



TV Spectrum Auction & Repack Update

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NAB Show 2015

Featuring
GatesAir's



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TV Spectrum Auction & Repack Update



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Presentation Agenda

- Spectrum Auction & Repack Timeline
- Spectrum Rules & Regulations
- Reverse Auction Process
- Television Spectrum Repacking Process
- Q&A

Spectrum Auction & Repack Timeline

FCC's Predicted Timeline

- Original goal (2012 NPRM):
 - Conclude rulemaking in 2013
 - Hold auction in 2014
- Wheeler December 2013 blog post:
 - “I believe we can conduct a successful auction in the middle of 2015.”
 - But . . . “managing a complex undertaking such as this also requires an ongoing commitment to continuously and honestly assess its readiness and its project plan.”

Not All Predictions Become Reality

- Two lawsuits have been filed against the FCC to resolve issues with the FCC's plan
 - National Association of Broadcasters
 - Sinclair Broadcast Group
- Several proceedings remain pending
- New timeline announced in Oct. 2014:
 - Accept applications Fall 2015
 - Begin auction Early 2016

An Auction on the Move

Event	Original Date	Current Estimate
FCC issues <i>Auction Procedures Public Notice</i>	1Q 2015	3Q 2015
Stations file pre-auction applications	2Q 2015	3Q 2015
FCC conducts Incentive Auction	Mid-2015	Early 2016
FCC issues <i>Channel Reassignment Public Notice</i>	3Q 2015	2Q 2016
Repacked stations must file construction permits (CPs) for new facilities and submit repacking cost estimates	4Q 2015	3Q 2016

An Auction on the Move

Event	Original Date	Current Estimate
Station deadlines to build out CPs (station-specific deadlines)	4Q 2015 – 4Q 2018	3Q 2016 – 3Q 2019
Filing window for expanded facilities or alternate channel assignments	1Q 2016	4Q 2016
Stations that auctioned spectrum begin to receive payments	1Q 2016	4Q 2016
Stations relinquishing channels (entirely or to channel share) must end broadcasts on pre-auction channels	2Q 2016 (90 days from receipt of payments)	1Q 2017(90 days from receipt of payments)

An Auction on the Move

Event	Original Date	Current Estimate
Filing window for displaced translators	3Q 2016	2Q 2017
Deadline for repacking expense finalization and true-up process	3Q 2018	3Q 2019
All repacked stations to be operating on new channels; all broadcasts on pre-auction channels end	4Q 2018	4Q 2019

Spectrum Rules & Regulations

Broadcast Industry Regulatory Wins

- **Advance reimbursement** – 80% Commercial 90% Non-Com licensees
- **Expanded eligible expenses** in Catalog of reimbursable costs
- **Better signal-contour protection** – same viewers, not just same number of viewers
- **Better protection of TV translators** – can stay on air until wireless provider is ready to build out new facilities
- **Consumer education costs reimbursable** for involuntarily repacked stations
- **VHF stations can channel-share** on UHF channel
- **Statutory protections** for must-carry and Relocation Fund size

Many Important Issues Still Unresolved

- **Number of Stations Repacked**
 - FCC proposal would prioritize keeping stations on pre-auction channel, if possible
- **Permissible Amount of Aggregate New Interference**
 - Stations could be subject to 0.5% new interference *per station*
 - FCC proposal would seek to minimize number of stations with aggregate new interference > 1%
- **Unserved Areas (“white areas”)**
 - If white areas occur, FCC will consider “appropriate actions to address such losses,” which might theoretically include accepting applicants for new stations
- **Translators**
 - No outright protection for translators
 - Future proceedings to determine additional issues (e.g., DTV timing and prioritization)

FCC Decisions To Come

- **Incentive Auction Reconsideration Order(s)**
 - 30 petitions for reconsideration of Incentive Auction *Report and Order*
 - Likely several orders addressing different issues
- **Auction Procedures Public Notice**
 - How to set initial clearing target
 - Opening prices for broadcasters, including how to value individual stations
 - Dynamic reserve pricing
 - Information available to broadcasters during auction
 - Price decrements
 - Optimization priorities during repacking

FCC Decisions To Come

- **Low Power TV/TV Translators Third Report and Order**
- **Inter-Service Interference Third Report and Order and Reconsideration Order**
- **Wireless Microphones Report and Order**
- **Unlicensed Devices Report and Order**
- **Mobile Spectrum Holdings Reconsideration Order**
- **Competitive Bidding Report and Order**

Auction Participation – Bid Options

- **Pre-auction application to ask** stations to indicate which options broadcaster is interested in pursuing
- **Options**
 - **Relinquish license entirely**
 - **Channel share** with another broadcaster in same DMA
 - **Move** from UHF to VHF
 - Can specify “high V” or “low V”
 - **Move** from high VHF to low VHF
- **Eligible stations** must be licensed by May 29, 2015

Pre-auction Application

- **FCC will protect confidentiality** of stations through auction
 - Includes protection for two years thereafter for any broadcaster who did not successfully exit or move
- **Applications to be submitted** – and auction conducted – electronically
 - Provide licensee name, address, channel
 - Provide names of all officers and board members
 - Whether bidder will continue to hold broadcast license for any station after the auction (FCC enforcement hook)

Channel Sharing

- **Bidder** in channel sharing arrangements is entity relinquishing spectrum
- **Existing rules**
 - **Must submit copy of finalized channel sharing agreement**
 - **Certify** that move to new facility
 - Will not change local “Designated Market Area”
 - Will either provide full coverage for community of license or meet FCC’s Table of Allotment priorities if community must change
- **Petition for Reconsideration**
 - Would allow **post-auction sharing agreements** and **term agreements**

Channel Sharing

- **Post-auction operating requirements**
 - Should be covered in channel-sharing agreements
 - **Agreements must include:**
 - Rights of access to facilities
 - Allocation of bandwidth (may be dynamic)
 - Handling of operation, maintenance, and modification of facilities, including each party's financial obligations
 - Termination or transfer/sale rights
- **If one partner loses license, rights of other unaffected**
 - **Under current rules** FCC will take back license and reassign to qualified new licensee

Anti-Collusion Rule

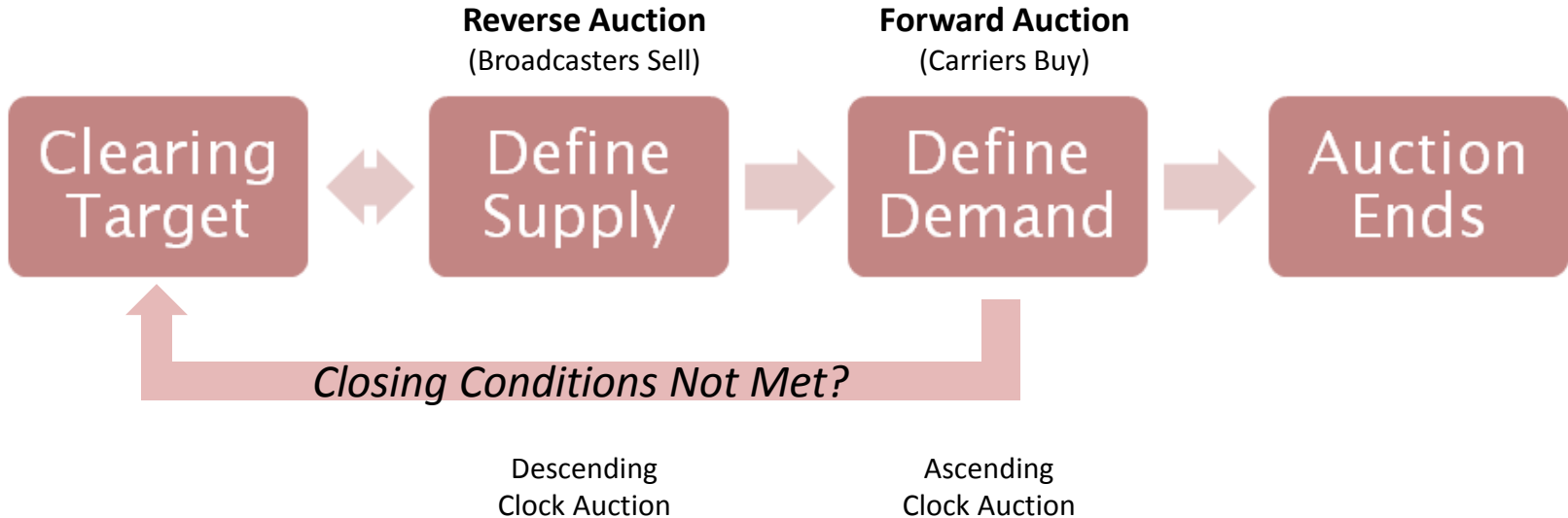
- **All TV licensees**, *whether participating in the reverse auction or not*, are barred from disclosing info about:
 - Any broadcaster's planned bid amount
 - Any broadcaster's bidding strategy
 - Applies to all broadcasters nationwide, not just your local market info
- **Exceptions:**
 - Parties to channel-sharing agreements or co-owned stations
- **Ban kicks in** at deadline for pre-auction application and remains in place until FCC officially declares auction closed

Consumer Education

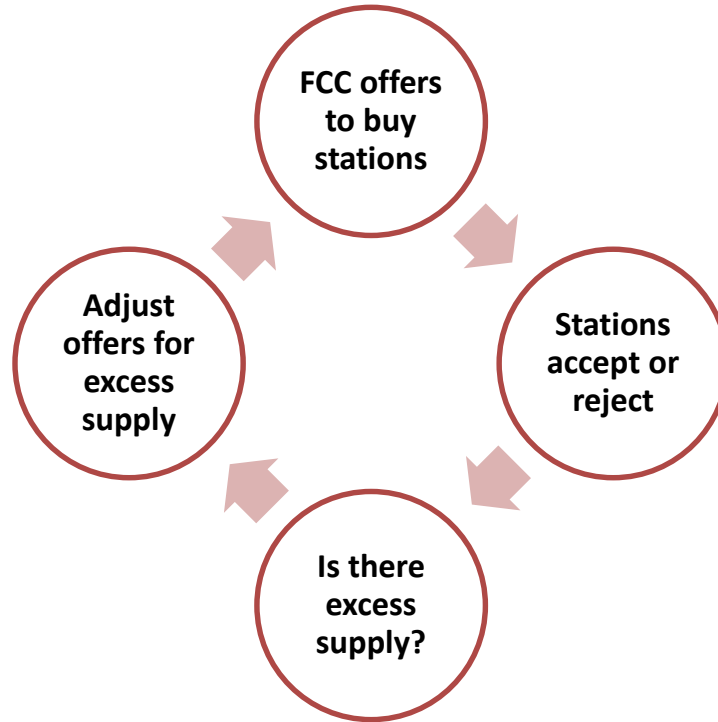
- **All broadcasters that move to a new channel** required to engage in some consumer alerts
- **All stations must:**
 - Air at least one PSA and also a 60-second crawl in every quarter of every day for a 30-day period before ending operations on original station
- **Will this be enough?**

Reverse Auction Process

Macro Auction Design



Defining Supply: Descending Clock Auction



Initial Price Offers (FCC Proposal)

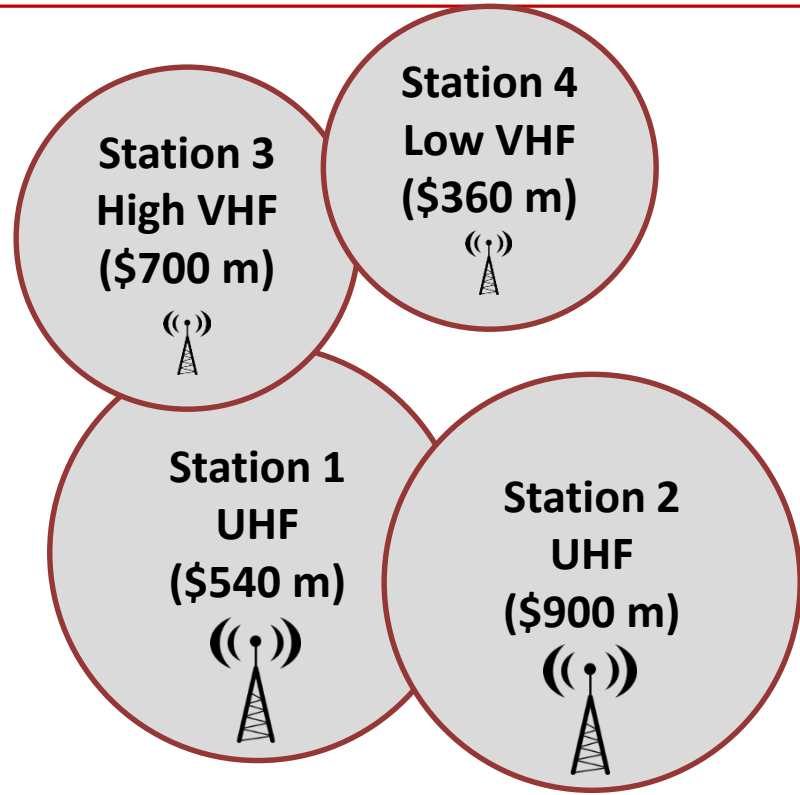
- Individual pricing for each station
 - Volume = (Interference Count)^{1/2} x (Interference-Free Pops)^{1/2}
- Normalize volume to one million
- Multiply by base clock price
- Variations:
 - High VHF stations: 50-67% of UHF price; Low VHF stations: 33-40%
 - Move to High VHF: 33-50% of relinquishment price
 - Move to Low VHF: 67-80% of relinquishment price

Initial Price Offers

	Station 1 (UHF)	Station 2 (UHF)	Station 3 (High VHF)	Station 4 (Low VHF)
Interference Count	144	100	100	100
Population	10,000	40,000	40,000	40,000
Volume Factor	1,200	2,000	2,000	2,000
Normalized Volume	600,000	1,000,000	1,000,000	1,000,000
Relinquishment Bid	\$540 million	\$900 million	\$700 million	\$360 million
Move to High VHF	\$162 million	\$270 million	---	---
Move to Low VHF	\$324 million	\$540 million	\$420 million	---

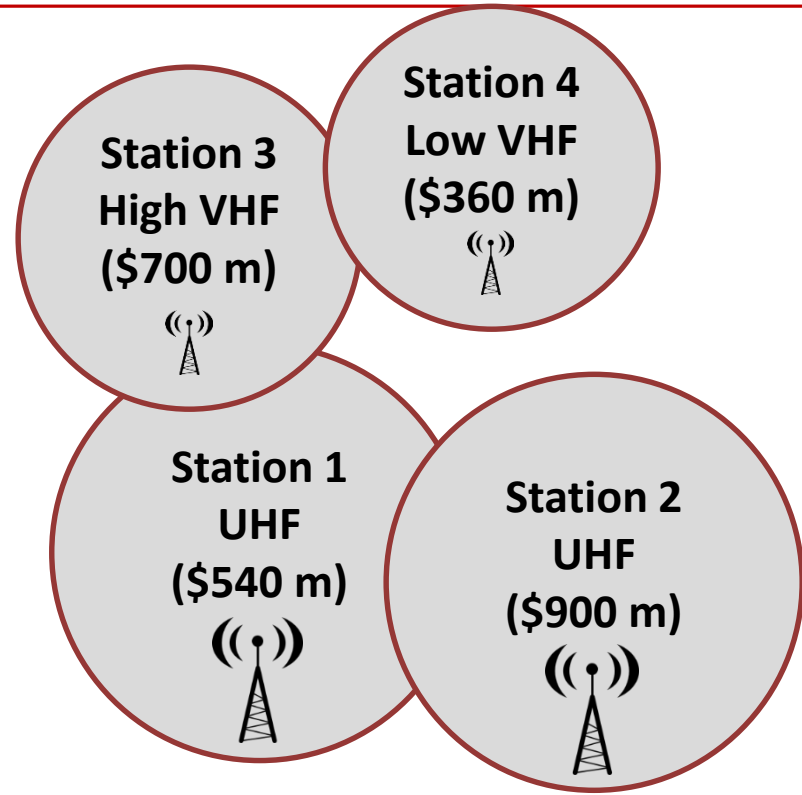
Simulated Auction

- **New Wheeler, USA**
 - 4 existing stations
 - 1 available channel assignment in each band (UHF, High VHF, Low VHF)



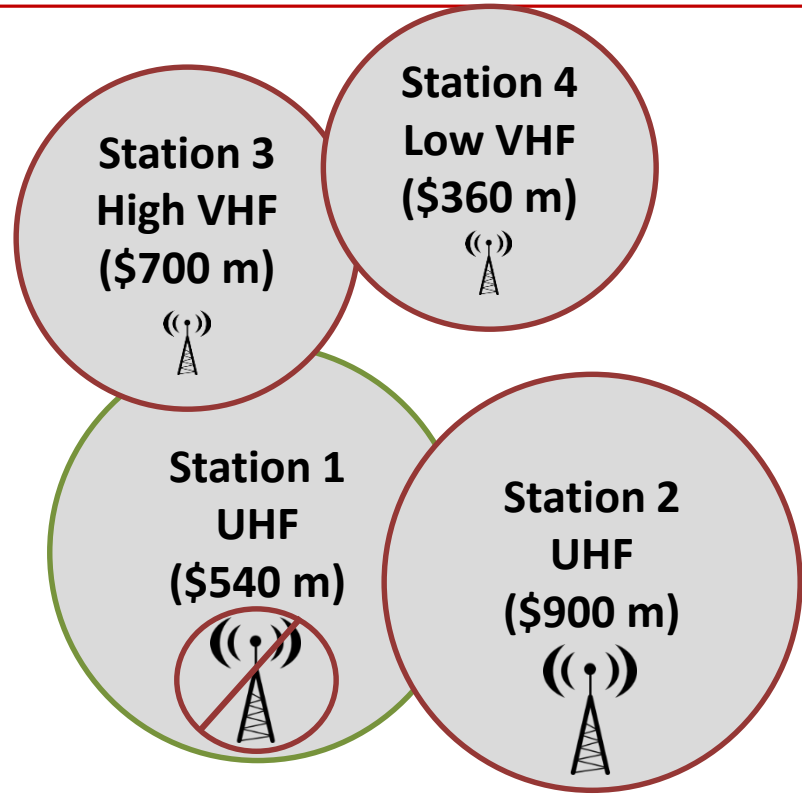
Simulated Auction

- **New Wheeler, USA**
 - 4 existing stations
 - 1 available channel assignment in each band (UHF, High VHF, Low VHF)
- **Many ways to solve puzzle**



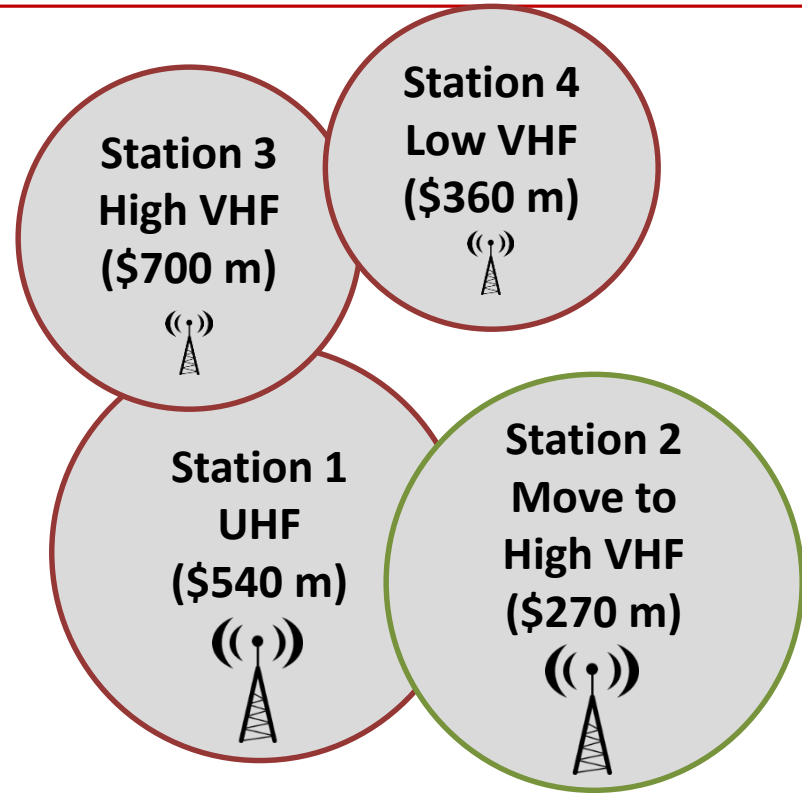
Simulated Auction

- **Option 1:**
 - Pay Station 1 to go off air
 - Repack remaining stations
 - Total cost: \$540 m



Simulated Auction

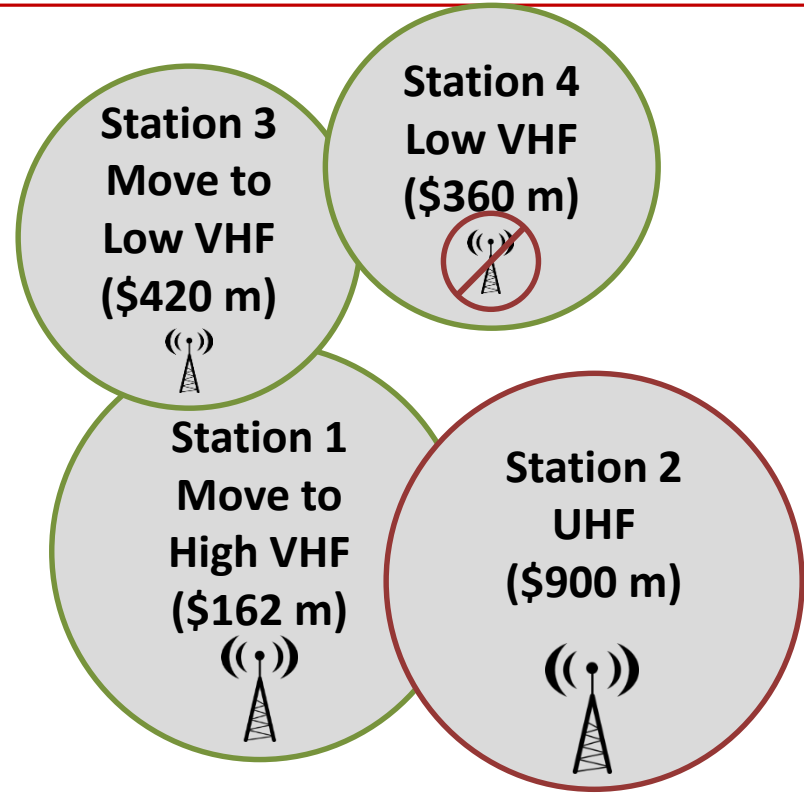
- **Option 2:**
 - Pay Station 2 to move to High VHF
 - Station 2 and Station 3 can be co-channel
 - No loss of TV service
 - Total cost: \$270 m



Simulated Auction

- **Option 3:**

- Pay Station 1 to move to High VHF
- Pay Station 3 to move to Low VHF
- Pay Station 4 to go off air
- Total cost: \$942 m



Calculating Excess Supply

Pre-Auction

TV Study

Define Pairwise
Relationships

Auction

SAT Solver

Determine
Intra-Round
Repacking
Feasibility

Post-Auction

Assignment
Optimization

Make Actual
Channel
Assignments

Calculating Excess Supply

- **Complex game** of musical chairs
 - If Station A is on Channel 20, can Station B be co-channel?
Upper adjacent? Lower adjacent?
- Essentially, a **large table**:

		A			B		
		Below	Same	Above	Below	Same	Above
A	Low VHF				Y	N	Y
	Mid VHF	-	-	-	Y	N	Y
	High VHF	-	-	-	Y	N	Y
	UHF	-	-	-	Y	Y	Y
B	Low VHF	Y	N	Y			
	Mid VHF	Y	N	Y	-	-	-
	High VHF	Y	N	Y	-	-	-
	UHF	Y	Y	Y	-	-	-

Calculating Excess Supply

- **Central Question:** Based on stations that dropped out of auction, can all remaining stations be repacked on at least one remaining channel?
 - **If Yes:** Proceed to subsequent round, drop prices, re-assess
 - **If No:** Stations with no “feasible” channel assignments must be “conditionally frozen” at most recent accepted price

How Much Money to Pay Broadcasters?

- Total forward (wireless) auction revenues



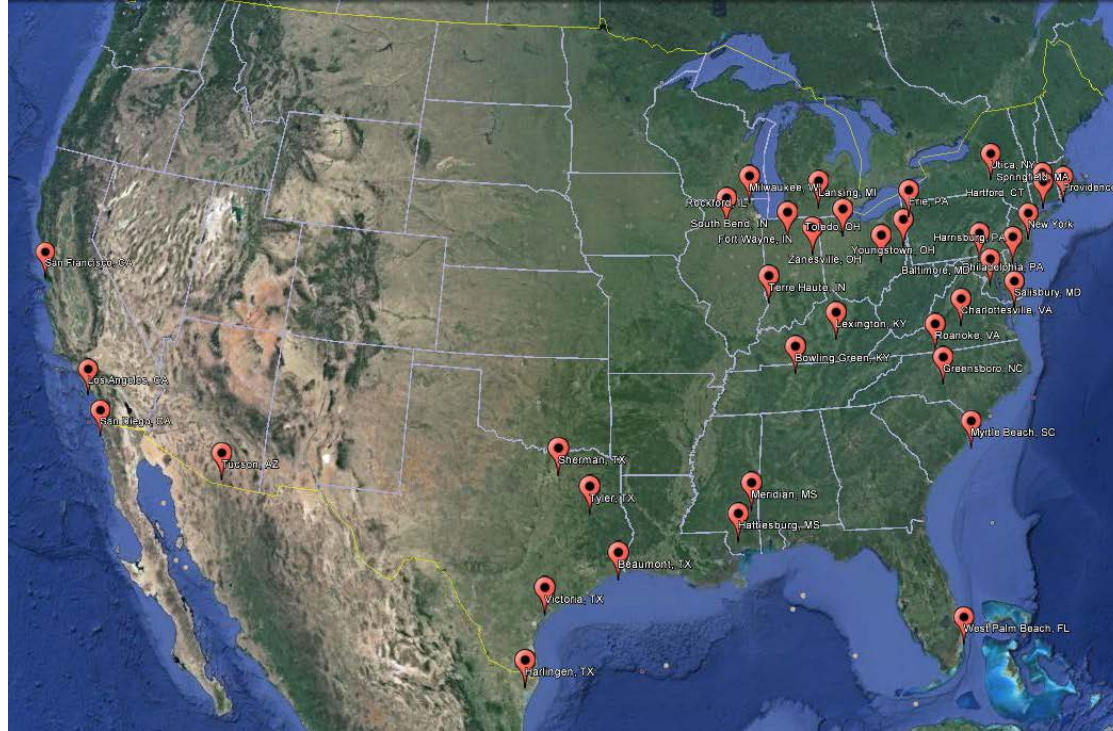
- Total payments to broadcasters to relinquish spectrum
- TV Broadcaster Relocation Fund (up to \$1.75 billion)
- FCC expenses (estimated at \$250 million)

- AWS-3 auction raised \$41 billion
 - Equates to more than \$60 billion for 600 MHz auction
 - Concerns: Dish bidding practices; availability of capital for Verizon/AT&T

Analysis of Markets

- Not only Top-10 or even Top-50 market issue
 - Clearing 84 MHz will result in 104 markets being targeted in the auction based on multiple simulations
 - Clearing 120 MHz will increase the targeted markets to 156

Analysis of Markets



Simulations indicate that there are 35 markets where more than half of the UHF TV stations will be needed for spectrum clearing

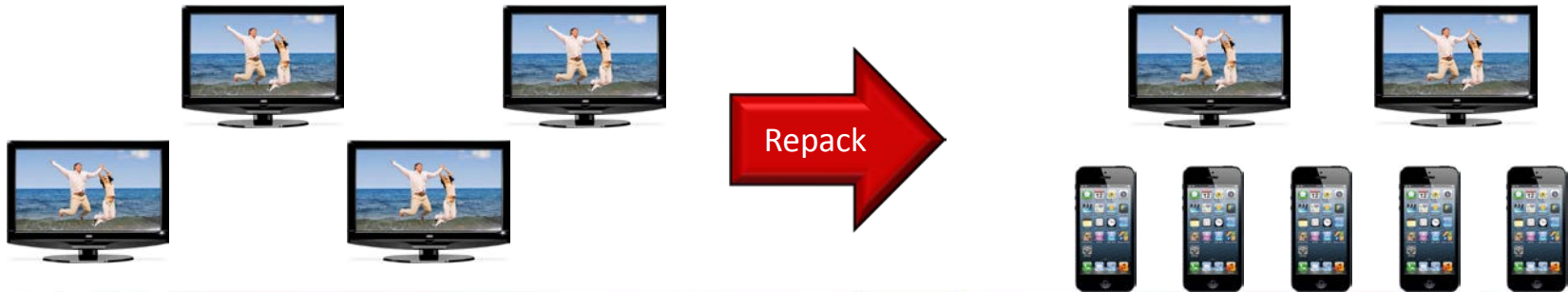
Television Spectrum Repacking

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.”



UHF Band Plan specified by FCC PN 14-191A1

- Nationwide clearing target
 - Minimum 84 MHz up to 126 MHz (Original 120MHz + CH37 = 126MHz)
- Guard bands between Wireless and TV services
 - Between 3 and 11 MHz depending on actual clearing
- Wireless duplex gap
 - Nationwide uniform position of 11 MHz gap required for mobile device interoperability
 - Partial duplex gap TV assignments may be made as *impaired spectrum*
- Channel 37 remains and protected by 3 Mhz guard bands....but not assigned for TV service

UHF Band Plan specified by FCC PN 14-191A1

2	144	21	22	23	24	25	26	7	A	B	C	D	E	F	G	H	I	J	3	37	3	K	L	11	A	B	C	D	E	F	G	H	I	J	K	L	700 MHz UL
1	138	21	22	23	24	25	26	27	11	A	B	C	D	E	F	G	H	3	37	3	I	J	K	11	A	B	C	D	E	F	G	H	I	J	K	700 MHz IJL	
10	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	
9	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	
8	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 IJL		
7	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 IJL		
5	78	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	7	A	B	C	D	E	F	11	A	B	C	D	E	F	700 MHz UL			
5	72	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	11	A	B	C	D	E	11	A	B	C	D	E	700 MHz UL				
1	60	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	9	A	B	C	D	11	A	B	C	D	700 MHz UL				
3	48	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	7	A	B	C	11	A	B	C	700 MHz UL				
2	42	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	11	A	B	11	A	B	700 MHz UL					

- Wireless spectrum channelized into 5 MHz pairs
- TV service remains 6 MHz channels
- Duplex gap between wireless uplink and downlink
- Guard band spectrum between services

WHITE – TV Channels

Gray – Guard bands

Blue – Wireless Channels

How Many Stations Directly Impacted?

Spectrum Recovered MHz	Highest Remaining TV Channel	Stations Directly Impacted
84	36	543
108	32	729
114	31	770
126	29	860

- **Directly impacted** stations are those currently assigned to spectrum that is cleared for wireless services
 - Some might be participating in the auction while others will be forced to relocate
- **Indirectly impacted** stations are those in lower channels required to move to accommodate relocated stations

Spectrum Clearing Impact For 120 MHz

	LOW	High
Eligible UHF Stations	1675	1675
Stations Eliminated	415	443
Stations Remaining On Channel (No Optimization)	71	92
Stations Required to Repack (No Optimization)	1147	1184
Stations Remaining On Channel (Optimized)	400	167
Stations Required to Repack (Optimized)	860	1065

- Data based on FCC's more than 100 auction & repack simulations
- Optimization estimates range from 10% to 25%

Spectrum Clearing Impact For 84 MHz

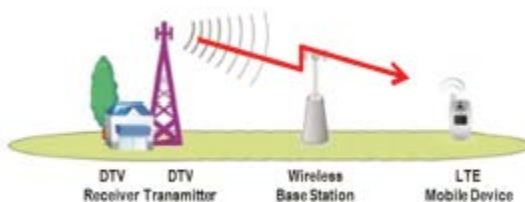
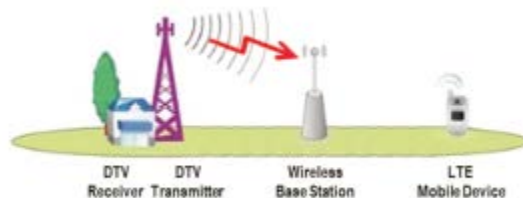
	LOW	High
Eligible UHF Stations	1675	1675
Stations Eliminated	222	249
Stations Remaining On Channel (No Optimization)	92	132
Stations Required to Repack (No Optimization)	1361	1294
Stations Remaining On Channel (Optimized)	433	262
Stations Required to Repack (Optimized)	1020	1164

- Data based on FCC's more than 100 auction & repack simulations
- Optimization estimates range from 10% to 25%

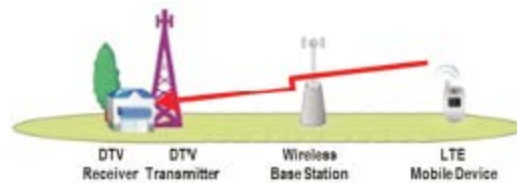
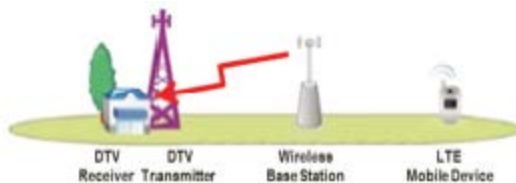
Impaired Spectrum

- **Impaired Spectrum** is primarily assigned to wireless services but regionally assigned to TV broadcast
 - Risk of inter-service interference (ISIX)

DTV to Wireless



Wireless to DTV



Impaired Spectrum

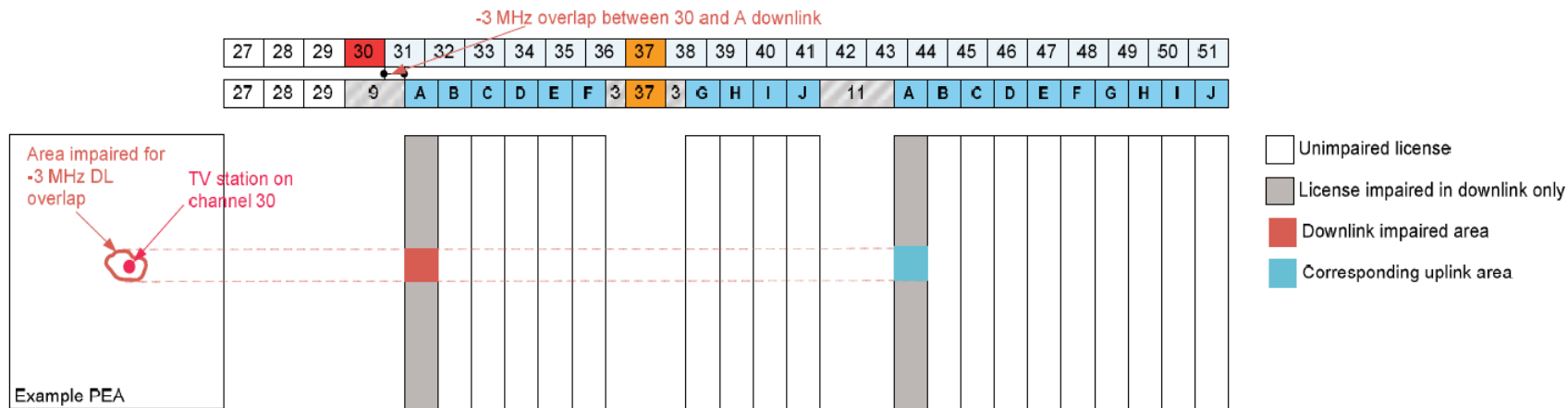


Figure 4: Impairments from a TV station on Channel 30 in 126 MHz Band Plan

Impaired Spectrum

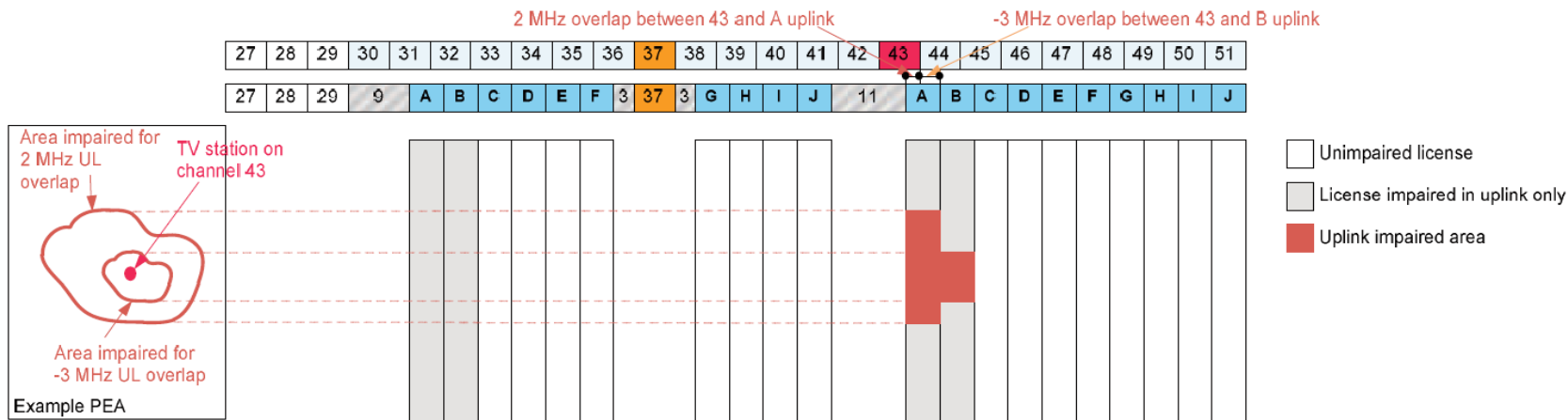


Figure 3: Impairments from a TV station on Channel 43 in 126 MHz Band Plan⁸⁹

Will Stations Not Changing Channels Be Impacted?

- **Possibly if stations....**

- Share a Tower
- Have stacked antennas
- Operate on a shared antenna and transmission line

...with a station that is forced to change channel

- **Additional issues**

- Who will pay the cost for accommodating these stations?
- Potential increased interference from neighboring stations (0.5% of population per other station)



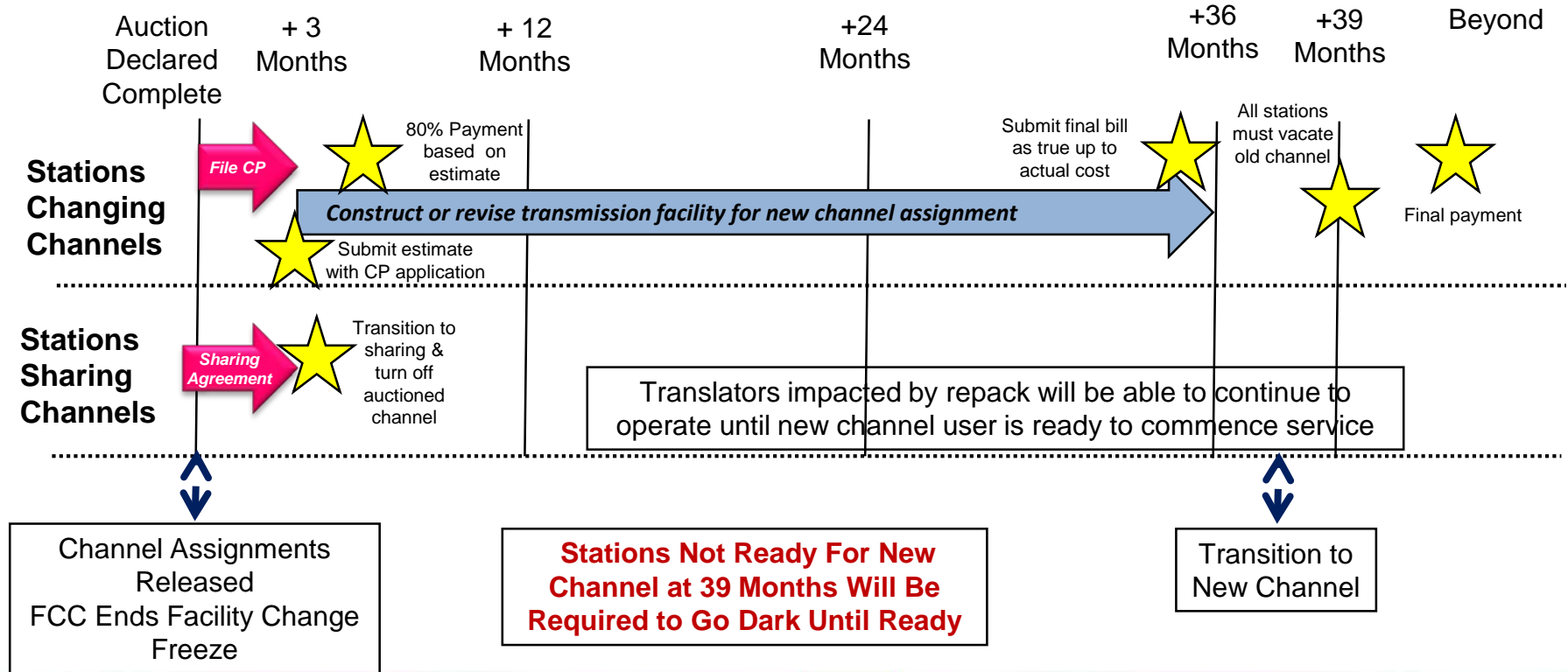
Staying On Air During Repack

- Your station may need:
 - Temporary antenna system
 - Replacement or second transmitter
- Temporarily channel share with another station
- **Note: FCC has not ruled out interim channel assignments**

Considering Moving From UHF to VHF?

- How important are future **Mobile** services to your stations business plan?
 - ATSC 3.0 opens new opportunities but VHF has inherent limitations for mobile delivery
- Is **In-Home reception** without outdoor antennas important?
 - UHF penetration is superior to VHF
- How will future VHF noise floor growth impact VHF reception?

Repack Timeline



Timeline - The Rest of the Story

- Report & Order states the FCC will determine individual timetables for each station
 - Timeline will be determined by the FCC's opinion on how complex the transition process will be for each station
 - No apparent consideration for supplier deliveries, resources such as tower crews, local permitting, weather or other un-controllable factors
 - FCC indicates that one extension might be granted for due cause.

Widely Report

- FCC commissioned Widely to develop comprehensive list of reimbursable items , establish reasonable costs for items, review proposed repack time and determine if compensation fund is sufficient.
- Some items and cost estimates on target
 - Transmitter technology moves from IOT to SS with cost impact
- No compensation for business interruption
- 39 month repack window could be an issue

Paying for Repack

- Congress set aside \$1.75 B to reimburse...
 - Stations forced to change channels
 - **NOTE:** Stations moving voluntarily must pay for their move costs out of auction proceeds.
 - Multi-channel video providers who use OTA broadcast signals as source
 - **But... What about those stations indirectly impacted?**

Proposed Reimbursement Items

- Engineering study
- Transmitter(s)
- Transmitter installation
- Channel mask filter
- Antenna
- Tower rigging
- Permits
- Building modifications
- Electrical service modifications
- Tower loading study
- Proof of performance testing
- Coverage verification
- Transmission line
- Channel combiners at common sites
- Constructing a new tower if needed
- Legal services for filing
- Clean up and removal of old equipment
- Leasing temporary antenna and transmission line

NOTE: Widelity's Dec. 2013 report provides greater detail and estimates

Repack Issues

- Time line...Is 39 months adequate for the number of stations forced to repack? *
- Reimbursement Fund...Is the fund sufficient for the number of stations? *
- Stations unable to start planning process due to reimbursement policy

*Driven by the uniform clearing of spectrum resulting in increased number of stations forced to repack

How To Prepare For Repack

- Start early... be ready by auction end*
 - Determine tower compliance and added loading capacity
 - Sweep transmission line to determine what channels it will not support
 - Prepare initial estimates of cost for transmitter, RF system, antenna and other related costs
 - Develop list of resources, suppliers, estimated time line and implementation plan
 - Line up commitments with suppliers and contractors such as tower crews

*FCC will require accurate estimate of costs to be filed with CP Application within 3 months after auction end

A Typical DTV Transmission Plant

- Basic transmission system blocks:

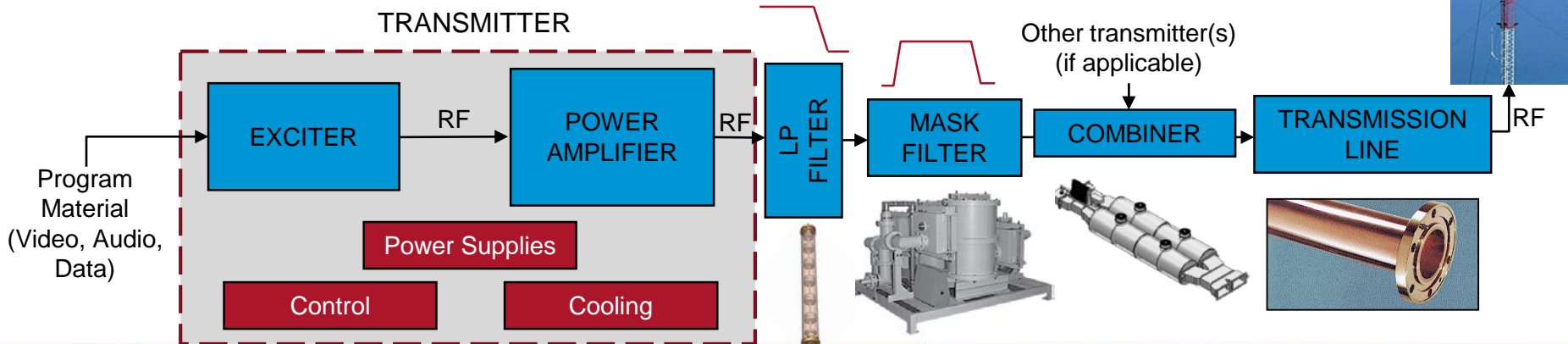
- Transmitter, comprising:

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

- External RF Items:

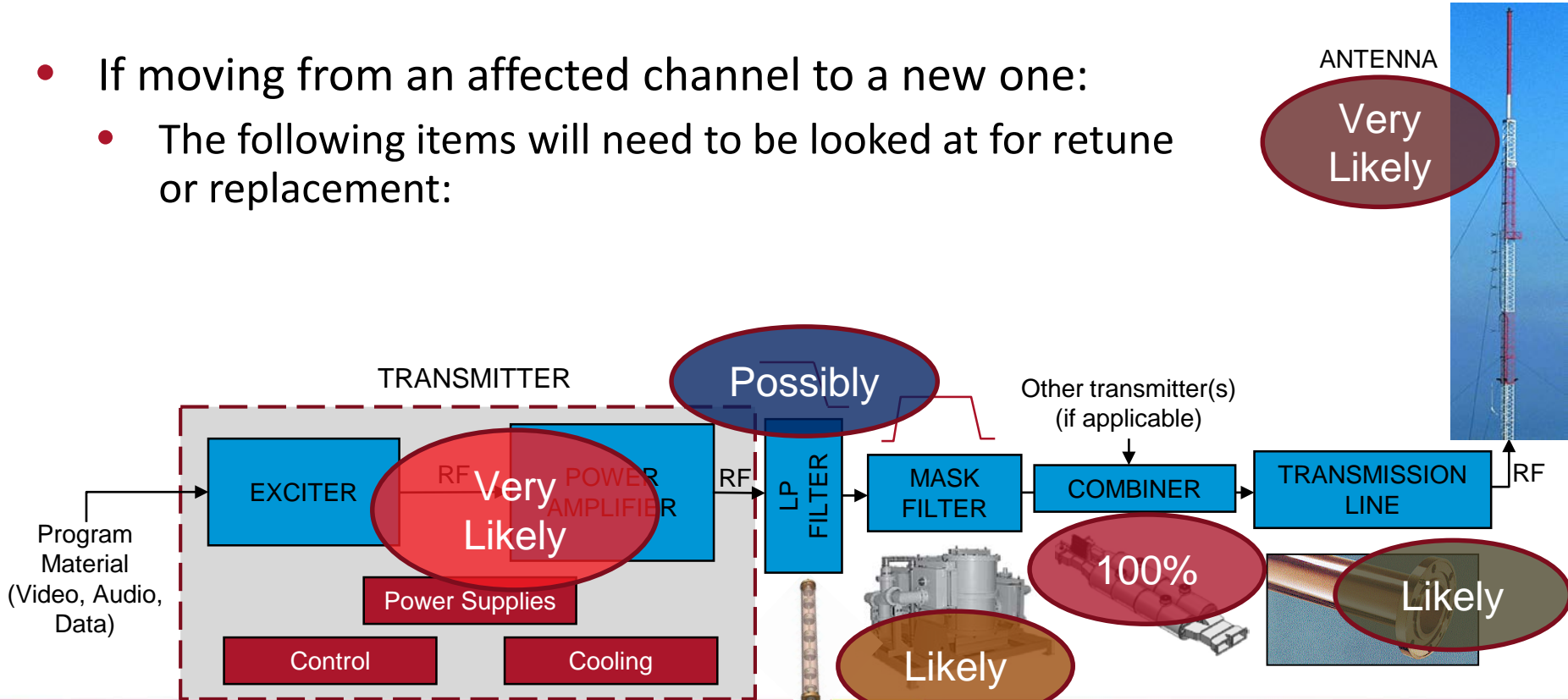
- Mask Filter
- RF Combiner
- Transmission line
- Antenna

ANTENNA

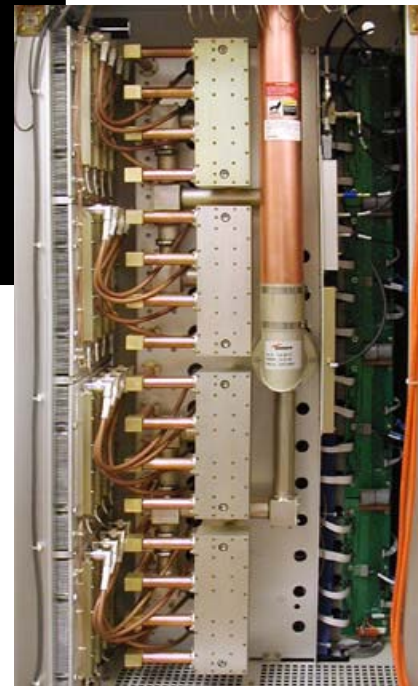
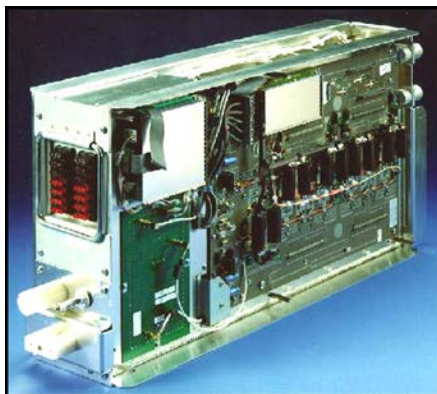
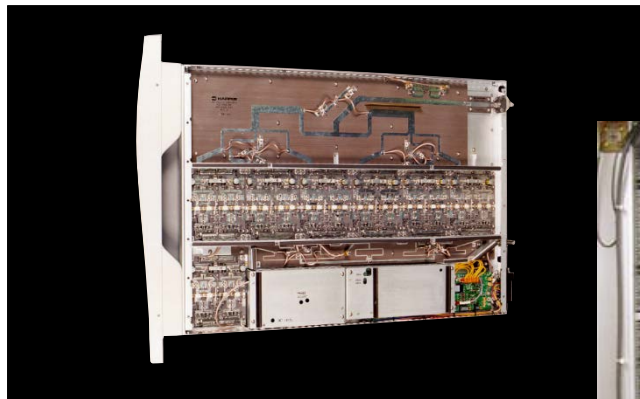


What's Impacted by Repack?

- If moving from an affected channel to a new one:
 - The following items will need to be looked at for retune or replacement:



Examples of Banded Tx Parts...



Example of PA & Circulator Bands

PA Module Channels

14 - 26

27 - 41

42 - 58

59 – 69 (no longer used)

Circulator Channels

14 - 21

22 - 34

35 - 52

53 – 69 (No longer used)

PA Modules	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
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Circulators	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
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Low Pass Filter



- Low Pass Filter Bands:
 - 470-596 MHz (Ch 14-34)
 - 596-704 MHz (Ch 35-52)
 - 736-860 MHz (Ch 52 and up)

High Power RF Output Systems

- Waveguide bands
- WR1800, WR1500, WR1150
- Mask Filter Cavities per Channel
- In general, a new RF system will be needed



Channel Compatibility of Transmission Line

Transmission Line
Section Lengths

	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
20			■	■			■	■				■	■			■	■		
19 ¾	■				■	■			■	■			■	■				■	■
19 ½	■	■			■	■				■	■			■	■			■	■

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
20	■	■			■	■			■	■			■	■			■	■	
19 ¾		■	■			■	■			■	■			■	■			■	■
19 ½			■	■			■	■				■	■			■	■		



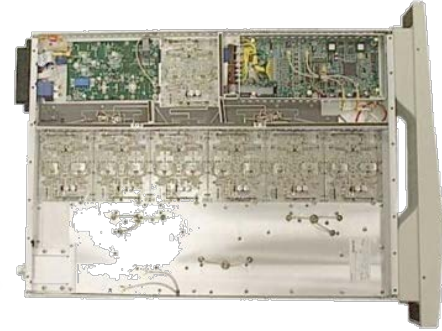
Prohibited Channel per catalog

Is Transmitter Replacement Necessary?

- You are moving how many channels from the current assignment?
 - Tube Technology Transmitters
 - Solid State Transmitters
- What about efficiency and power costs?
- How about staying “On Air” during repack

Transmitter Replacement is Likely

- Most transmitters are ~10 - 20 years old
- Current UHF transmitters designed around three band segments
- May require new amplifier pallets, combiners or driver modules - adequate device availability unlikely



Channel Change Cost vs. Replacement

- Carefully evaluate the cost of conversion versus replacement
- In many cases, a good argument for tx replacement can be made:
 - Much higher efficiency
 - Save on Electricity costs (over 50% in some cases)
 - Broadband
 - Spares consolidation
 - Serviceability – ease of maintenance
 - Save on service costs
 - Long-term support
 - Tube prices and availability
 - Safety (low Voltage vs. High)

Cost Estimate Checklist:

Tx upgrade in-band
or - Tx upgrade out-of-band
or - New Transmitter

RF System Components (Mask Filter, etc.)

Antenna

+ Antenna change-out cost

RF Line

+ RF Line change-out cost

Tower Study & modifications (if needed)

Key Takeaways

- **All** stations are possible repack candidates
- Even **stations not required to change channels** can be **impacted**
- Staying **ON AIR** during repack will **most likely require additional facilities**
- **Converting from UHF to VHF will impose future limitations** on the station's coverage and ability to deliver mobile service
- **Channel sharing will limit future** ability to deliver mobile, multichannel, and UHDTV services

Key Takeaways

- If you are interested in **channel sharing**, find your partner and start negotiating *immediately*
 - Deal must be signed before auction starts (under current rules, subject to reconsideration)
 - Must address community-of-license issues
- If you are interested in participating in the auction, pay close attention to the “**anti-collusion rule**”
 - Strictly bars communications among *any* broadcasters in *any* market about bidding targets and bidding strategies

Q & A