Ham Radio Above 50MHz

- Evolution of this presentation:
  1. New England Weak Signal (N.E.W.S.) Group
     - http://www.newsvhf.com/
  2. Northern Lights Radio Society (NLRS)
     - http://www.nlrs.org/

  3a. Roadrunners Microwave Group (RMG)
     - http://www.k5rmg.org/

  3b. VHF South
     - http://www.vhfsouth.org/
- Thanks is given to all contributors!

Amateur Bands above 50 MHz (VHF/UHF/SHF….)

- VHF (30-300 MHz)
  - 50 MHZ (6 m)
  - 144 MHZ (2 m)
  - 222 MHZ (135 cm)
- UHF (300-3,000 MHz)
  (or 300 MHz-3 GHz)
  - 432 MHZ (70 cm)
  - 903 MHZ (33 cm)
  - 1296 MHZ (23 cm)
  - 2304 MHZ (13 cm)
- SHF (3-30 GHz)
  - 3456 MHZ (9 cm)
  - 5760 MHZ (6 cm)
  - 10 GHZ (3 cm)
  - 24 GHZ (12 mm)
- There ARE bands higher in frequency; see:

http://www.k5rmg.org/bands.html
http://www.vhfsouth.org/tutorials/bands.htm
http://www.arrl.org/FandES/field/regulations/bandplan.html

What can you expect?

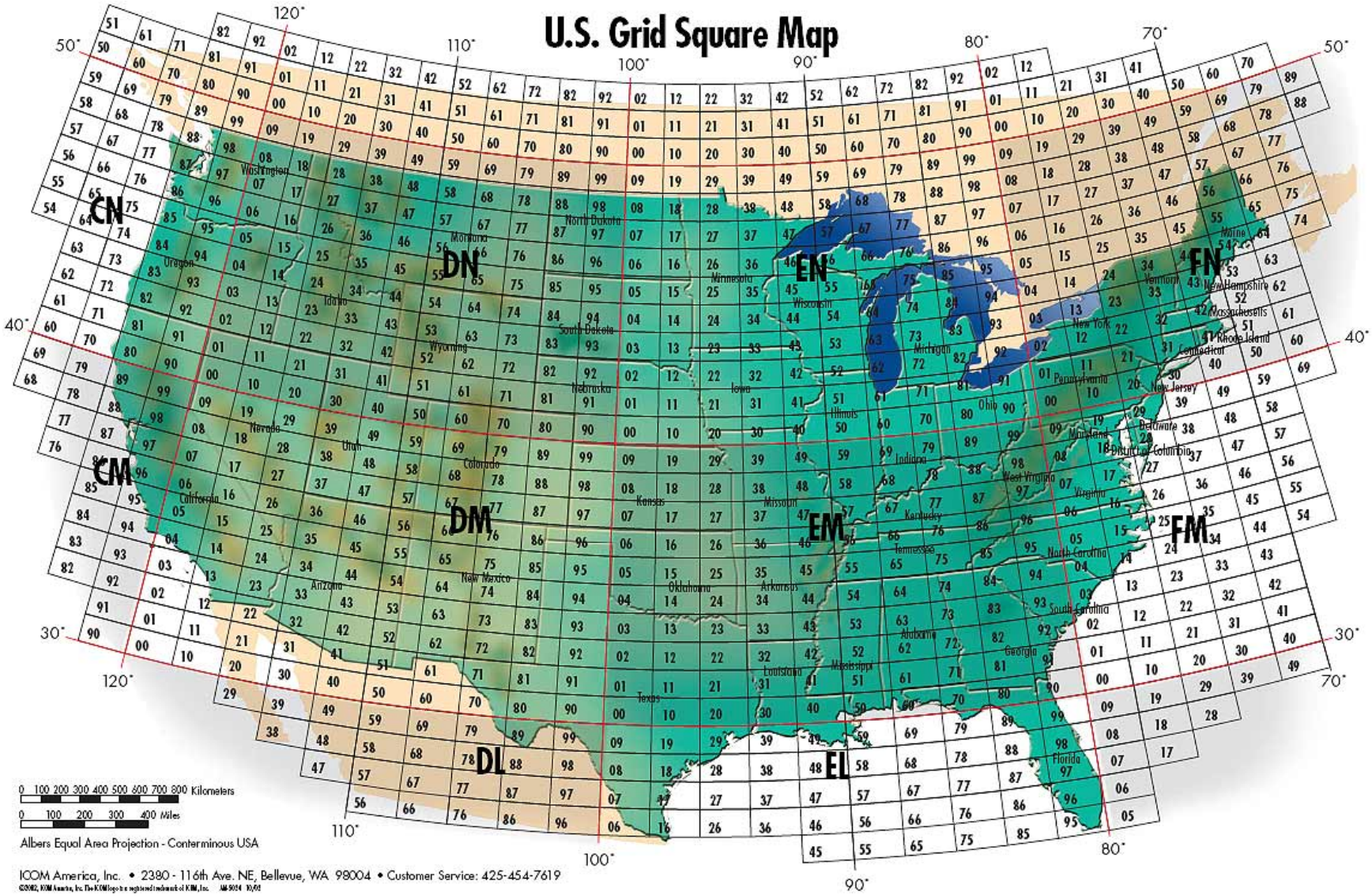
Band	Typical Range	Enhanced Range
50 MHz	200 miles	Worldwide
144 MHz	300 miles	500-1,500 miles
222 MHz	350 miles	500-1,500 miles
432 MHz	250 miles	400-1,200 miles
1296 MHz	200 miles	350-1,000 miles
2304 MHz	200 miles	250-1,000 miles
10 GHz	200 miles	250- 500 miles

10-14dBd gain antenna, 150 W on 50/144/222/432MHz,
10 W on 1296 & 2304 MHz, 1 W on 10 GHz w/2 ft dish

VHF Operators “collect” Gridsquares, like an HF Operator collects countries

- Use of Worldwide “Maidenhead” grid system
  - Developed in Maidenhead, England in 1980
  - Identifies location based on latitude / longitude
    - World divided into 20° x 10° fields
    - Each field divided into 100, 2° x 1° “squares” (or “grids”)
    - Each “square” is divided into 576, 5’ x 2.5’ “subsquares” (“subgrids”)
- Examples:
  - San Antonio is in grid EL09 (EL = field, 09 = “grid”)
  - N. Dallas is in grid EM13 (EM = field, 13 = “grid”
  - Lubbock is in DM93 (DM = field, 93 = “grid”)
  - ND2X’s San Antonio home is in EL09ql (ql = “subgrid”)
  - W8CM’s Van Alstyne home is in EM13rk (rk = “subgrid”)

USA Grid Square Map



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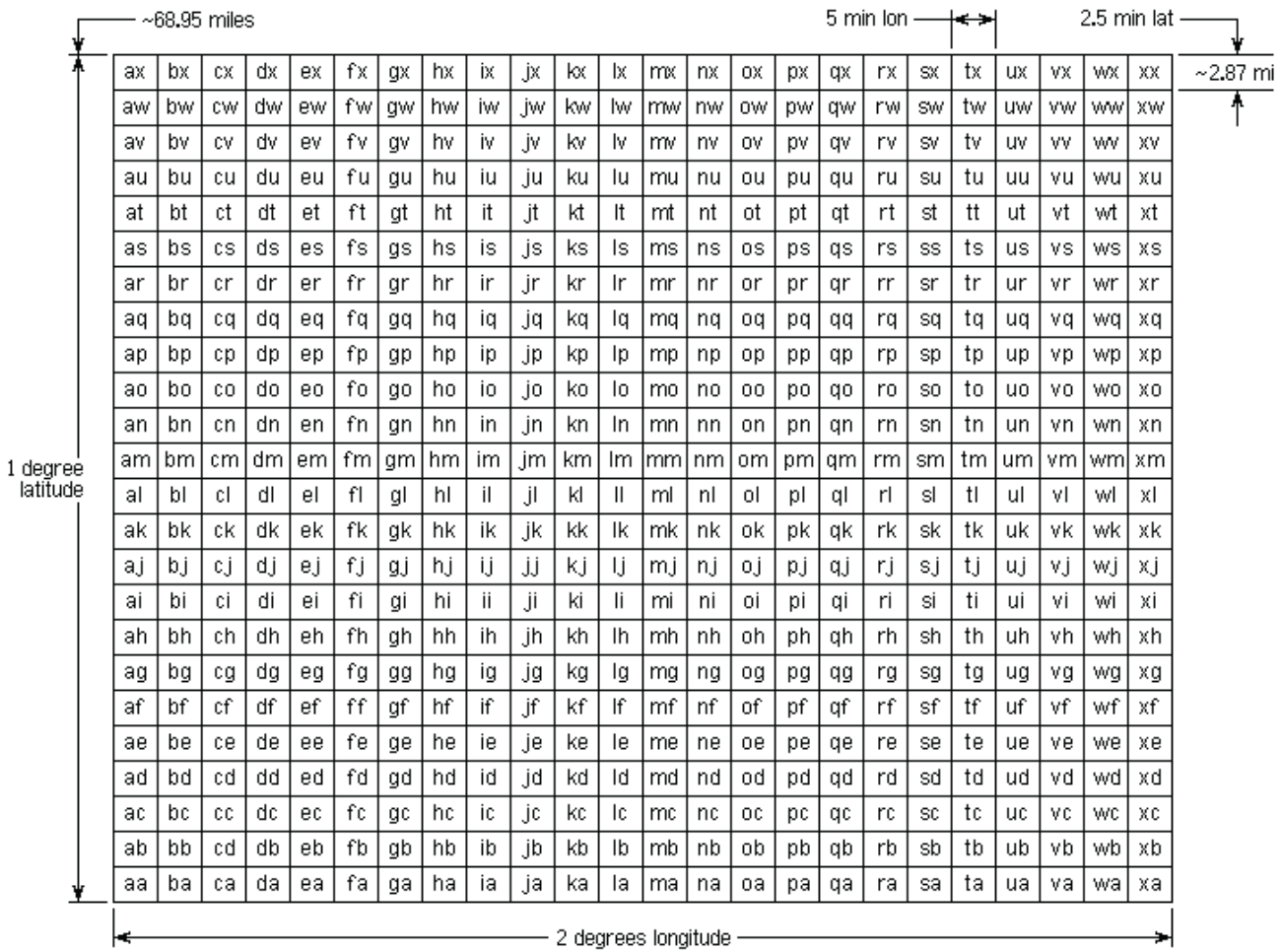
Maidenhead “Subgrids”



ax	bx	cx	dx	ex	fx	gx	hx	ix	jx	kx	lx	mx	nx	ox	px	qx	rx	sx	tx	ux	vx	wx	xx
aw	bw	cw	dw	ew	fw	gw	hw	iw	jw	kw	lw	mw	nw	ow	pw	qw	rw	sw	tw	uw	vw	ww	xw
av	bv	cv	dv	ev	fv	gv	hv	iv	jv	kv	lv	mv	nv	ov	pv	qv	rv	sv	tv	uv	vv	wv	xv
au	bu	cu	du	eu	fu	gu	hu	iu	ju	ku	lu	mu	nu	ou	pu	qu	ru	su	tu	uu	vu	wu	xu
at	bt	ct	dt	et	ft	gt	ht	it	jt	kt	lt	mt	nt	ot	pt	qt	rt	st	tt	ut	vt	wt	xt
as	bs	cs	ds	es	fs	gs	hs	is	js	ks	ls	ms	ns	os	ps	qs	rs	ss	ts	us	vs	ws	xs
ar	br	cr	dr	er	fr	gr	hr	ir	jr	kr	lr	mr	nr	or	pr	qr	rr	sr	tr	ur	vr	wr	xr
aq	bq	cq	dq	eq	fq	gq	hq	iq	jq	kq	lq	mq	nq	oq	pq	qq	rq	sq	tq	uq	vq	wq	xq
ap	bp	cp	dp	ep	fp	gp	hp	ip	jp	kp	lp	mp	np	op	pp	qp	rp	sp	tp	up	vp	wp	xp
ao	bo	co	do	eo	fo	go	ho	io	jo	ko	lo	mo	no	oo	po	qo	ro	so	to	uo	vo	wo	xo
an	bn	cn	dn	en	fn	gn	hn	in	jn	kn	ln	mn	nn	on	pn	qn	rn	sn	tn	un	vn	wn	xn
am	bm	cm	dm	em	fm	gm	hm	im	jm	km	lm	mm	nm	om	pm	qm	rm	sm	tm	um	vm	wm	xm
al	bl	cl	dl	el	fl	gl	hl	il	jl	kl	ll	ml	nl	ol	pl	ql	rl	sl	tl	ul	vl	wl	xl
ak	bk	ck	dk	ek	fk	gk	hk	ik	jk	kk	lk	mk	nk	ok	pk	qk	rk	sk	tk	uk	vk	wk	xk
aj	bj	cj	dj	ej	fj	gj	hj	ij	jj	kj	lj	mj	nj	oj	pj	qj	rj	sj	tj	uj	vj	wj	xj
ai	bi	ci	di	ei	fi	gi	hi	ii	ji	ki	li	mi	ni	oi	pi	qi	ri	si	ti	ui	vi	wi	xi
ah	bh	ch	dh	eh	fh	gh	hh	ih	jh	kh	lh	mh	nh	oh	ph	qh	rh	sh	th	uh	vh	wh	xh
ag	bg	cg	dg	eg	fg	gg	hg	ig	jg	kg	lg	mg	ng	og	pg	qg	rg	sg	tg	ug	vg	wg	xg
af	bf	cf	df	ef	ff	gf	hf	if	jf	kf	lf	mf	nf	of	pf	qf	rf	sf	tf	uf	vf	wf	xf
ae	be	ce	de	ee	fe	ge	he	ie	je	ke	le	me	ne	oe	pe	qe	re	se	te	ue	ve	we	xe
ad	bd	cd	dd	ed	fd	gd	hd	id	jd	kd	ld	md	nd	od	pd	qd	rd	sd	td	ud	vd	wd	xd
ac	bc	cc	dc	ec	fc	gc	hc	ic	jc	kc	lc	mc	nc	oc	pc	qc	rc	sc	tc	uc	vc	wc	xc
ab	bb	cb	db	eb	fb	gb	hb	ib	jb	kb	lb	mb	nb	ob	pb	qb	rb	sb	tb	ub	vb	wb	xb
aa	ba	ca	da	ea	fa	ga	ha	ia	ja	ka	la	ma	na	oa	pa	qa	ra	sa	ta	ua	va	wa	xa

Grids: ~124.4 miles wide at Brownsville, TX, & ~90.9 miles wide at the Canadian border.
SUBgrids: ~5.2mi wide (Brownsville) to ~3.8 mi wide (Canada). There are 576 subgrids.

VUCC is like DXCC
(VHF/UHF Century Club award)

Bands	Grids req'd for VUCC
• 50 MHz, 144 MHz	100
• 222 MHz, 432 MHz	50
• 902 MHz, 1296 MHz	25
• 2304 MHz, 3456 MHz	10
• 5760 MHz, 10 GHz, 24 GHz	5

Propagation

- “Propagation” is how a signal gets from a transmitter to a distant receiver.
- There are several types, or “modes”, of propagation possible at VHF+ frequencies.
- The following slides list these modes with a few of their characteristics. The goal here is simply to understand there are many ways a VHF+ signal gets from a transmitter to a receiver.

Propagation Modes

- 1. Tropospheric Scatter
  - Atmosphere scattering within troposphere
  - Very reliable mode
  - Workable on all bands with sufficient power

- 2. TROPO (ducting, bending, coastal)
  - Weather-related enhancement
  - Very common Apr-July in SE USA
  - Workable on all bands with “normal” power

Propagation Modes

- 3. Aurora
  - Common above 45 degrees latitude
  - Not UNcommon above 40 degrees latitude
  - South Texas has had Aurora twice since 1987
  - Bounce signals off Auroral curtain
    - All antennas pointed at the aurora
    - Similar to HF backscatter or 10GHz rain scatter
  - Common on 50 & 144 MHz
  - Also works on 222 & 432 MHz

Aurora (northern lights) – SIGH!

Aurora in South Texas is predominantly red!

Propagation Modes

- 4. Ionospheric Sporadic E (Es)
  - Peaks around shortest & longest days of year
  - Signals “reflected” by ionization in E layer
  - Single hop distances ~1200 miles
  - Multiple skips possible, two is not uncommon
  - Most common on 50 MHZ; 144 MHZ skip occurs occasionally, 222MHz skip rarely

Propagation Modes

- 5. Meteor scatter
  - Reflecting signals off atmosphere ionized by meteors burning up in the ionosphere
  - Ionization occurs at E layer altitudes (~68mi)

    (higher if velocity is sufficiently fast; can get ~1400 mile “links”)
  - Short duration communication opportunity
  - Common & easy on 50 MHZ using “randoms”
  - Works on 144 MHZ, esp. during “showers”
  - Possible also on UHF during “showers”

Meteors seen in dark sky

This picture was taken 18 Nov during the great 2001 Leonid meteor storm.

This is a meteor from a Geminid meteor shower – note the big dipper

Propagation Modes

- Other
  - 6. Ionospheric scatter
  - 7. Ionospheric F2 (like HF), ~155 mi altitude
  - 8. TE (trans-equatorial, good to S. America)
  - 9. Rain scatter
  - 10. Airplane scatter
  - 11. EME (“moonbounce”)
- Remember, the point is to realize there are many ways VHF+ signals “travel”!

Getting on VHF/UHF/SHF bands

- Equipment is currently available for 50 MHz, 144 MHz, 432 MHz, 1296MHz
  - HF thru 432MHz (lacking 222MHz) common
    - FT-100D, IC-706mkIIG, FT-857, etc.
  - HF thru 1296MHz (lacking 222 & 902 MHz) available
    - TS 2000X
  - At least one example of 144, 432 and 1296 MHz
    - IC-910H
  - An older, hard-to-find radio offers a choice of four bands starting with 28MHz & going thru 50, 144, 222, 432, & 1296 MHz
    - FT-736R
  - Old single-band gear exists, 28 – 1296MHz (no 902)
    - IC-575, IC-275, IC-375, IC-475, IC1275

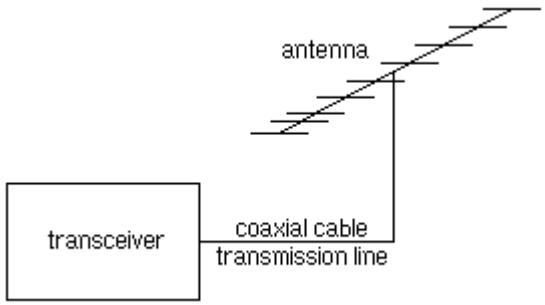
Getting on VHF/UHF/SHF bands

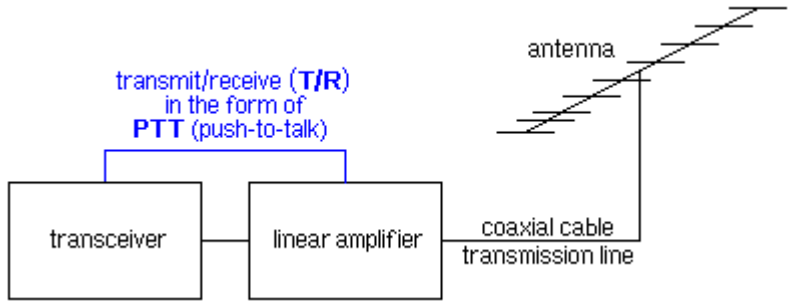
- Generally, currently available radios are used as basis for 222, 902, & 2304MHz thru 10 & 24 GHz
  - Transverters used for frequency translation
  - More complicated than radio alone
  - Very capable

What's a Transverter?

- Convert radio frequencies to bands not otherwise available
  - IF ("Intermediate Frequency") considerations; which band in an existing radio to convert to/from the band of interest?
  - Answer depends on how you operate & what gear you own
- Several sources for transverters & accessories
  - Downeast Microwave
  - DB6NT (Kuhne)
  - Elecraft

Station Configuration Diagrams

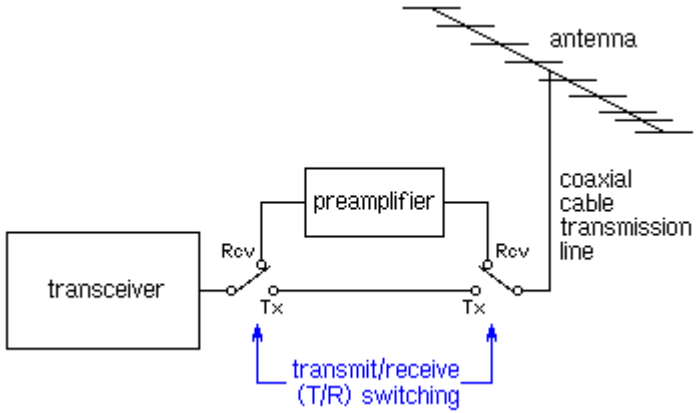


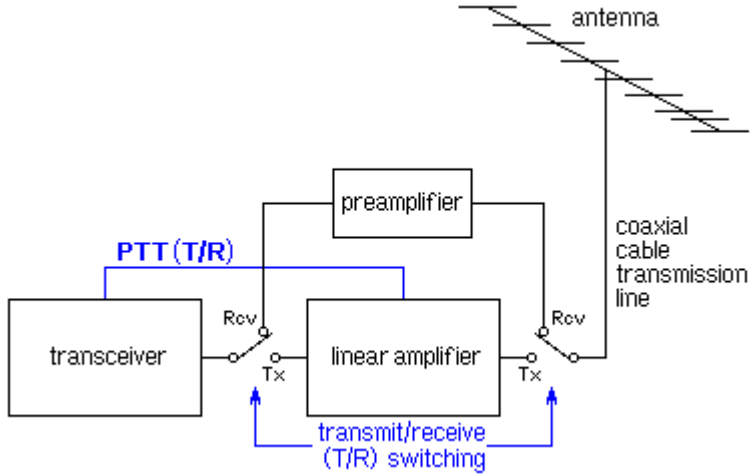


- Simplest Station
  - Transceiver
  - Coax
  - Antenna

- Add a Linear Amplifier
  (others can hear you better)
  - Transceiver
  - Linear (power) Amplifier
  - Coax
  - Antenna

Station Configuration Diagrams





- Add a Preamplifier

(you can hear others better)

  - Transceiver
  - Preamplifier
  - T/R switching
  - Coax
  - Antenna

- Both Pre- & Power-amplifiers

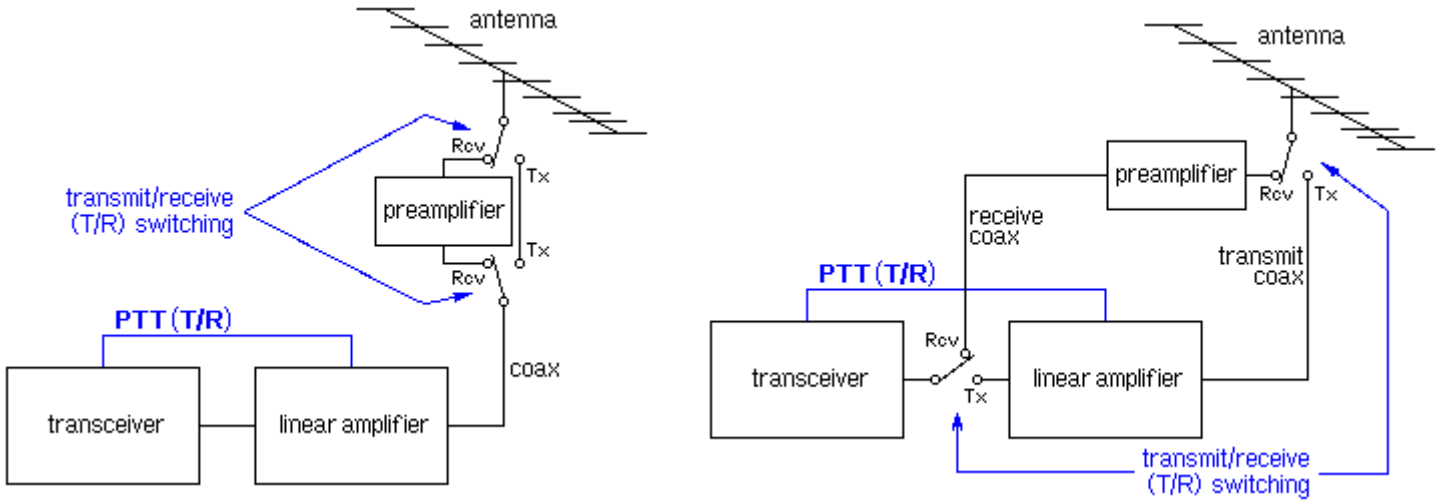
(everyone can hear everyone better)

  - Transceiver
  - Preamplifier
  - Linear amplifier
  - T/R switching
  - Coax
  - Antenna

NOTE: T/R switching must be timed to prevent “blowing up” the preamplifier

Station Configuration Diagrams

- Transmission lines have losses
  - Losses decrease the amount of RF energy
  - Less comes out than goes in
  - Require best quality to minimize loss, especially on transmit
  - Can compensate for loss on receive with preamplifier
    - Install preamplifier close to the antenna
    - Two ways to install preamplifier close to antenna

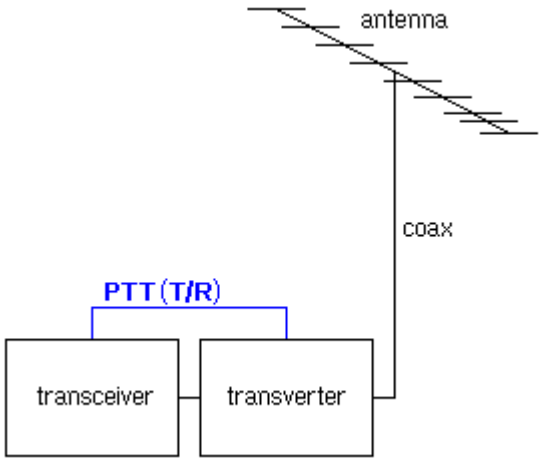


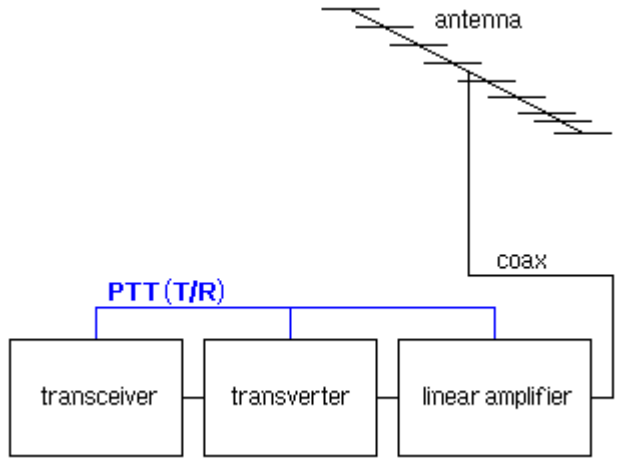
- Transmission losses increase as frequency increases.

Station Configuration Diagrams

- Use a transverter to add another band to your station

(Type #1: Single Transmit output/Receive input connector, like the standard transceiver)

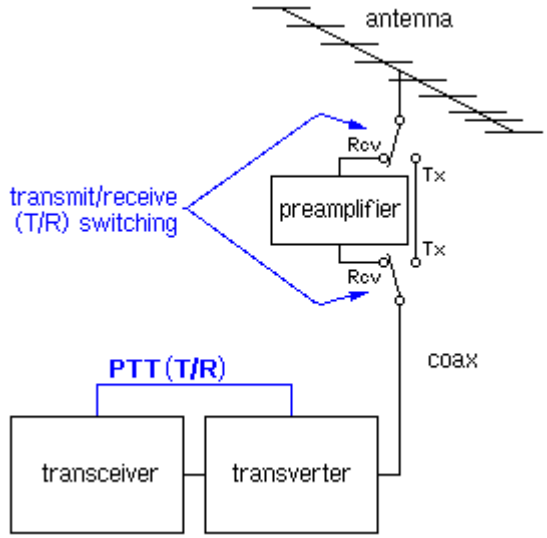


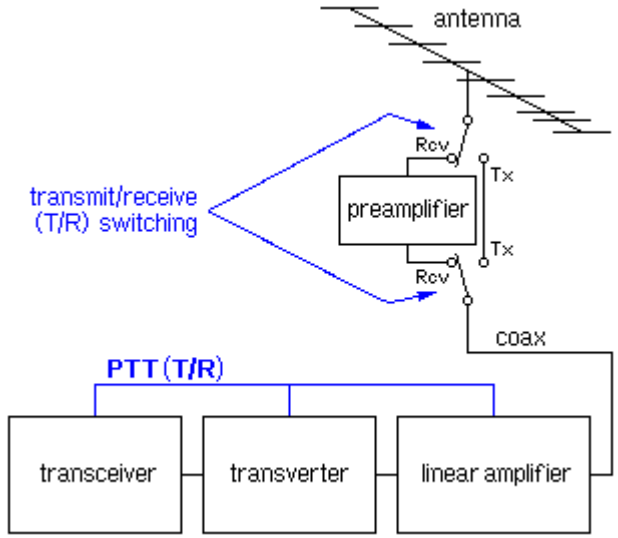


- Simplest configuration (Internal T/R switching)
- Add a Power Amplifier (T/R switching must still be timed)

Station Configuration Diagrams

- Adding another band to your station using transverters





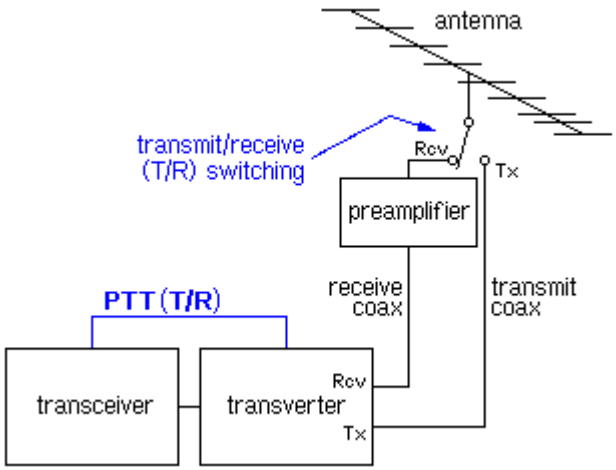
•Add a preamplifier

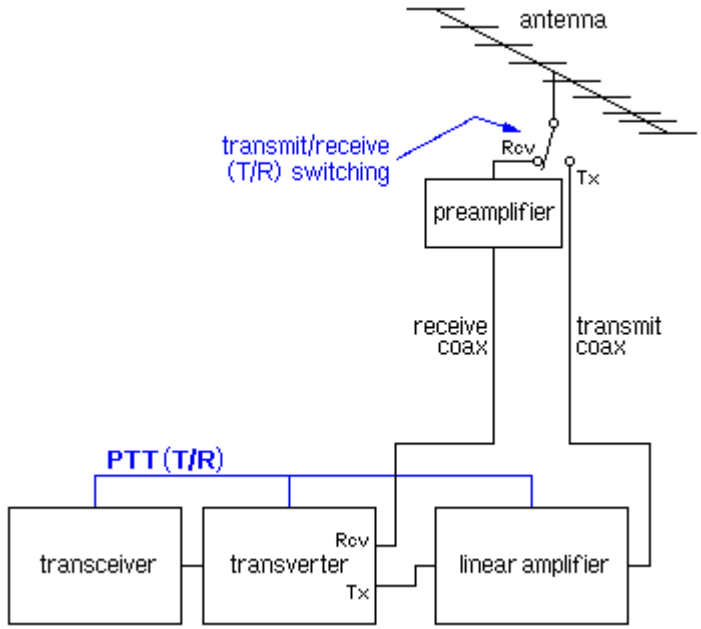
•Both Pre- & Power-amplifiers

Generally, frequency of bands requiring use of transverters is high enough to be concerned about the loss of the transmission line making “mast mounted” the way to go!!

Station Configuration Diagrams

- Adding another band to your station using transverters
  (Type #2: Separate Transmit output/Receive input connectors)
- To facilitate addition of “mast mounted” preamplifier
- Many operators feel this is the best way to do it!



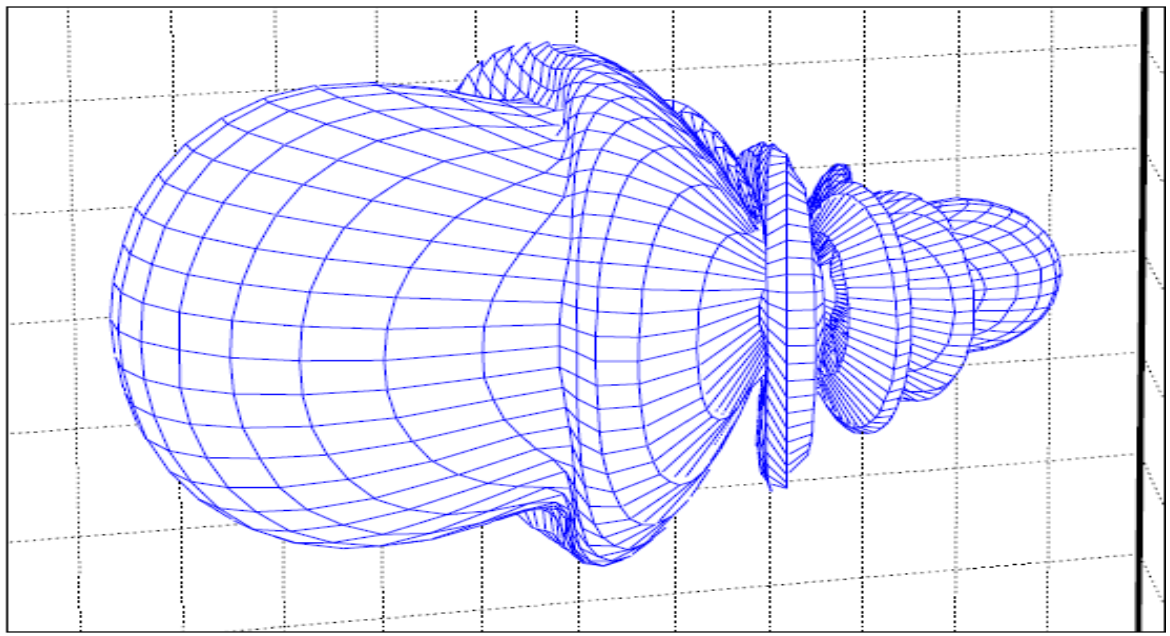


ANTENNAS

Horizontal polarization

- Less susceptible to man-made electrical noise
- Easier to install on vertical support mast
- Single yagis can experience ground-gain

- High-gain yagis have fairly narrow bandwidth
- Yagi gain proportional to boom length
- No. of elements affect pattern, not gain



ANTENNAS

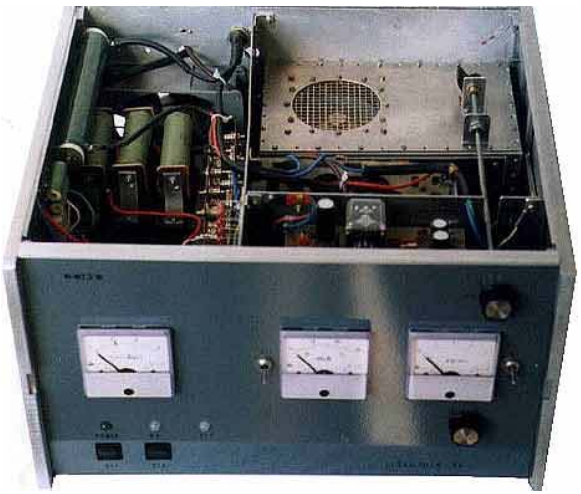
- **Can be home-built**

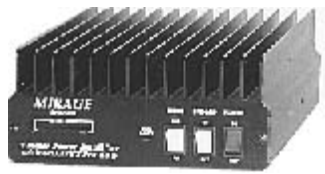
Typical antenna sizes:

Band	Elements	Boom Length
50 MHZ	4-7	12-36 feet
144 MHZ	8-18	10-36 feet
222 MHz	12-26	9-33 feet
432 MHZ	16-33	8-25 feet
1296 MHZ	23-55	4-15 feet
10 GHZ	2 foot dish	N/A

VHF/UHF antenna stack (WZ1V)

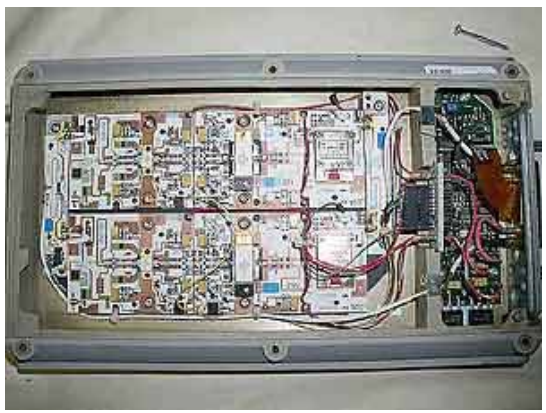
VHF AMPLIFIER





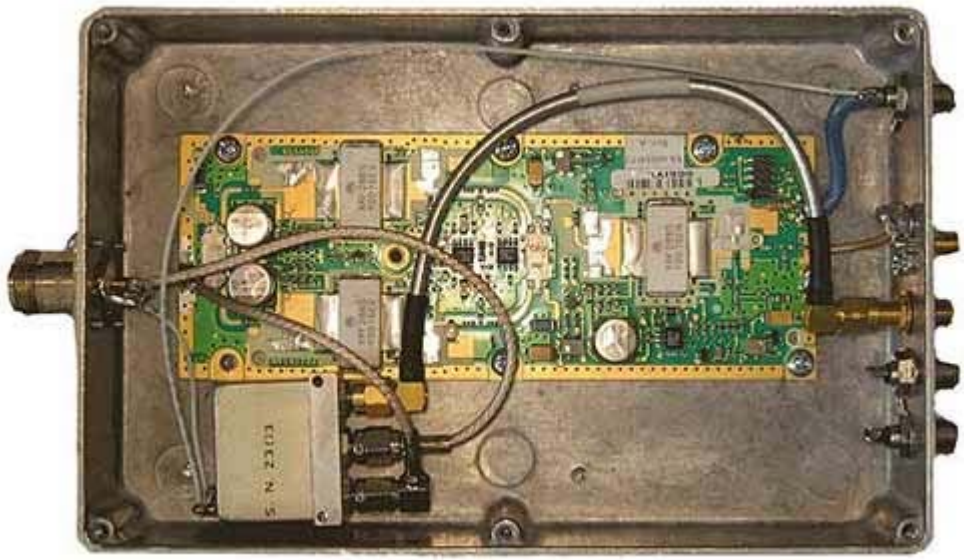
902 MHz

- Motorola Amplifiers
  - 150 (110), 300 (250), 600 (450) W
- Required replacing existing connector with SMA/N-Connectors, power, etc.
- Cost about $20 to convert
- 300W amps are available for about $100



2304 Spectrian

- Available from pyrojoseph for $80-100
- These modules make 60-80W



•Large amps from which the above modules are taken make 200W; buy from pyrojoseph for ~$399

Operating VHF+ DX

- **Location, Location, Location!**
  - Since most communication is “line of sight” or troposcatter, location has significant impact!!
  - **Optimal:** Antennas significantly above average terrain (the reason “hilltopping” is popular with weak-signal enthusiasts, especially “up east”!!)
  - **Desirable:** Antenna above average terrain
  - **Most common:** Antenna equal to average terrain
  - Try to keep antennas above or away from foliage
    - RF absorption increases with frequency
    - 6m & 2m not affected TOO much
    - 222 MHz like 6&2 except if foliage is wet, then much worse
    - 432 MHz significantly attenuated, 1296 virtually impossible

Front Range of the Colorado Rockies – not often found in Texas (interstate overpass, anyone?)!

Operating VHF+ DX

National **weak-signal** calling frequencies

Band	Calling Frequency
• 50 MHz	50.125
• 144 MHz	144.200
• 222 MHz	222.100
• 432 MHz	432.100
• 902 MHz	902.100west/903.100east
• 1296 MHz	1296.100
• 2304 MHz	2304.100
• 3456 MHz	3456.100
• 5760 MHz	5760.100
• 10 GHz	10368.100

Note: 1. 50.1-50.125 MHZ is “DX Window”
2. DX calling frequency is 50.110 MHZ

- Protocol is to call CQ on calling frequency and QSY

Operating VHF+

- **Typical QSO**
  - Runs the range from DX (foreign)/contest type to ragchewing
  - Common to exchange Grid Squares
  - Unlike HF, “RST” not common (no such thing as “S zero”)
- **Other**
  - Antenna aiming challenge
  - Ending transmission "W8CM (this is) ND2X (mobile 5) over"
  - Wide open, (generally) QRM-free spectrum
  - DO NOT ragchew on calling frequencies!
    - You’re not “creating activity”
    - You’re blanketing large areas with strong signals
    - This PRECLUDES activity

Operating VHF+

- **Contests and Band Openings**
  - Significant activity during both
  - Generally more of an operating event than a competition (for most ops)
  - Competition is fun, too, if that's your interest
- **Major Contesting Events**
  - ARRL January Sweepstakes; June/Sept. QSO Parties
  - ARRL August UHF, 10 GHZ and EME Contests
  - CQ July VHF Contest
  - Field Day, Fall & Spring Sprints

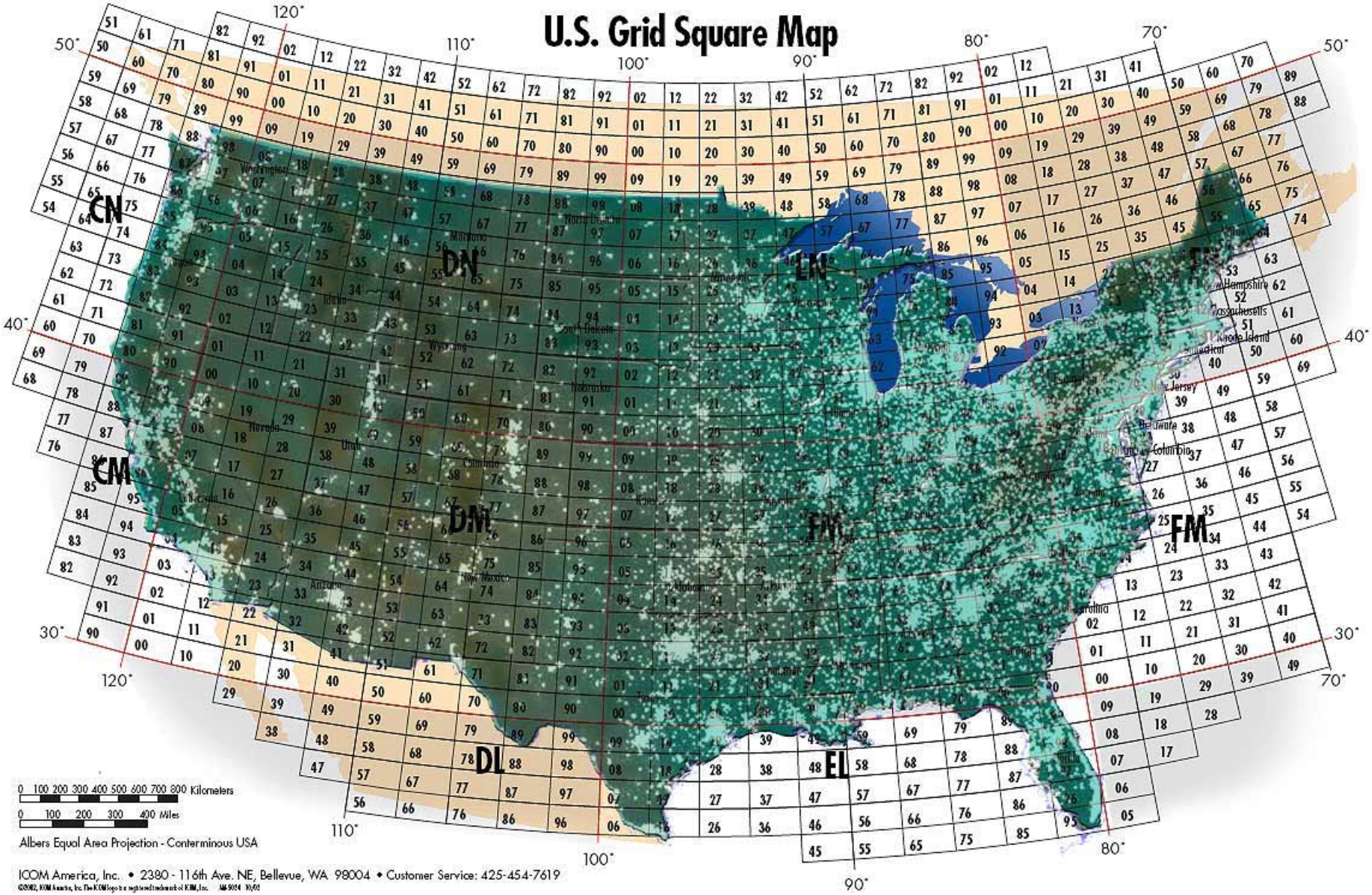
Operating VHF+

- **Openings**
  - Increased activity
  - Opportunity for extended range
- **Indicators**
  - Checking the band; Using FM repeaters; Beacons; TV/FM Broadcast stations
  - Weather reports; WWV; NOAA wx radio
  - Packet/internet spots, APRS map “explosions”
  - Time of the year (e.g., SW USA Apr-Jun)

Operating VHF+

- Whole ‘nuther world!
- Mobile stations (“Rovers”) play huge part
- Lots of grid “squares” out there with no hams in them at all, let alone VHF+ ops!
- Mobile stations “activate” grids otherwise silent

USA Grid Square Map + Population Overlay



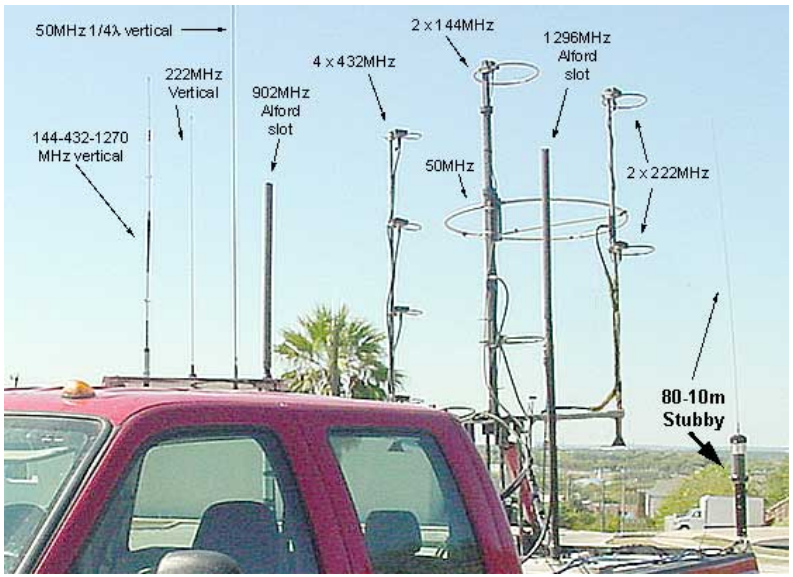
Rovers (mobile stations)

- Mobile stations can be fancy or simple!!
  - The more bands and antennas, the fancier
  - Antennas can be omni or directional
  - Configuration depends on type of roving
    - Mobile in motion (“Run ‘n’ Gun”)
    - Portable from “hilltops” (“Shoot ‘n’ Scoot”)
- Simple rovers
  - magnetic mount antennas
  - velcro & IC-706 Mk II G, FT-100D, FT-857, etc.
  - Amplifiers if desired

Simple Rovers: 50, 144 & 432 MHz

Some mag-mount antennas, a little velcro & a tank of gas; a rover is born

“Fancy” Rovers



Operating VHF+

- Challenging aspect of HAM Radio
  - Many bands (16 allocations between 50MHz & 300 GHz)
  - Many modes (analog, digital, weak signal, 802.11/x, …..)
  - Many ways (fixed, mobile, portable, DX-peditions, ...)
  - Many levels (simple, fancy, few bands, many bands, …..)
  - Digital EME, HSMS, etc.; amazing results!
- Lots of room for more activity
- ANYbody can bounce signals off the ionosphere!

(ya gotta know what yer doin' to work from San Antonio to Dallas on 10GHz! – HIHI!)

How to “Git ‘er Done!”

- Buy equipment with VHF+ bands
  - Get some good coax and some antennas (preferably long)
  - Clear the trees (if req’d)
  - Learn to point (or go mobile with omni’s)
- Find local VHF+ operators and bug ‘em
  - Weak signal Terrestrial (analog as well as digital)
  - Weak signal moonbounce (EME)
  - “Forget” FM (No challenge using STRONG signals)
- Attend VHF+ weak signal conferences
- Join local VHF+ weak signal organizations

Some Regional VHF+ groups

- North East Weak Signal (NY & NE)
- Packrats (PA, NJ, DE, MD, VA)
- Grid Pirates (MD-DC-VA)
- SB Microwave Society (Southern Cal)
- Roadrunners Microwave Group (S-Cen TX)
- North Texas Microwave Society (Dallas TX)
- VHF South Contesting Group (Hemphill, TX)
- Central States VHF Society (Central US)

PACKRATS--MT. AIRY VHF R. C.

- Web Site: http://www.packratvhf.org/
- Weekly SSB nets (Mondays, 50.150, 7:30 local, up one band each half hour) Check website for details
- Monthly Meetings, 3rd Thurs 7:30PM, Ben Wilson Senior Center Warminster, PA including:
  - Brief Business meeting
  - Mario Raffle -- great parts for building
  - Engaging speakers
  - Construction projects
- Beacons from 50MHz through 10GHz bands
- VHF+ “Elmering” / Band(s) of emphasis
- Contesting
- White Elephant Auction
- Club Picnic
- Annual Conference and HAMARAMA

Ham Radio Above 50MHz

- Haben Sie Fragen?
- ¿Tiene usted alguna preguntas?
- Вы имеете какие-нибудь вопросы?
- Do you have any Questions?