C-C RIDER –

A new concept for amateur satellites

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Future Amateur Satellites = Microwaves

- **Need More Bandwidth for Modern Techniques**
- **L-Band (1260 – 1270 MHz) is Uplink Only**
- **S-Band (2400 – 2450 MHz) is a SEWER !**
  - **WiFi LAN**
  - **Bluetooth**
  - **Cordless Telephones**
  - **In-home TV Links**
  - **Microwave Ovens**

The "sewer" has seriously compromised the performance of AO-40.

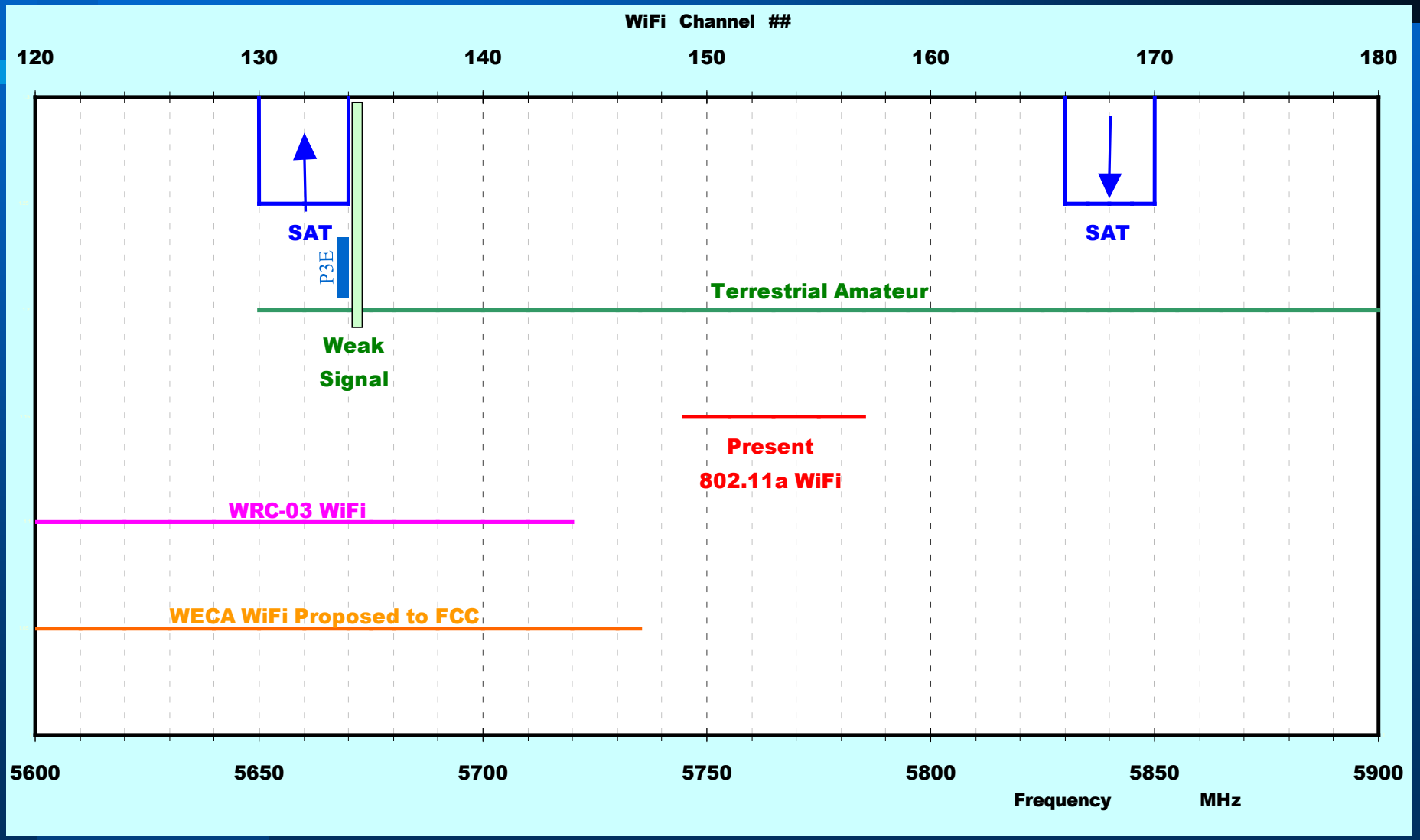
United States Microwave Allocations

Amateur Service		Amateur-Satellite Service	
Band (MHz)	**Bandwidth (MHz)**	**Band (MHz)**	**Bandwidth (MHz)**
1240-1300	60	**1260-1270 ↑**	**10**
2300-2310 2390-2450	10 60	- **2400-2450**	- **50**
3300-3500	200	**3400-3410**	**10**
5650-5925	275	**5650-5670 ↑** **5830-5850 ↓**	**20** **20**
10000-10500	500	**10450-10500**	**50**
24000-24250	250	**24000-24050**	**50**

↑ means Earth-to-Space (uplink) direction only
↓ means Space-to-Earth (downlink)direction only

(Thanks to W4RI for table)

An Expanded Look at the C-Band (5.6 – 5.9 GHz) Microwave Picture



C-C Rider – The Basic Concept

- **Single-band, In-band Transponder**
  - Uplink: 5650-5670 MHz
  - Downlink: 5830-5850 MHz
- **Wide Bandwidth Available**
  - Up to 20 MHz
- **Uplink & Downlink Share One Antenna**

About the C-C Rider name:

- C-Band to C-band package to RIDE on future satellites
- A famous Blues song written by Ma Rainey in the 1920's

Why C-Band?

- **If we don't use it, we will lose it !!!**
  - **This region of the spectrum is under INTENSE scrutiny by the commercial world.**
- **It is the lowest frequency band that can support wide bandwidth links.**
  - **Digital Voice, Video, Multimedia, ???**
- **The paired Uplink and Downlink frequencies are a truly unique resource.**
- **Amateurs need the challenge to develop new technology and not grow stagnant.**

etcetera

But I have NO suitable C-band equipment now!

- **Nobody does!**
- **We will need to develop the ground-based user hardware IN PARALLEL with the spacecraft hardware.**
  - **Leverage common technology**
  - **Most of the microwave components unique to our C-Band needs could be stamped out "*Cookie Cutter*" for both spacecraft and ground use !!!**

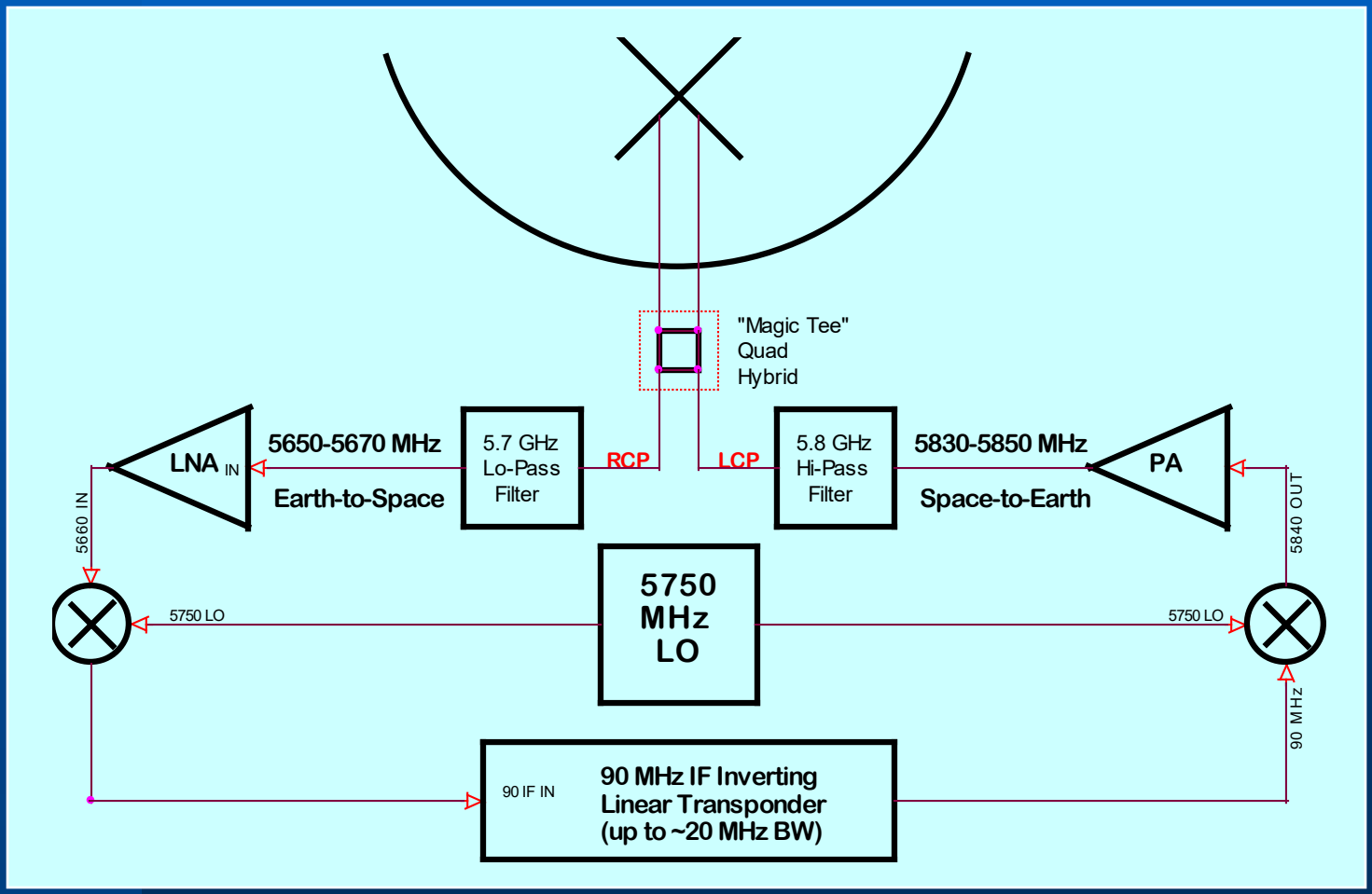
Some thoughts on progress…..

- **Amateur Radio needs new horizons**
- **What will your shack look like in 5-10 years?**
- **Some words from the past:**

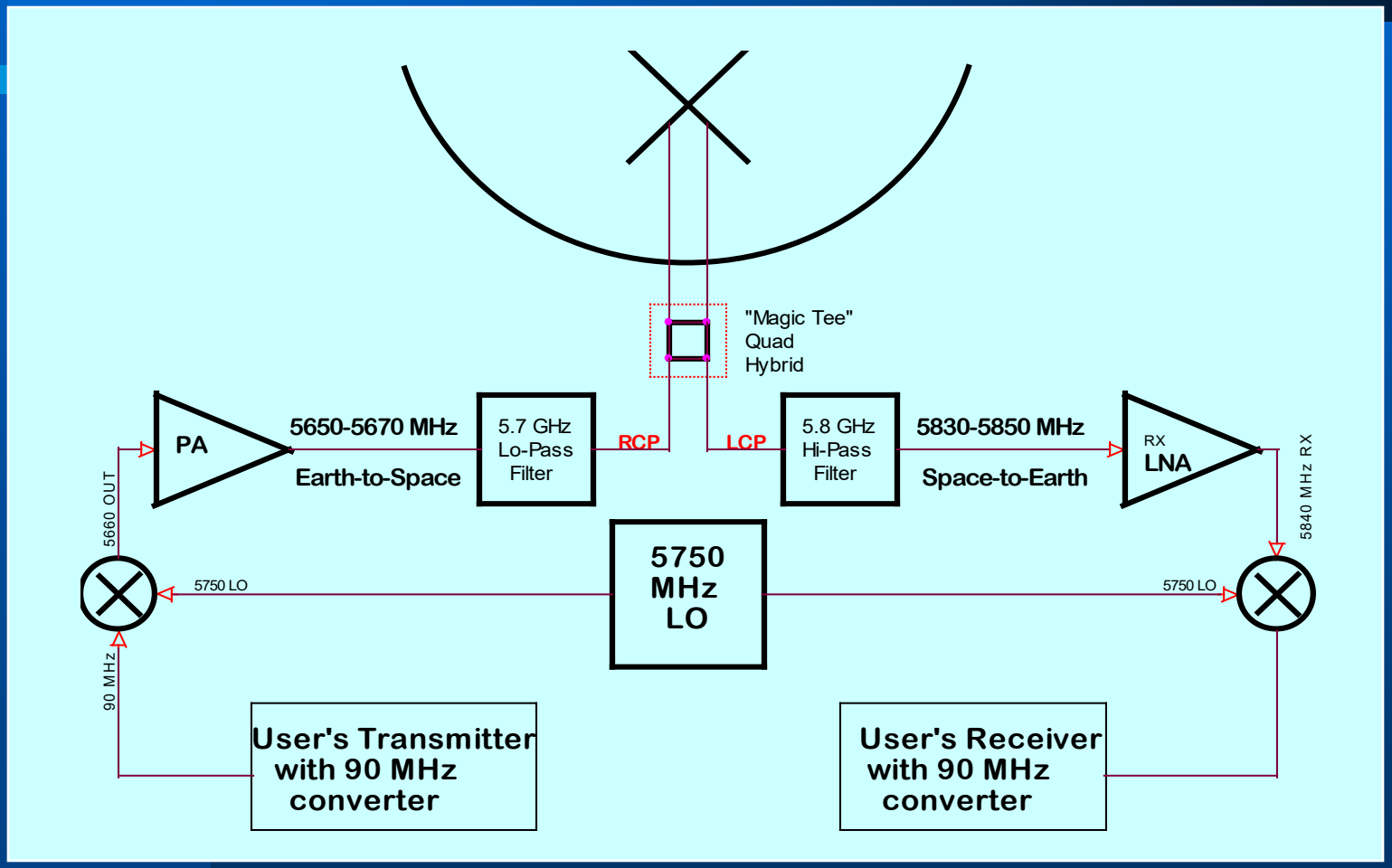
1975: Stick with Mode-A --- Mode-B is too advanced for amateurs.
1980: Don't publish satellite tracking software – amateurs will NEVER have computers in their shacks
1986: Digital satellites are of no interest to amateurs – stick with analog.
1988: DSP – who needs it? Real men rely on LC and Xtal filters.
1998: Nobody will ever use the Model L/S hardware on P3D. Give us Mode-B.
1999: Only a few people will be able to copy the P3D PSK telemetry.
2001: Coding and FEC are too complicated to be used in satellite telemetry.

etcetera

C-C Rider – The Basic Concept

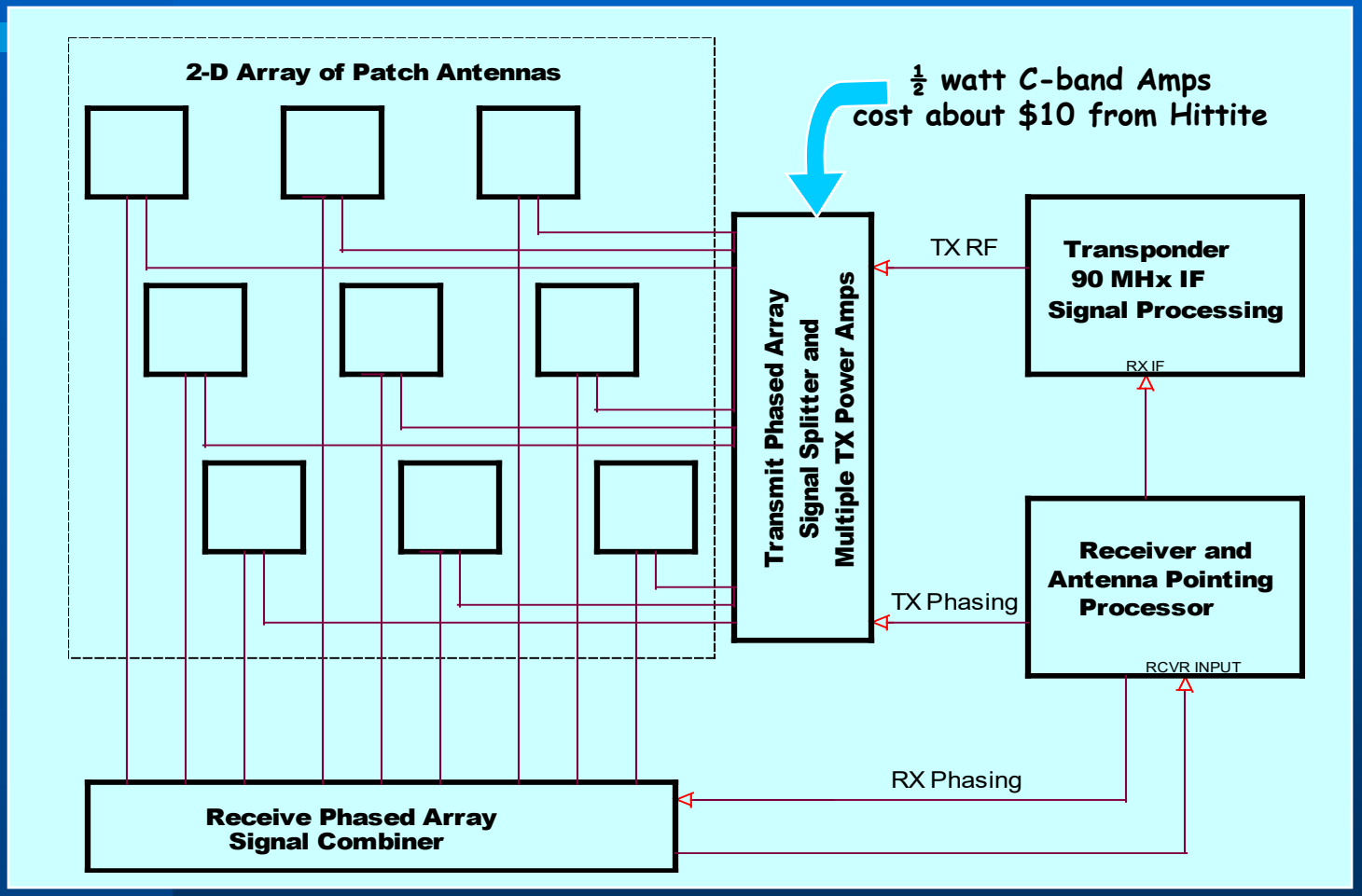


A simple user terminal might look like:



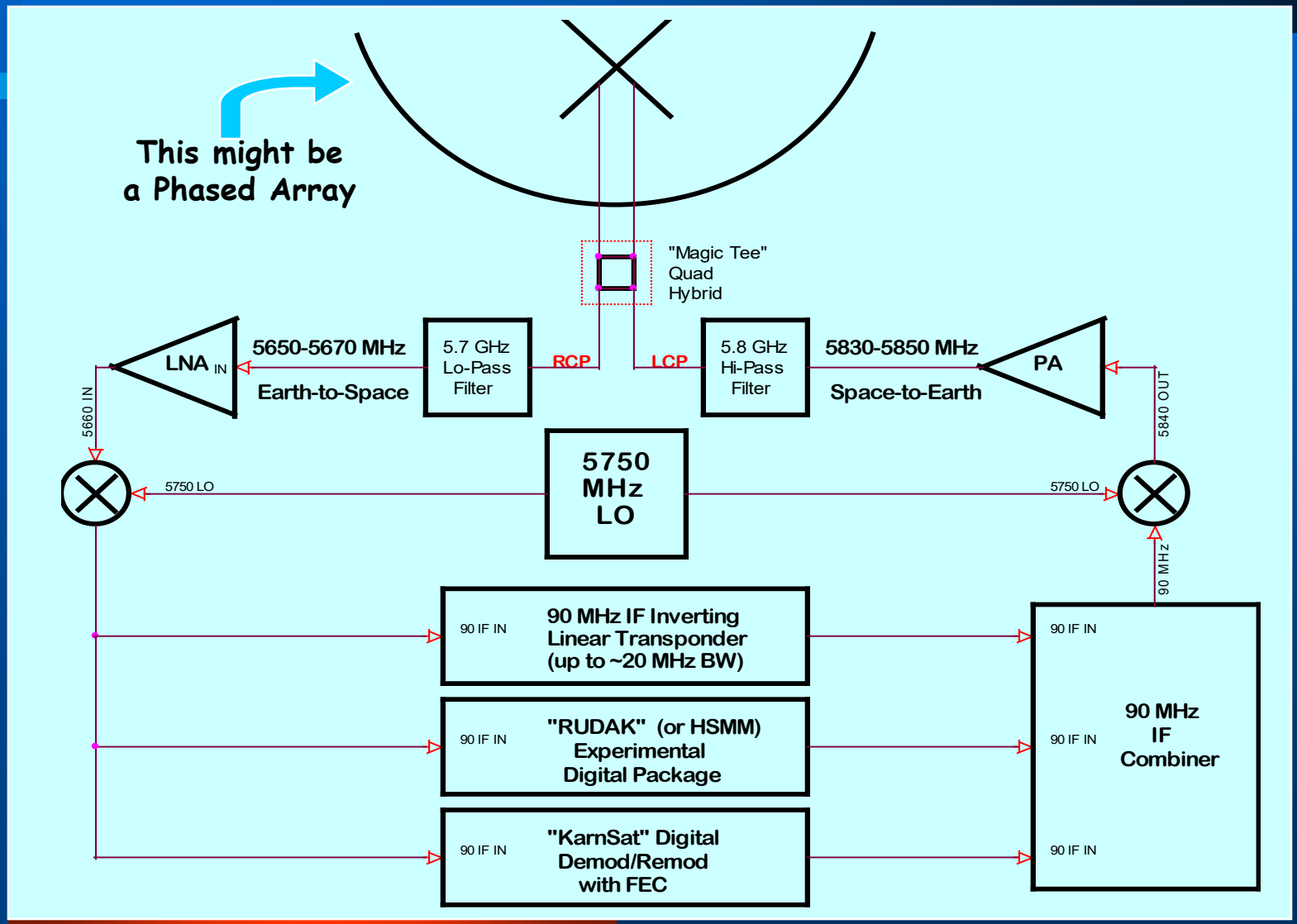
Note that all the microwave widgets are the same as those used on the spacecraft, except that TX/RX ports are reversed.

Instead of using a dish, how about using a Phased Array of Patch Antennas:

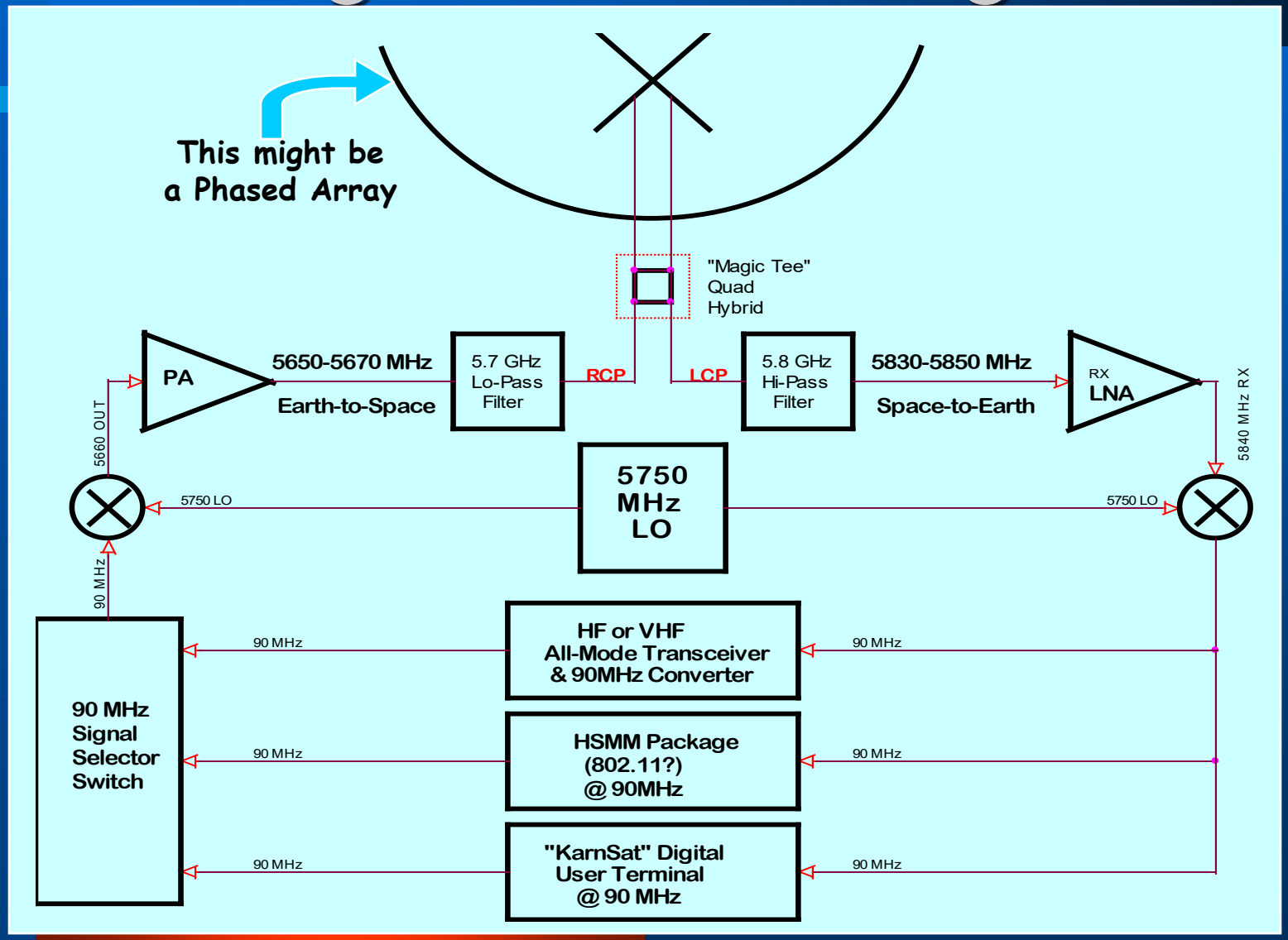


Pointing data from the multi-channel receiver is used to point the transmitter.

To accommodate many types of users, the spacecraft might look something like:



And a Multi-Mode Ground User terminal might look something like:



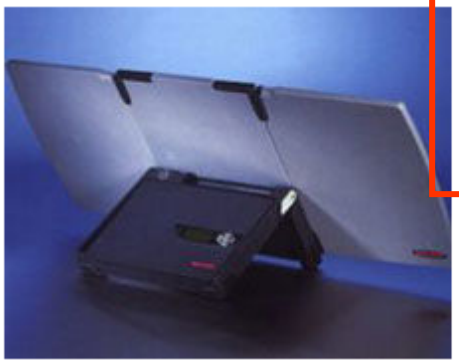
- **INMARSAT:**

A possible model for a C-C Rider user terminal?

Commercial Price is under $5000

Usable on Field Day & from apartment balconies.

http://www.123-satellite-phone.com/nera-world-communicator.html



Key Features

- 64 kbps data
- 4.8 kbps compressed voice (low cost)
- ISDN compatibility
- USB (Universal Serial Bus) interface *
- Infrared interface *
- Self explanatory man machine interface
- Built-in Lithium-Ion battery
- Handy cordura bag supplied with the terminal.
- Built-in DECT base station

Technical Specifications

Environmental Conditions

Operating	*Temperature*
antenna:	-25 - +55 C
modem:	-25°C to +55°C

Note that battery efficiency is degraded under low temperatures

Physical Characteristics

Dimensions collapsed:	H=68mm W=275mm D=355mm
Antenna folded out:	H=340mm W=774mm D=12mm
Weight (including battery):	3.9kg (3.4kg without battery)

Link Budget Estimates: C-C Rider on a LEO Platform

- 800 km orbit means path loss (both ways) ~175 dB
- Satellite: assume 2W TX with 6 dBiC antenna on a "bent-pipe" transponder
- Ground User: assume 30 cm dish or 3x3 array of patches and 70ºK LNA
- Link supports 64kb/s digital or 64 kHz analog, and proper application of coding could bring this up to ~100 kb/s.

- BUT: The user antenna has beamwidth ~12º which needs to be pointed to 2-3º. Satellite peak motion is ~½º/s. The antenna pointing makes this a bad choice.
- However, the Doppler would only be like a satellite operating @ 180 MHz !!

Link Budget Estimates: C-C Rider on a GEO/GTO Platform

- **Assume satellite is at 36,000 km meaning path loss is ~200 dB.**
  - **This means we need to pick up 25 dB over LEO!**
- **Spacecraft: 20 cm (3½λ) aperture or patch array gives 17º beam with ~22 dBiC gain.**
- **Spacecraft TX: ~5 W (or ½ W per patch)**
- **Ground: 30 cm dish, 70ºK LNA & 10W TX**

- **120 kb/sec bent-pipe or ~600 kb/s with FEC & Coding & demod/remod on spacecraft.**