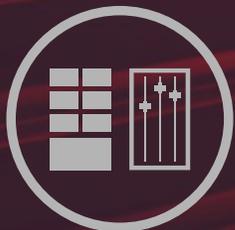


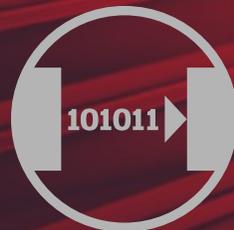
FCC Spectrum Repack

The Impact on TV and FM Stations

Rich Redmond
Chief Product Officer



Create



Transport



Transmit Television



Transmit Radio



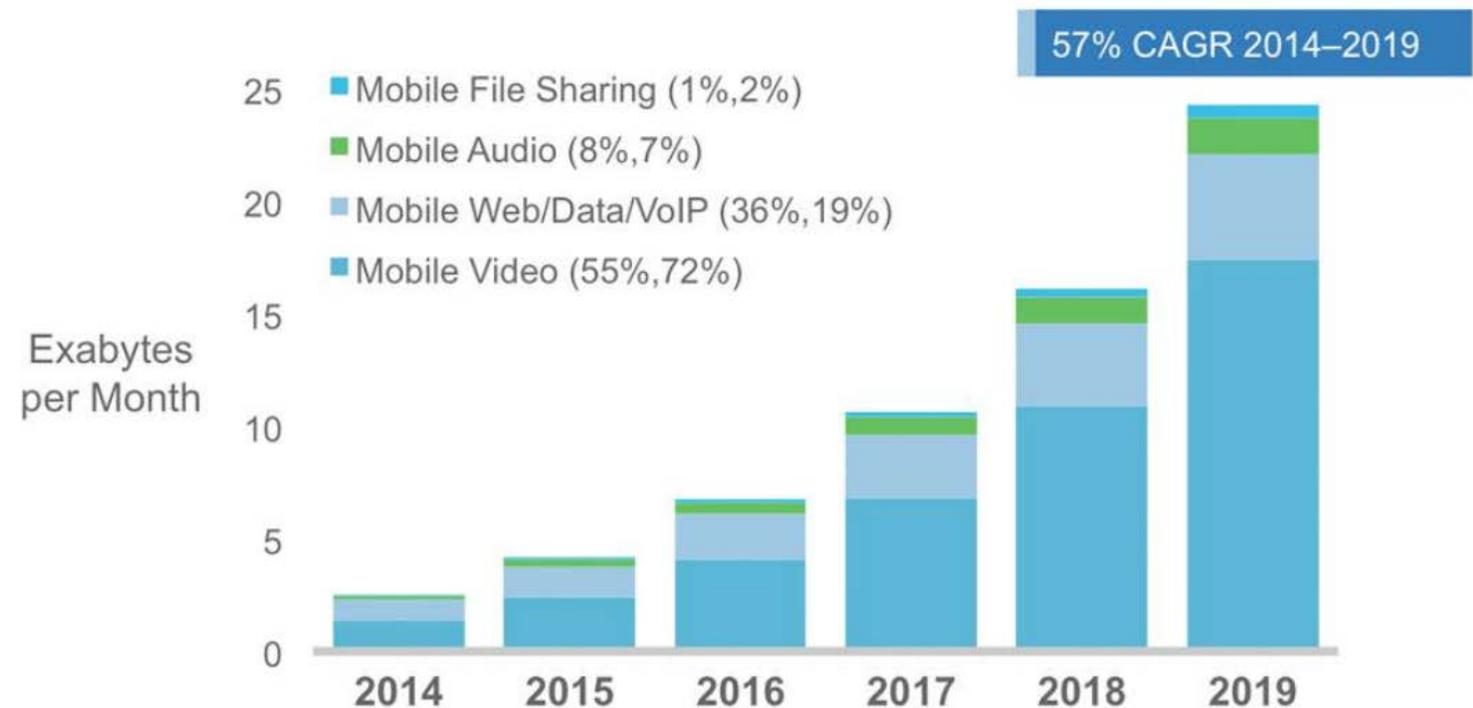
Agenda

- Background – Why the demand
- What is the repack
- What part of the TV facility is impacted?
- How does this impact FM radio
- Transmitter building impacts
- Tower Structure Impacts
- Antenna & Line Impacts
- Potential Interference
- Technical Resource Impacts
- Conclusions



Why the demand for spectrum

- Mobile data usage grows
- Traditional traffic of web-VOIP becomes smaller portion
- Mobile video consumption consumes almost 3 quarters of usage
- Unicast nature of mobile data drive one to one connection per user – does not scale well for common content
- EMBMS (broadcast LTE) helps but will not meet demand
- More spectrum needed to fuel data growth
- UHF TV spectrum – presented as underused beachfront property



Figures in parentheses refer to 2014, 2019 traffic share.

Source: Cisco VNI Mobile, 2015

Mobile Data Usage Projections

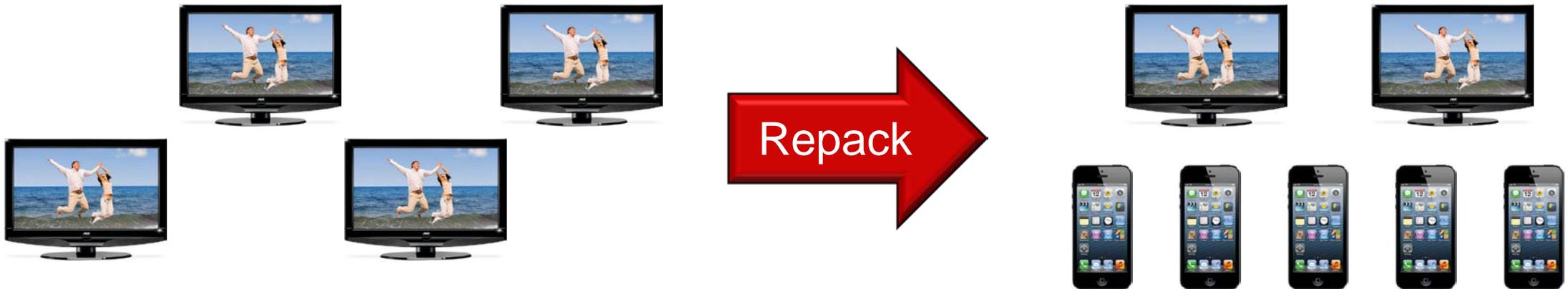


What is TV Spectrum “Repack”?

- FCC’s Definition of “Repacking”

(Source: <http://wireless.fcc.gov/incentiveauctions/learn-program/repacking.html>)

“Repacking involves reorganizing television stations in the broadcast television bands so that stations that remain on the air after the incentive auction occupy a smaller portion of the UHF band, thereby freeing up a portion of that band for new wireless services uses.”



Stations Affected

- 800 – 1200 stations are going to be impacted by the Repack
 - This number will be determined by the amount of spectrum that will need to be cleared
 - 84 MHz will be channels 38 and above
 - 126MHz will be channels 30 and above, except channel 37 (a protected channel)
 - These numbers were generated by the FCC, through the running of 100 different simulations

126	21	22	23	24	25	26	27	28	29	9	A	B	C	D	E	F	3	37	3	G	H	I	J	11	A	B	C	D	E	F	G	H	I	J	700 MHz UL
114	21	22	23	24	25	26	27	28	29	30	31	7	A	B	C	D	3	37	3	E	F	G	H	I	11	A	B	C	D	E	F	G	H	I	700 MHz UL
108	21	22	23	24	25	26	27	28	29	30	31	32	11	A	B	3	37	3	C	D	E	F	G	H	11	A	B	C	D	E	F	G	H	700 MHz LIL	
84	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	3	A	B	C	D	E	F	G	11	A	B	C	D	E	F	G	700 MHz LIL	

Spectrum Auction Station Impact

Data from FCC 120 MHz Clearing Target Repacking Simulations

Eligible UHF Stations	1675	
Stations Eliminated	415	443
Stations Remaining on Channel (No Optimization)	71	92
Stations Required to Repack (No Optimization)	1147	1184
DTC Estimated Stations remaining on channel (After Optimization)	400	167
DTC Estimated Stations Required to Repack (After Optimization)	860	1065

Data from FCC 84 MHz Clearing Target Repacking Simulations

Eligible UHF Stations	1675	
Stations Eliminated	222	249
Stations Remaining on Channel (No Optimization)	92	132
Stations Required to Repack (No Optimization)	1361	1294
DTC Estimated Stations remaining on channel (After Optimization)	443	262
DTC Estimated Stations Required to Repack (After Optimization)	1020	1164

Sources: FCC DMA Simulations and DTC Analysis

** The numbers above represent a range based on the analysis of the FCC 100 repack simulations



800 to 1200 stations will need to rebuild transmission infrastructure as part of repack

Estimated Costs for Total Repack

Total Cost Summary if 800 Stations are Repacked

Cost for Full Power Stations	\$ 996,554,020
Cost for Medium Power Stations	\$ 892,584,960
Cost for Lower Power Stations	\$ 31,480,000
Cost for Special Case Stations*	\$ 63,855,975
Total Cost	\$ 1,984,474,955

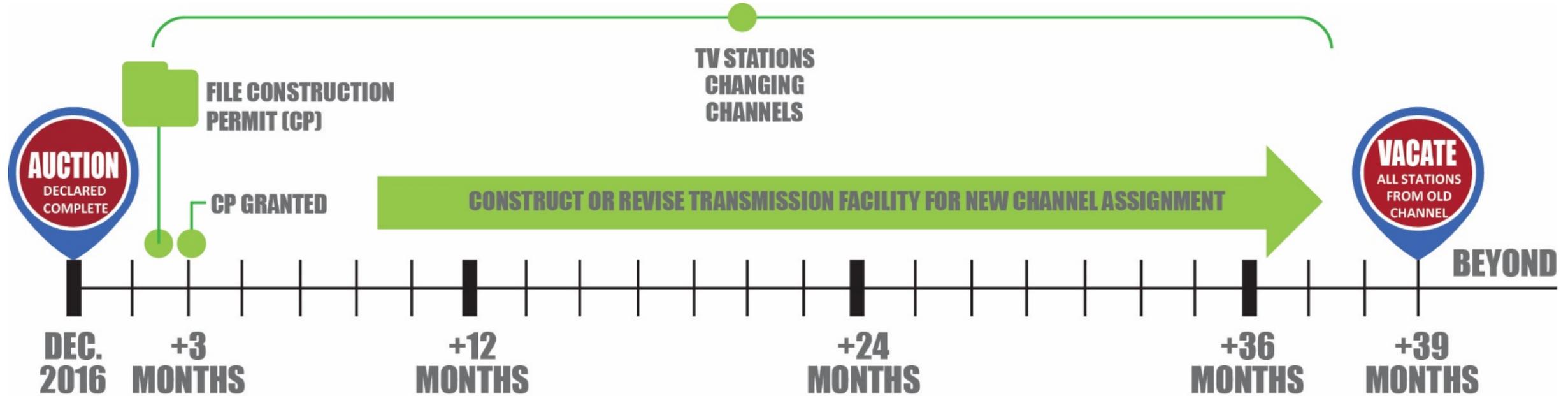
Total Cost Summary if 1200 Stations are Repacked

Cost for Full Power Stations	\$ 1,495,187,804
Cost for Medium Power Stations	\$ 1,338,877,440
Cost for Lower Power Stations	\$ 47,220,000
Cost for Special Case Stations*	\$ 63,855,975
Total Cost	\$ 2,945,141,219

* Represents shared sites with shared antennas such as 4 Times Square and Empire State Building in NYC, Wills and Hancock Towers in Chicago, Mt. Wilson in LA, and Mt. Sutro in San Francisco



Repack Implementation Timeline



Likely start delayed due to additional rounds of the auction

Recent regulations have stated that stations unable to make the transition within 39 months to their new channel will NOT be forced off the air

An Auction on the Move – Timeline

Event	Current Estimate
Stations file <i>Application to Participate in Reverse Auction</i>	December 1, 2015 to January 4, 2016
Broadcasters make minor corrections and modifications necessary to complete their applications	January - March 2016
Deadline for broadcasters that registered for reverse auction to commit to preferred bidding option. This is a binding commitment to accept FCC's initial offer	March 29, 2016
FCC notifies each reverse auction applicant of their status. FCC runs initial clearing target optimization and sets initial clearing target	April – May 2016



An Auction on the Move – Timeline

Event	Current Estimate
Reverse auction bidding rounds commence – bidding continues for about 1 month	May 2016
Forward auction is conducted. If revenues target not met, the FCC reruns the reverse auction with a lower spectrum target. If revenues are sufficient the auction closes, winning bidders, channel reassignments announced	June - September 2016
FCC commences payments to winning bidders on a rolling basis, as forward auction licenses are issued	November 2016

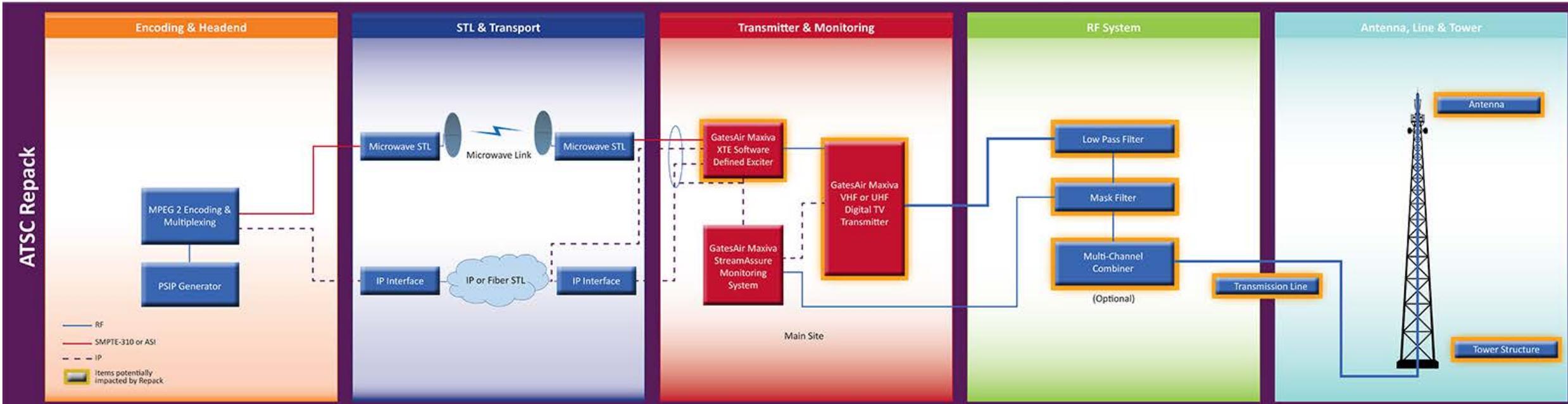
Likely start delayed due to additional rounds of the auction



An Auction on the Move – Timeline

Event	Current Estimate
Repacked stations must file construction permits (CPs) for new facilities and submit repacking cost estimates	December 2016 FCC set 90 day timeline to file CP applications following <i>Channel Reassignment Public Notice</i>
Station deadlines to build out CPs (station-specific deadlines)	February 2017 – December 2019
Filing window for displaced translators* Not protected, anyone displaced will hopefully be found a new space	August 2017
Deadline for repacking expense finalization and true-up process	September 2019
All repacked stations to be operating on new channels; all broadcasts on pre-auction channels end	December 2019

What part of a TV facility is impacted?



Television Transmission System Impact

Likely to be affected:

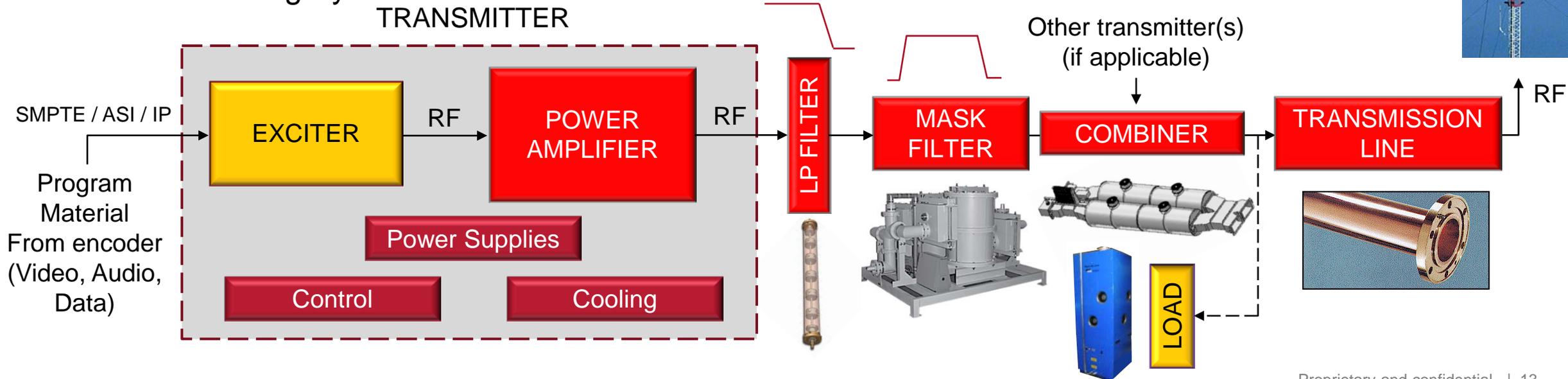
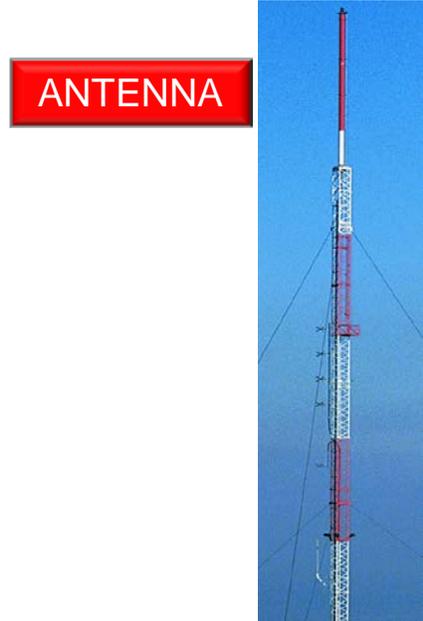
Possibly affected:

• Transmitter, comprising:

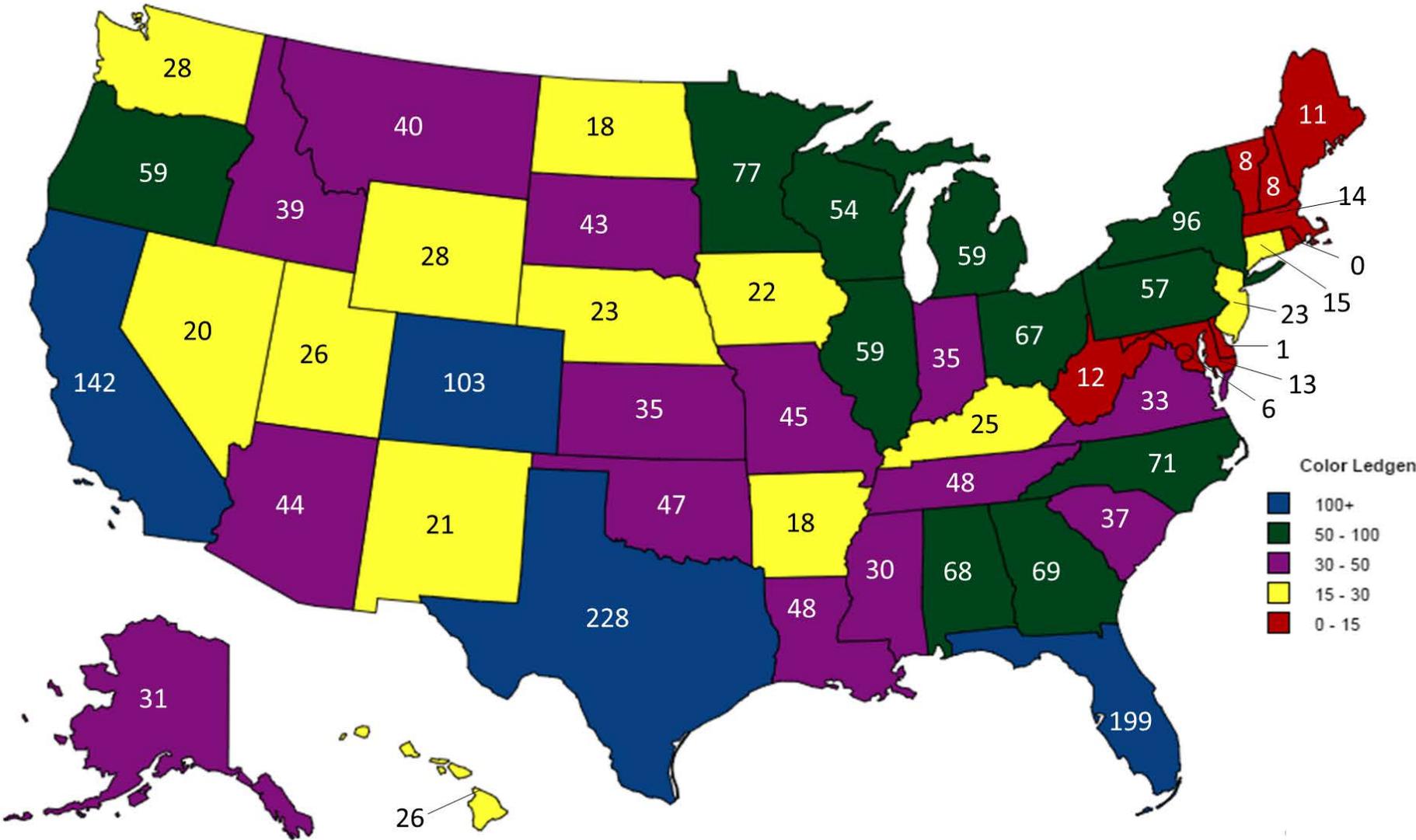
- ✓ Exciter
- ✓ Amplifier
- ✓ Power Supplies
- ✓ Control
- ✓ Cooling System

• External RF Items:

- ✓ LPF / Mask Filter
- ✓ RF Combiner
- ✓ Patch Panel / Dummy Load
- ✓ Transmission line
- ✓ Antenna



FM and TV stations that share towers



- TV & Radio** - FCC data indicates **1153** towers in the US have both Radio and TV stations
- Radio** - There are **2368** FM radio stations, or translators on TV towers that could be impacted by repack
- Full Power Radio** - Over **1300** are full power FM

New Side-mount Antenna is Likely

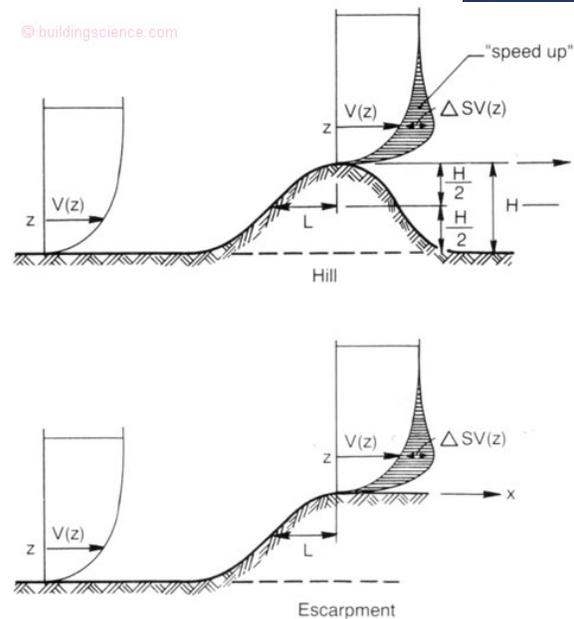
- Easy way to accommodate channel transition
- Long term operation (several months to a couple of years) is likely so full power / full gain side-mount will be preferred
- Tower Loading and possible re-enforcement will drive many decisions
- Required size for TV side mount may impact FM



Tower Structural Analysis

- TIA-222 Rev G
 - Ice
 - Wind Speed
 - Topography
 - Shape Factors

- Tower owner will need to get a structural analysis



- OET-69 “dipole factor”

Table 2

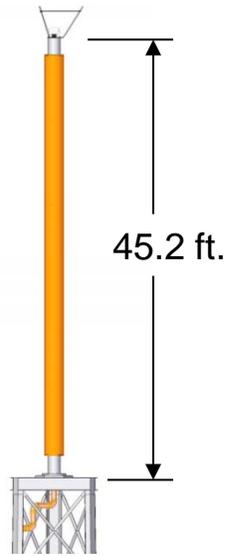
Field Strengths Defining the Area subject to Calculation for DTV Stations

Channels	Defining Field Strength, dBu, to be predicted for 50% of locations, 90% of time
2 - 6	28
7 - 13	36
14 - 69	$41 - 20 \log[615/(\text{channel mid-frequency in MHz})]$

$$P_r = P_t \frac{G_t G_r \lambda^2}{(4\pi R)^2}$$

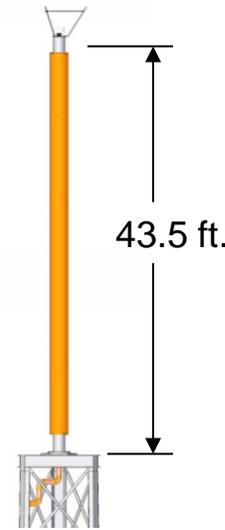
1 MW ERP AT CH49 WILL BE ALLOCATED 687 KW ERP AT CH 25

Replicate with Same Size Antenna



Channel 51
TFU-30JTH-R
O4
Ø10.75" Pipe
27 Gain

(EPA) = 42.4 ft²
W = 3800 lbs.



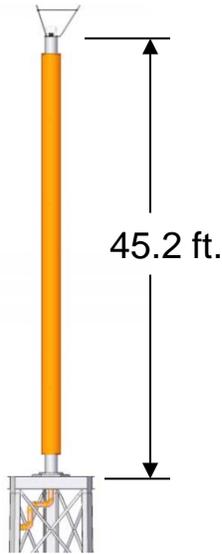
Channel 24
TFU-22JTH-R O4
Ø10.75" Pipe
20 Gain

(EPA) = 45.0 ft²
W = 3600 lbs.

SAME SIZE AND WINDLOAD – LOWER
GAIN

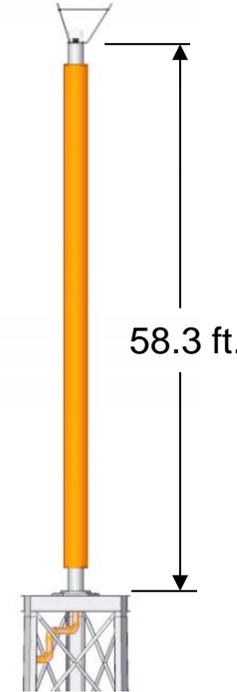


Replicate with Same Gain Antenna



Channel 51
TFU-30JTH-R
O4
Ø10.75" Pipe
27 Gain

(EPA) = 42.4 ft²
W = 3800 lbs.



Channel 24
TFU-30JTH-R O4
Ø14" Pipe
27 Gain

(EPA) = 68.7 ft²
W = 7000 lbs.

REQUIRES LARGER HEAVIER
ANTENNA



Site Density will Drive Impact to Radio

Lower Impact



Tall tower with open vertical space



FM antenna is top mounted & TV antenna is side mounted

Higher Impact



Congested tower

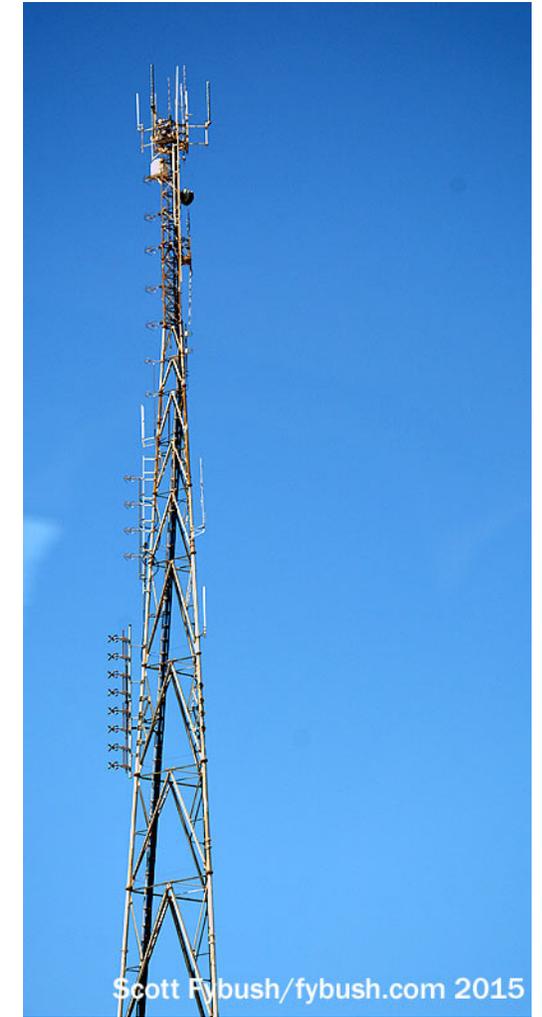


Congested mountain top site or building supporting multiple towers and multiple stations



Impact of an FM antenna move

- Vertical Polarization Pattern not effected – always broad cardioid
- H- pole pattern becomes directional with ~6' face size
- H-pole pattern becomes more omnidirectional with ~ 10' face size

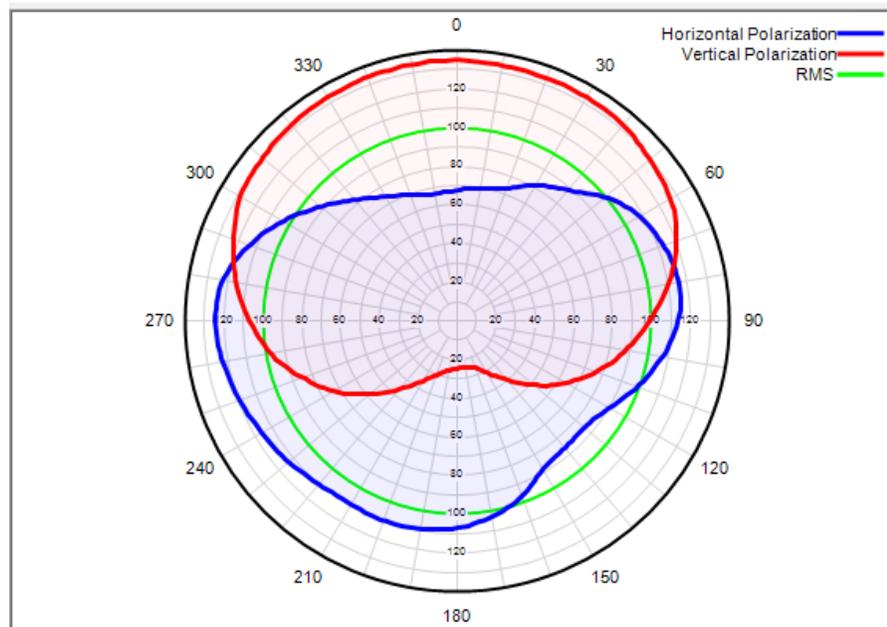


FM Pattern impacted by tower size

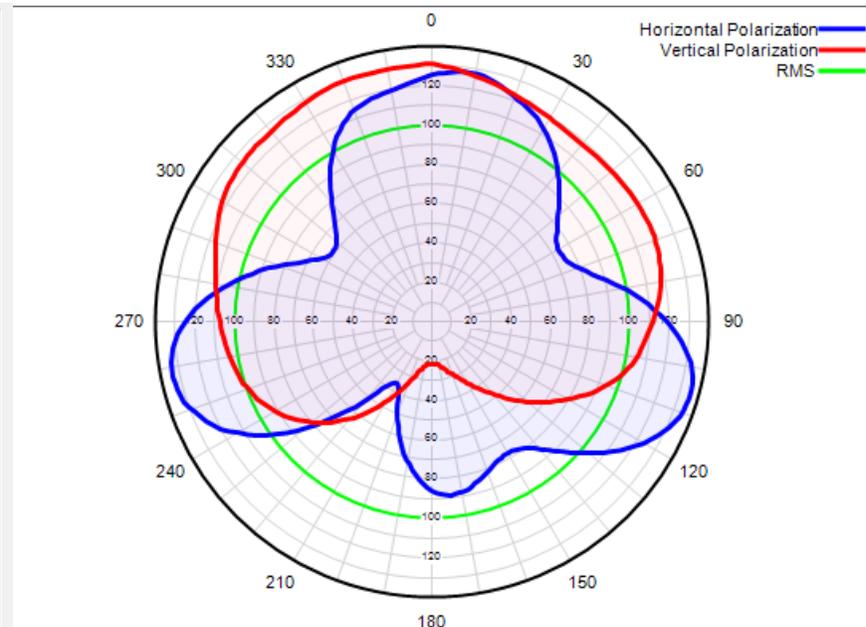
- Directional station would need to re-file with new pattern study

Both Antennas are leg mounted

DCRC on 24" Face Tower

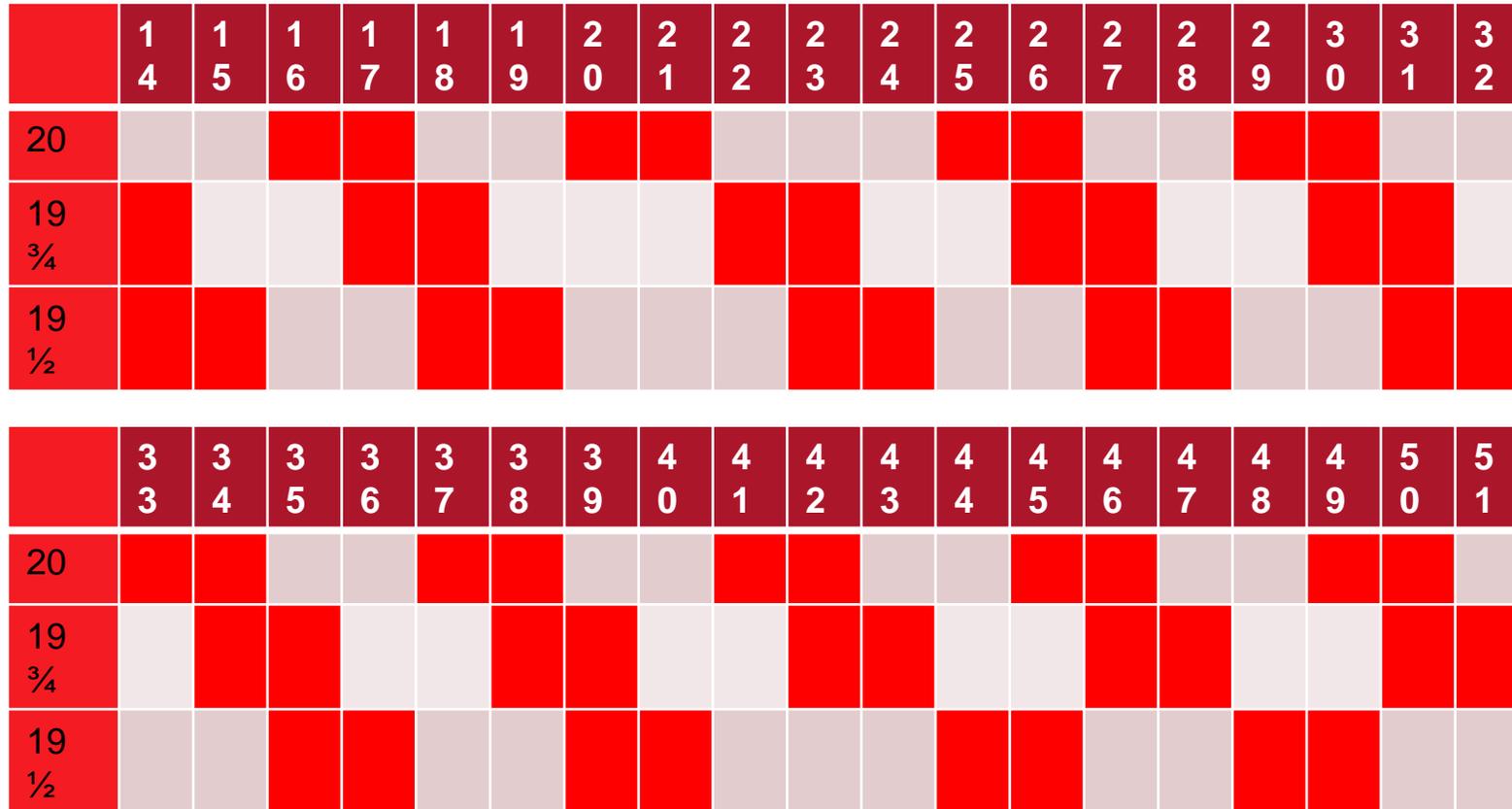


DCRC on 48" Face Tower



Channel impacts transmission line

- In UHF ridged line length has VSWR impact base on frequency



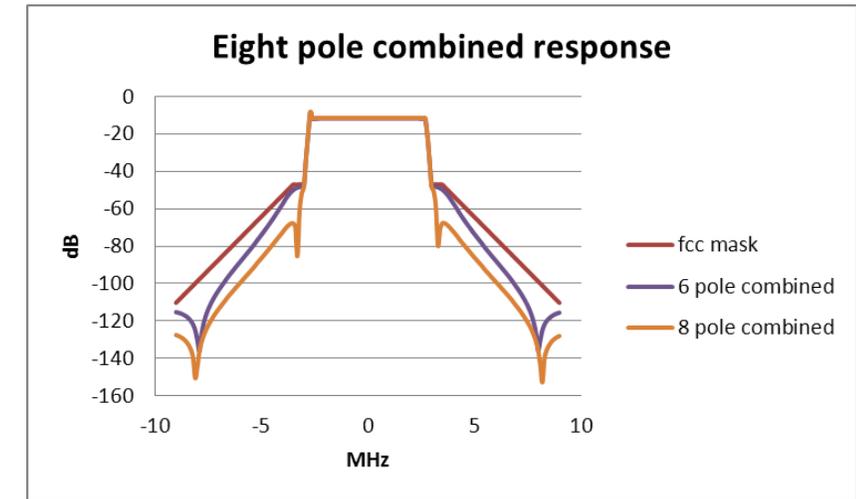
A move from CH 44 to CH 17 using 20' line lengths will need to replace transmission line



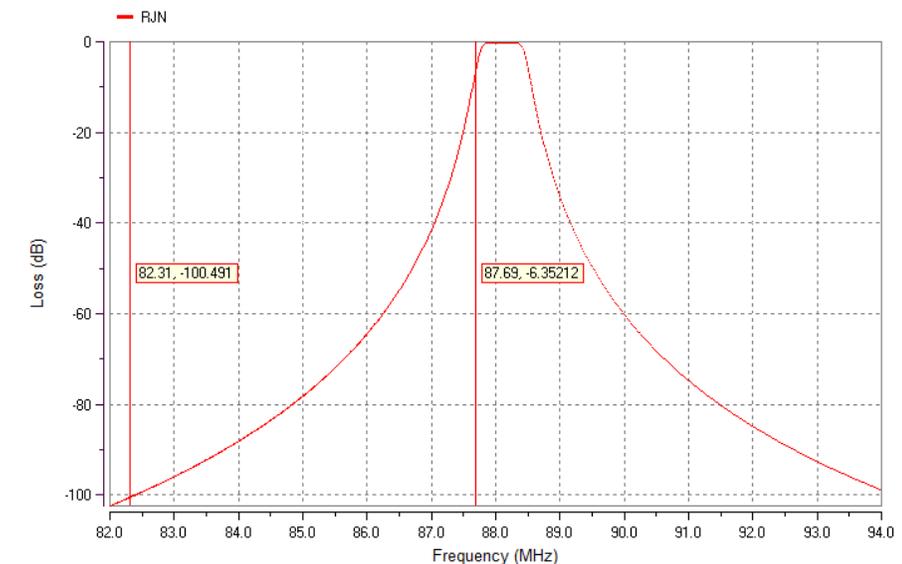
Prohibited Channel per catalog

TV Relocates to VHF CH 6

- FM Antenna can receive channel 6
- Power from Channel 6 can Mix in output stage of FM transmitter
 - Important for transmitters to have good turnaround loss
- IM Power is rebroadcast onto upper-adjacent FM frequencies
- Only an issue with very low FM channels (88.1~90.1)
- Channel 6 Antenna needs to be close to FM antenna
- Actual requirement for filter depends on several factors – distance, azimuth and elevation patterns, FM transmitter turn around loss...



Four_pole 88.1 - 2016/01/26 12:50:56



Impact on Broadcast Technical Resources

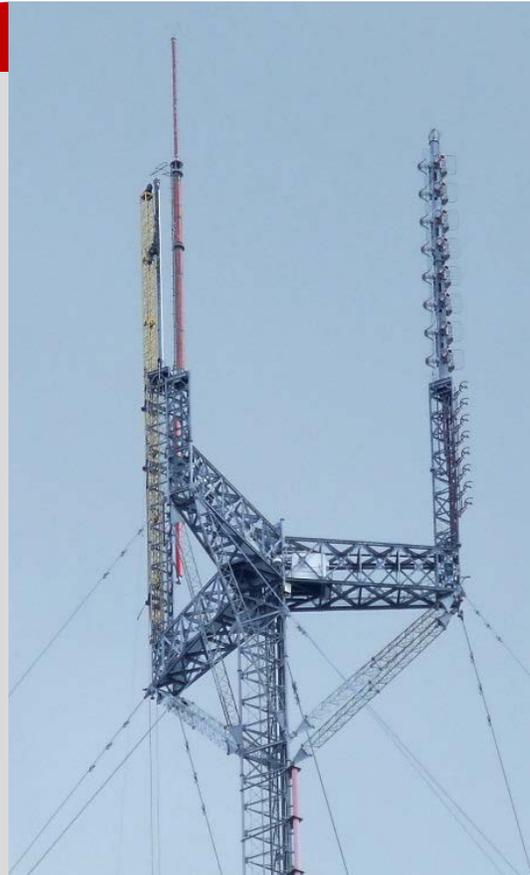
- Large demand on consulting engineers time
- Structural analysis
- Transmitter installers
- Tower crews – new towers and antenna installation
- May impact planned Radio projects
- May need to look for alternative resources
- Projects may get delayed



How does this impact the co located radio

TV Station Change

- Antenna Change
- Transmission Line Change
- Tower Structural Reinforcement
- RF System Change
- Transmitter Change
- Electrical Service



Impact On Radio Station

- Off air Time, may need to relocate
- Off air Time, may need to relocate
- Off air Time, may need to relocate
- In building floor plan changes – may need to move equipment
- In building floor plan changes – may need to move equipment
- Changes to Service may impact radio transmitter

Planning for site redundancy critical to avoid off air time

Summary

- With over 2300 radio stations sharing facilities, TV likely large impact
- Go see your neighbors – engage TV station soon
- Broadcaster transition fund is taken from auction proceeds
 - Paid to TV broadcasters involuntarily repacked to new channel
- Put together plan and budget if FM site is severely impacted
- Possible that impacted FM sites can re-coup costs due to TV channel change
 - FM costs must be considered in impacted TV stations budget
- Most severe resource constraints will be structural engineers, antenna supply, installation crews
- Most of all – Plan early and follow the Boy Scouts motto - Be Prepared

