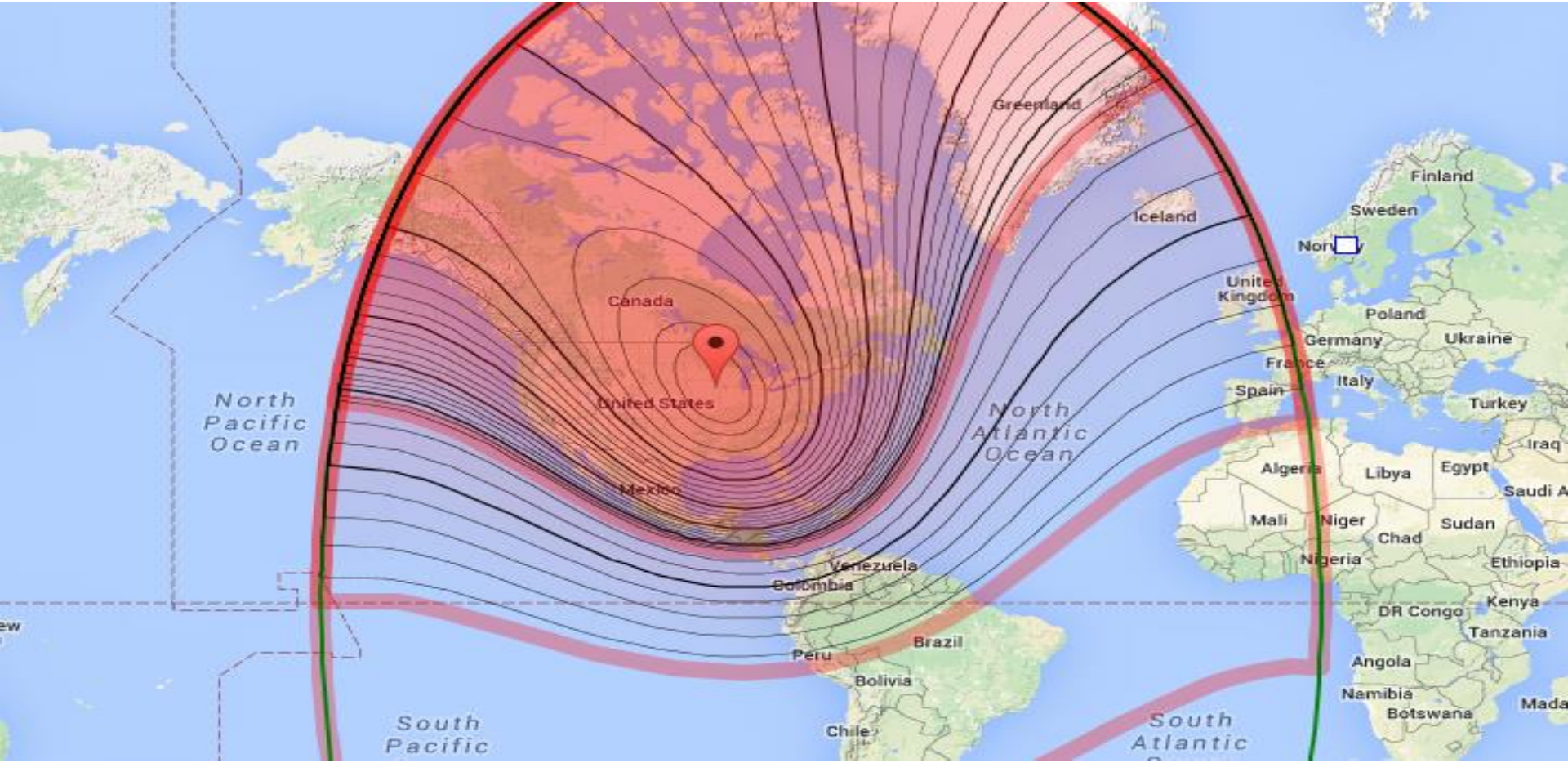


And lots of volunteers!

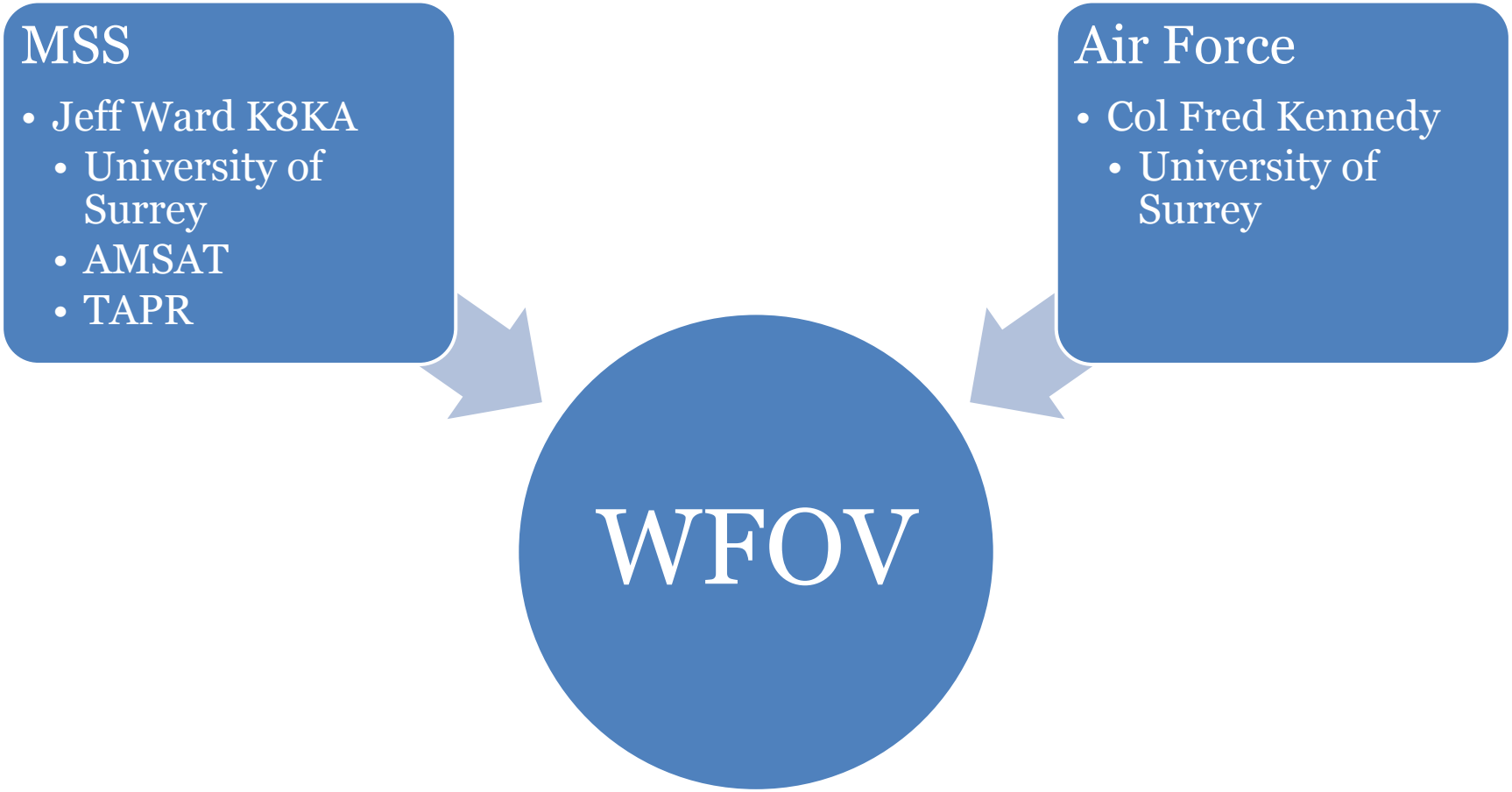
Current Status

- 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

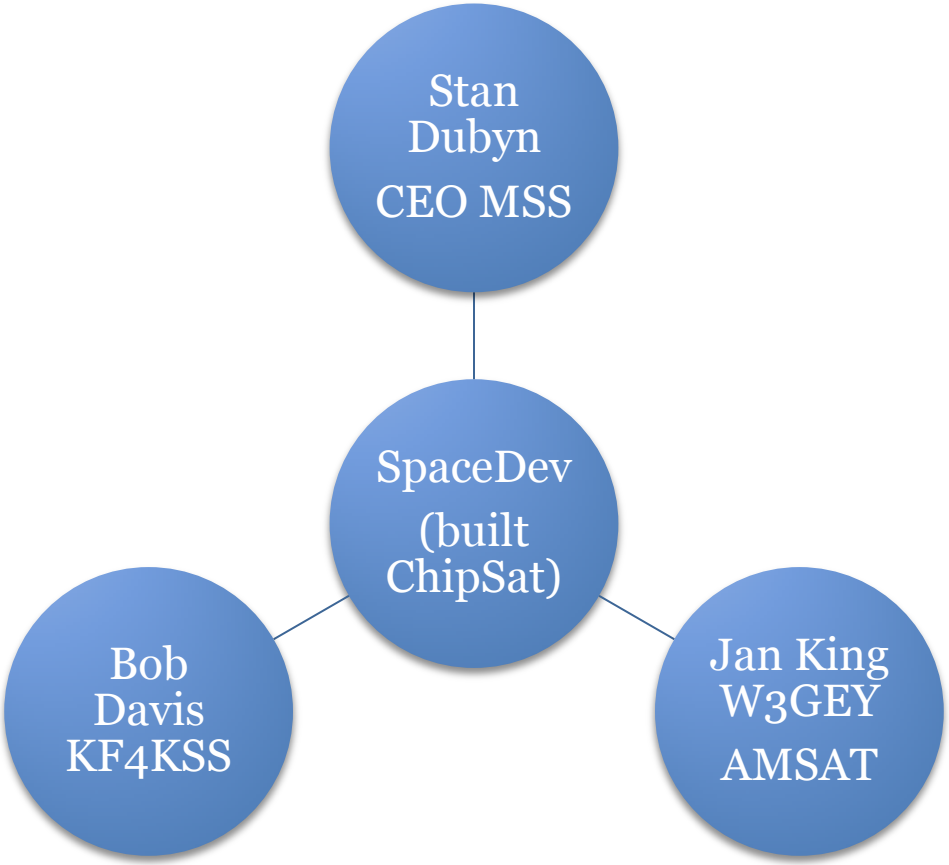


Wide Field of View Connections



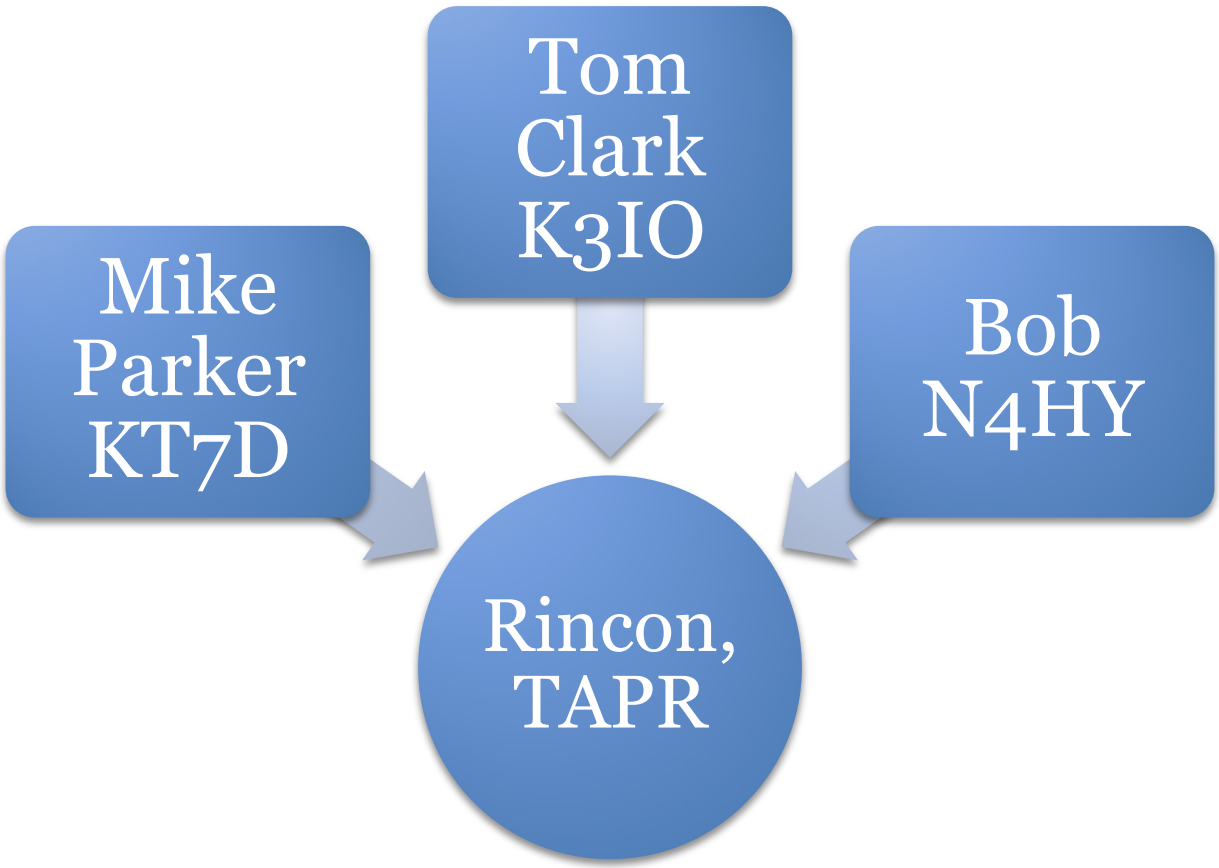

MILLENNIUM
SPACE SYSTEMS

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

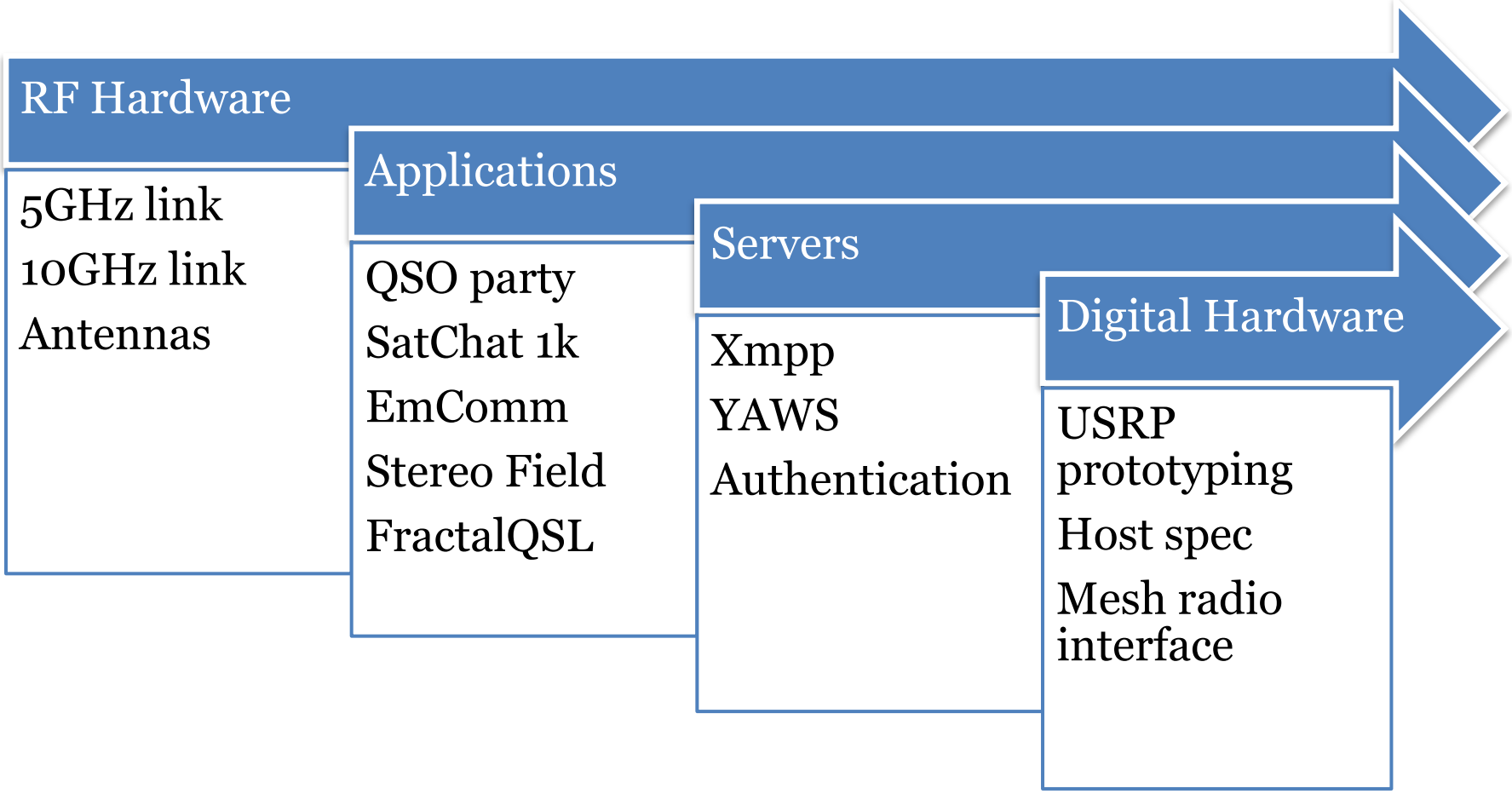
https://github.com/phase4ground

Common Air Interface

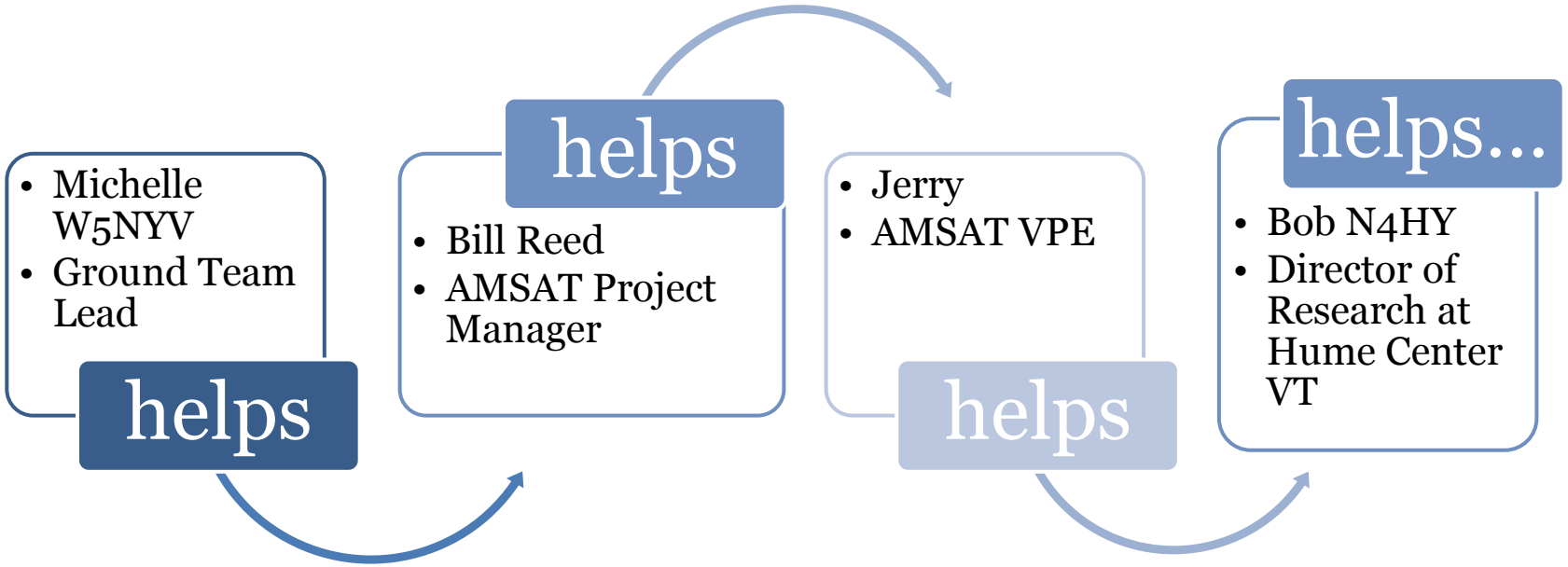
Phase 4 Ground Team

Phase 4 Ground Team Structure

It's All About The Team

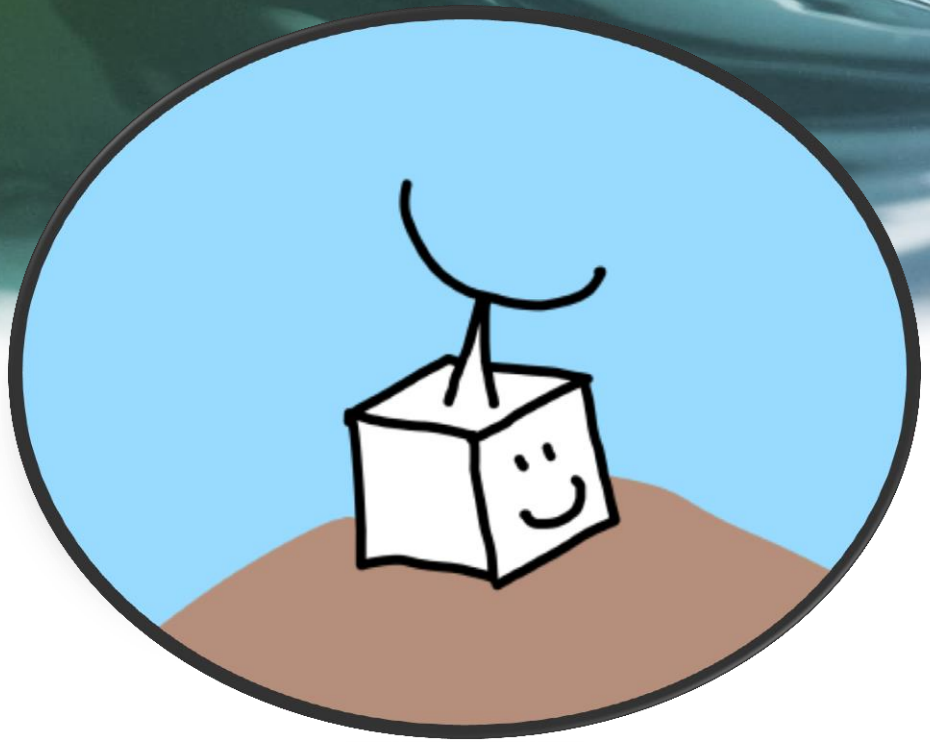


Phase 4 Ground Leadership Supports the Team



Development System

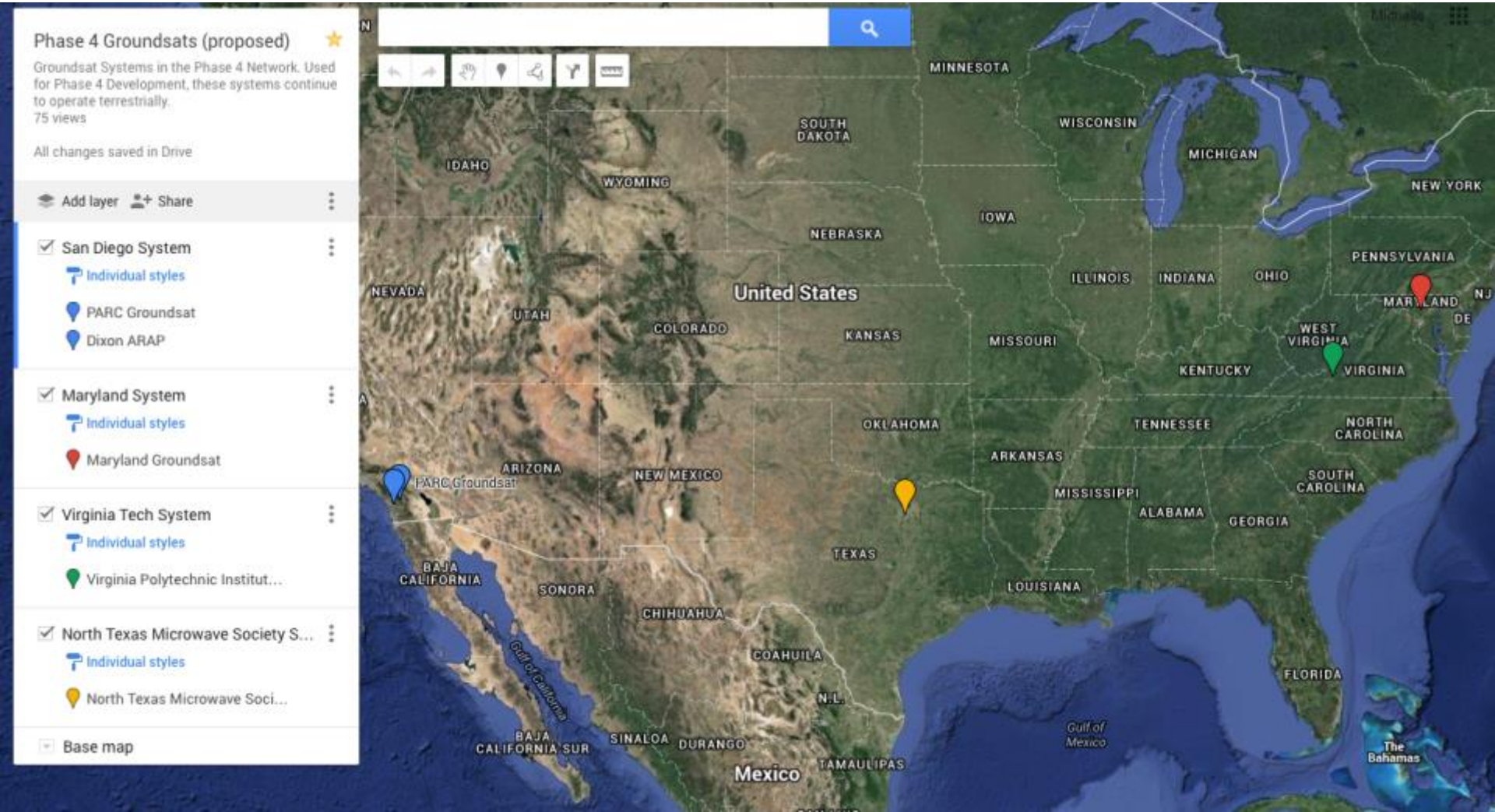
- **Groundsat**
- **ARAP**
- **User Terminals**



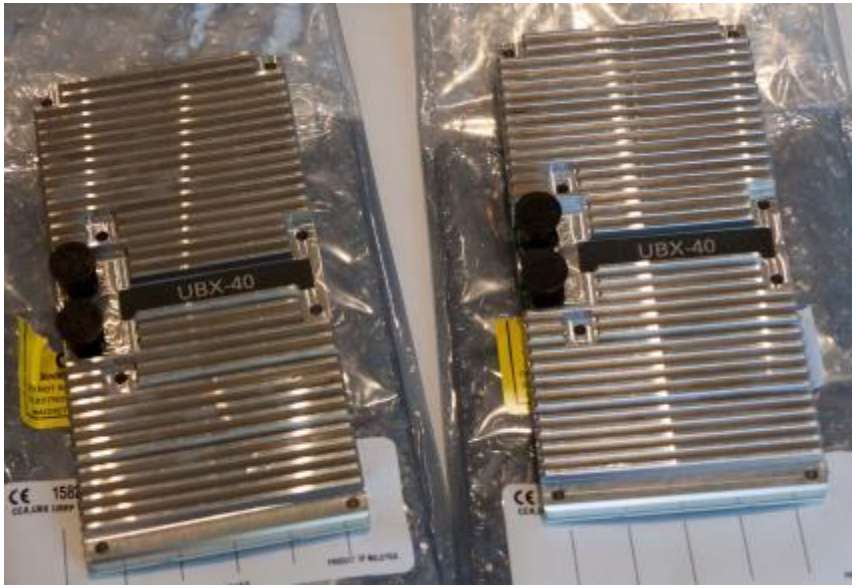
Groundsat

PALOMAR AMATEUR RADIO CLUB INC.
Since 1936
W6NWG
San Diego County, Ca

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



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

A — イヲケェコキ — MATEUR — ヲク

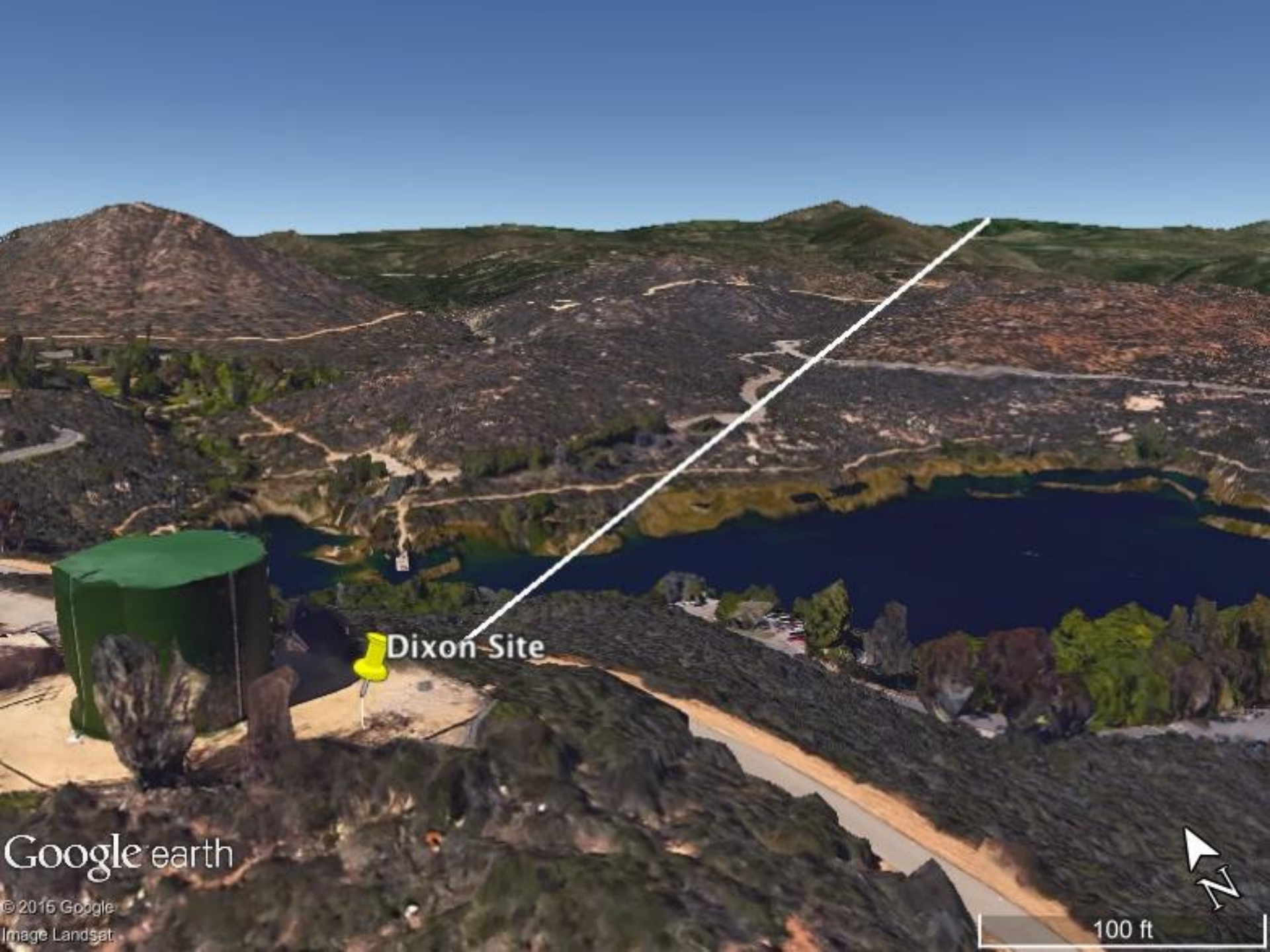
R — ヲウヨエ — ADIO — キエインアエクク

A — イイエクク — CCESS — ヲク

P — エヨウケ — OINT — エククヨアアエ

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.

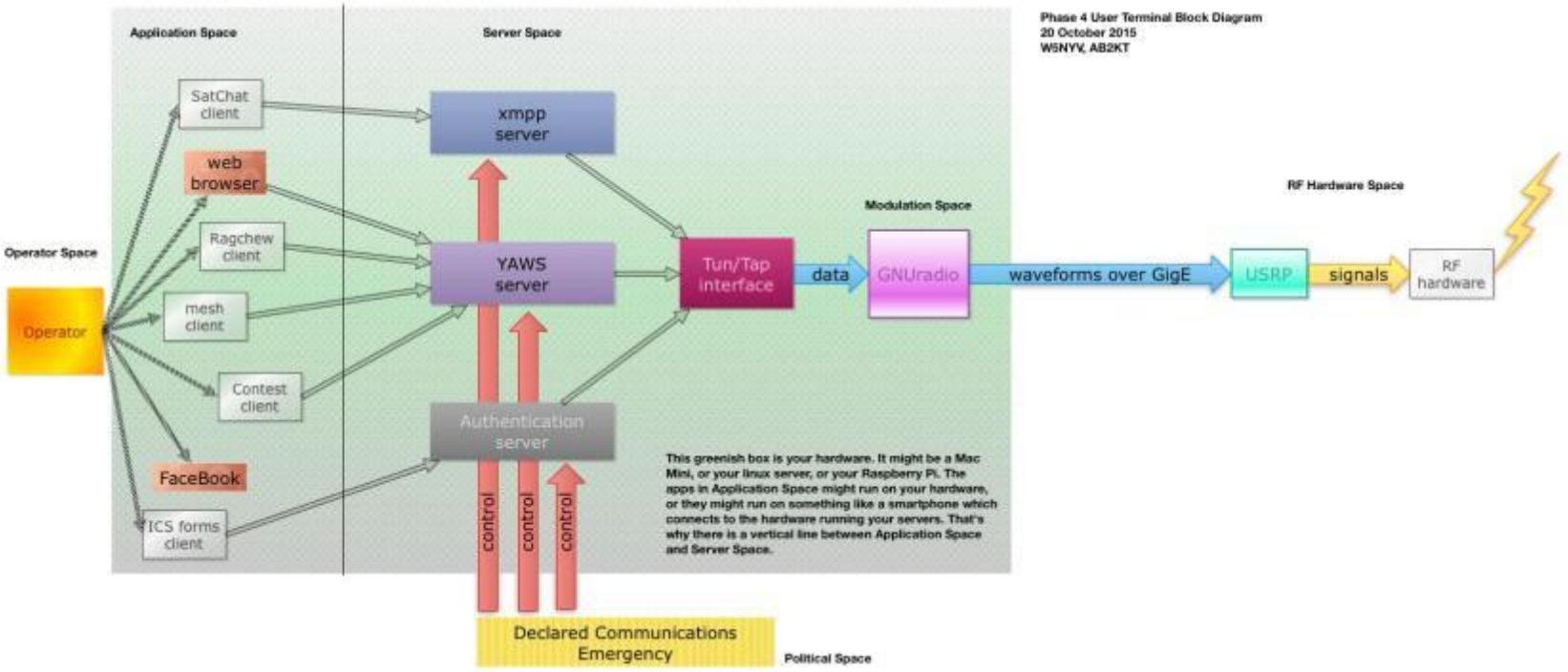

Dixon Site
Google earth
© 2016 Google
Image Landsat
N
100 ft

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

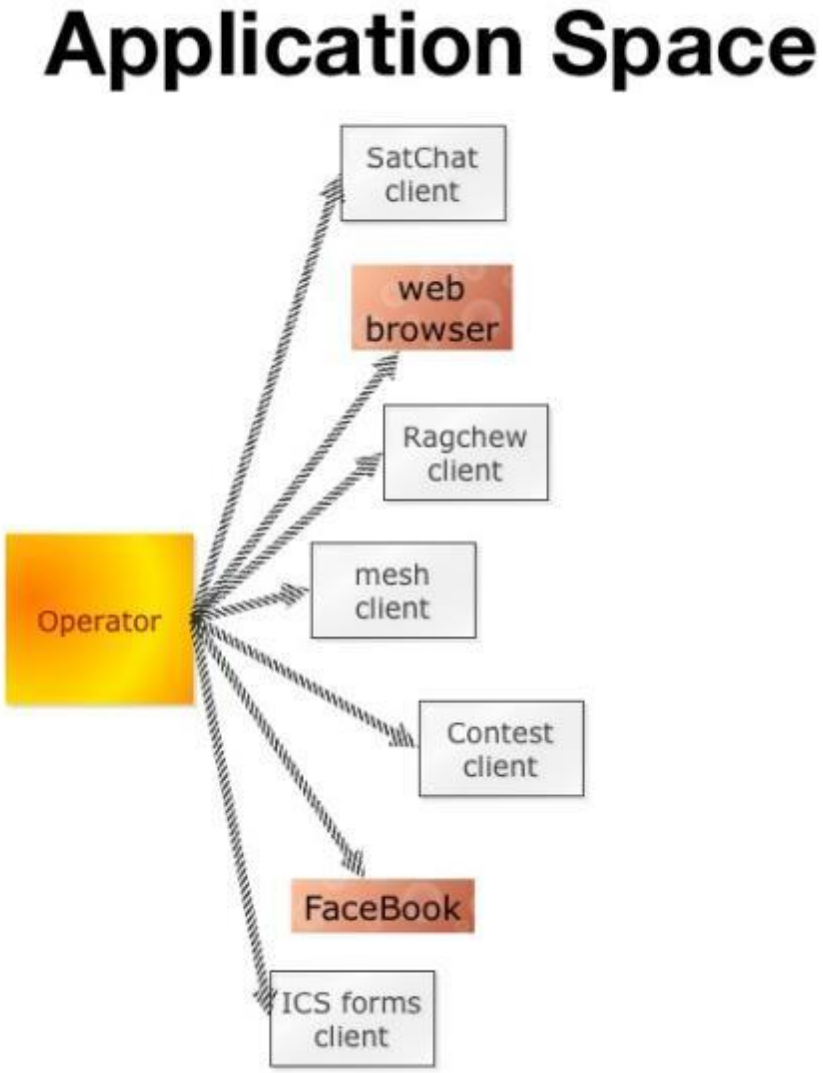
First demonstration was made at the AMSAT Symposium on 18 October 2015.

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

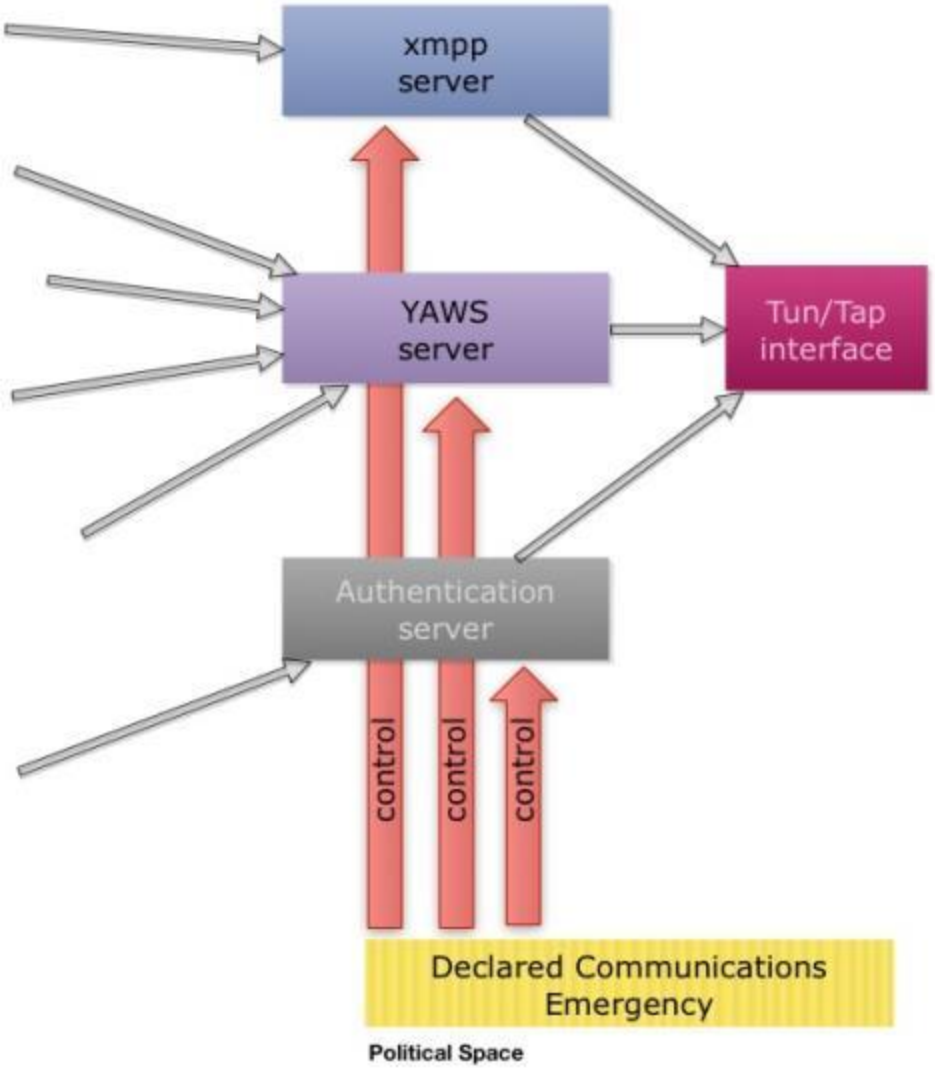
User Terminals… are still a block diagram



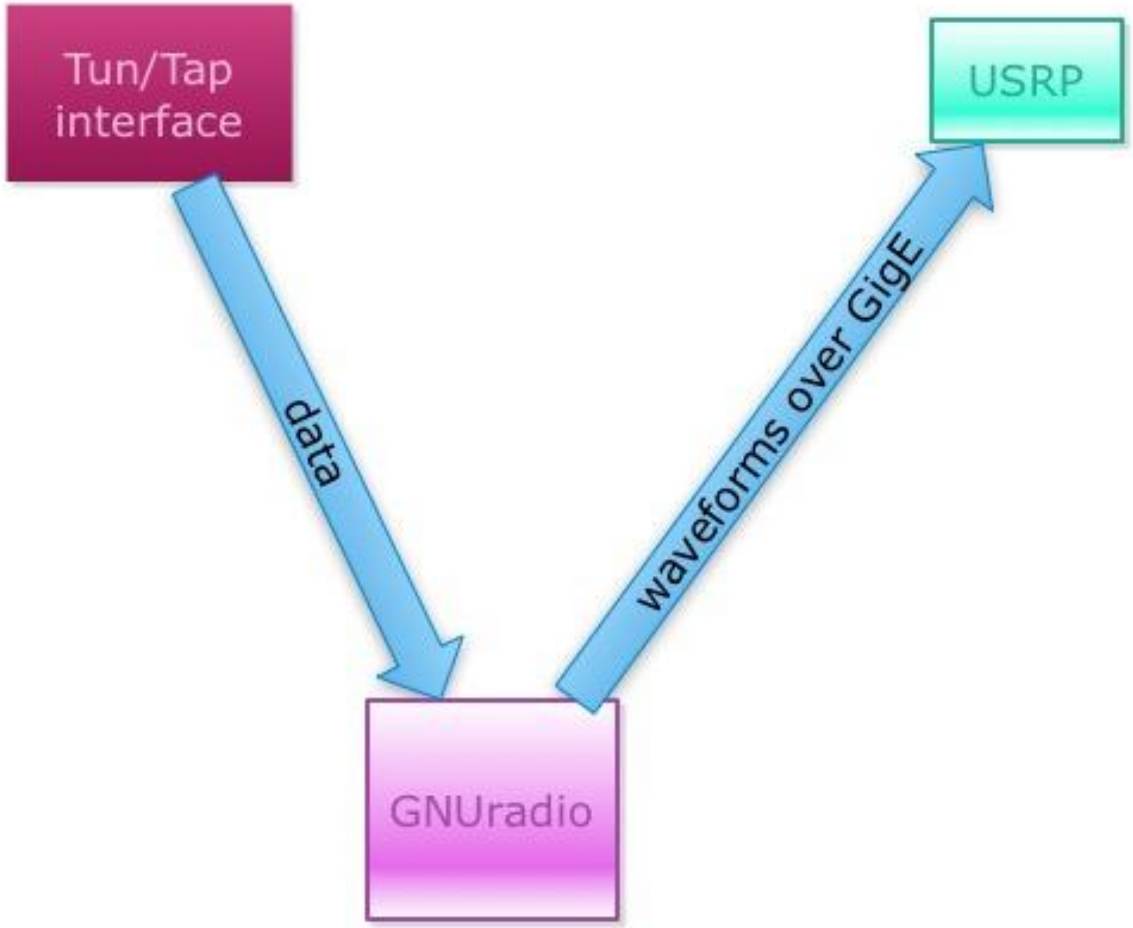
But, we have a great block diagram that has survived its first review.



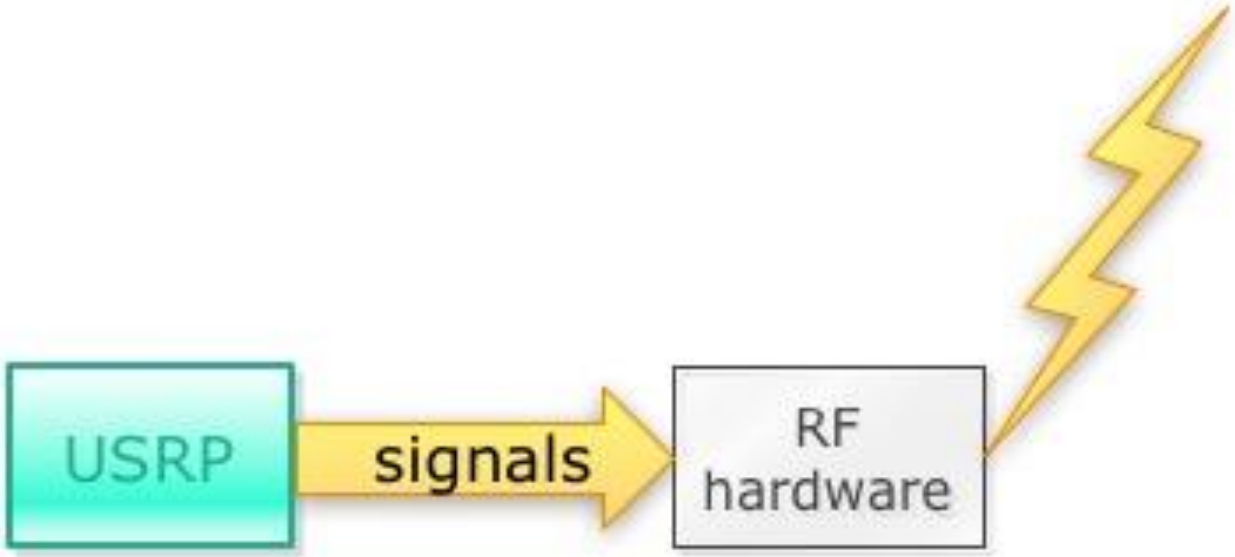
Server Space



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