TV Spectrum Repack Update

April 19, 2016

NAB Show 2016

Featuring GatesAir's

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TV Spectrum Repack Update

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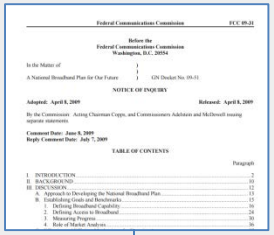
Presentation Agenda

- Spectrum Auction & Repack Timeline
- Repack Rules & Regulations
- Television Spectrum Repack Impact, Process & Challenges
- Q&A

Spectrum Auction & Repack Timeline

An Auction Six Years In the Making


Federal Communications Commission FCC 09-31

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)
)
A National Broadband Plan for Our Future) GN Docket No. 09-51

NOTICE OF INQUIRY

Adopted: April 8, 2009 Released: April 8, 2009

By the Commission: Acting Chairman Copps, and Commissioners Adelstein and McDowell issuing separate statements

Comment Date: June 8, 2009
Reply Comment Date: July 7, 2009

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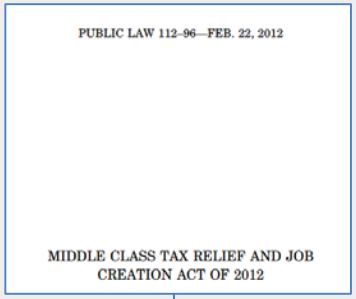
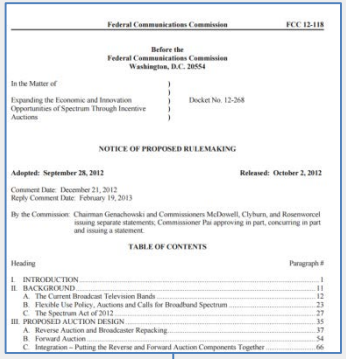
CONNECTING AMERICA:
THE NATIONAL BROADBAND PLAN


PUBLIC LAW 112–96—FEB. 22, 2012

MIDDLE CLASS TAX RELIEF AND JOB CREATION ACT OF 2012


Federal Communications Commission FCC 12-118

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)
)
Expanding the Economic and Innovation) Docket No. 12-268
Opportunities of Spectrum Through Incentive)
Auctions)

NOTICE OF PROPOSED RULEMAKING

Adopted: September 28, 2012 Released: October 2, 2012

Comment Date: December 21, 2012
Reply Comment Date: February 19, 2013

By the Commission: Chairman Genachowski and Commissioners McDowell, Clyburn, and Rosenworcel issuing separate statements; Commissioner Pai approving in part, concurring in part and issuing a statement.

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Federal Communications Commission FCC 14-50

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)
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Expanding the Economic and Innovation) GN Docket No. 12-268
Opportunities of Spectrum Through Incentive)
Auctions)

REPORT AND ORDER

Adopted: May 15, 2014 Released: June 2, 2014

By the Commission:

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Apr. 2009

Mar. 2010

Feb. 2012

Oct. 2012

June 2014

Incentive Auction Timeline

Event	Current Estimate
Reverse Auction Initial Commitment Deadline	March 29, 2016
FCC Announces Initial Clearing Target	Late April 2016
FCC Sends Confidential Letters to Applicants	April/May 2016
FCC Holds Mock Auction(s)	May 2016
Reverse Auction Clock Rounds Begin	May 2016
Reverse Auction Clock Rounds End	June/July 2016
Forward Auction Begins	June/July 2016

Will the Auction Close in One Stage?

Final Stage Rule

- Part 1:

Clearing target ≤ 70 MHz	Avg. $1.25 MHz-pop for category 1 blocks in 40 largest PEAs
Clearing target > 70 MHz	$1.25 MHz-pop * 70 MHz * total category 1 pops in 40 largest PEAs

- Part 2: Forward auction revenues exceed costs (reverse auction + repacking + FCC costs)

Why Stages Are Important

If auction closes in one stage:

Event	Current Estimate
Incentive Auction Ends / FCC Releases Reassignment PN	September 2016

If not:

Event	Current Estimate
Stage 2 Begins	September 2016
Incentive Auction Ends / FCC Releases Reassignment PN	???

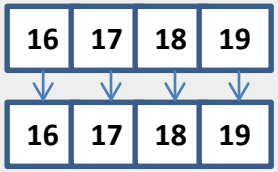
Repack Rules & Regulations

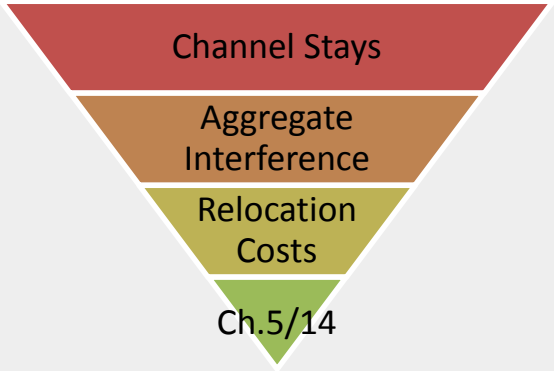
“There are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns – the ones we don't know we don't know. ”

- Former Defense Secretary Donald Rumsfeld

What's Next - Reassignment Public Notice

- Between Rounds = Feasibility
- After Auction = Optimization
  - Priority 1: Maximize Number of Channel Stays





  - Priority 2: Minimize New Aggregate Interference Experienced By Any Station
  - Priority 3: Avoid Reassignment of Stations with High Relocation Costs
  - Priority 4: Prioritize Assignments to Channel 5 in Low VHF and Off Channel 14 in UHF
- Must achieve 95% optimization at each subsequent level
- **No** optimization for stations assigned to 600 MHz band

What's Next – Auction Winners

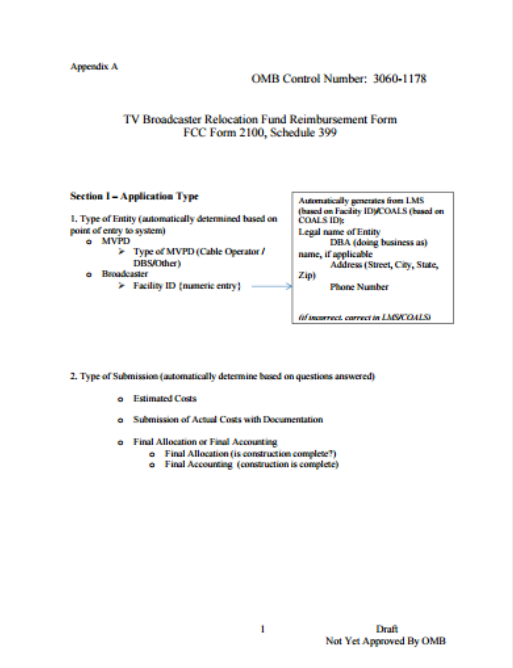
Event	
FCC Delivers Auction Proceeds	Rolling basis after forward auction licenses issued (~ 2-3 months after auction)
"Go Off-Air" Stations Must Cease Broadcasting	3 months after proceeds received*
Channel Sharing Stations Must File CPs	4 months after proceeds received*
Channel Sharing Stations Must Implement Sharing	6 months after proceeds received*

What's Next – Stations On the Move

Event	
File CP for Modified Facility	3 months after reassignment PN
Post-Auction Filing Windows (channel changes or expanded facilities) • Window 1: Stations unable to meet technical parameters in reassignment PN • Window 2: All other stations assigned to new channels	After staff processes initial applications
Construction Deadline	***Up to*** 39 mos. after reassignment PN

Reimbursement Procedure

- **Estimate of Reimbursement Costs**
  - Must be submitted via LMS within three months of Reassignment PN
  - Specific cost items:
    - Transmitter
    - Antenna
    - Transmission Line
    - Tower Equipment and Rigging
    - Outside Professional Costs
    - Other Expenses
  - For costs outside catalog, must submit supporting evidence and certify estimate made in good faith



Appendix A

OMB Control Number: 3060-1178

TV Broadcaster Relocation Fund Reimbursement Form
FCC Form 2100, Schedule 399

Section I – Application Type

1. Type of Entity (automatically determined based on point of entry to system)
   - MVPD
     - Type of MVPD (Cable Operator / DBS/Other)
   - Broadcaster
     - Facility ID {numeric entry}

Automatically generates from LMS (based on Facility ID)/COALS (based on COALS ID):
Legal name of Entity
DBA (doing business as) name, if applicable
Address (Street, City, State, Zip)
Phone Number
(if incorrect, correct in LMS/COALS)

2. Type of Submission (automatically determine based on questions answered)
   - Estimated Costs
   - Submission of Actual Costs with Documentation
   - Final Allocation or Final Accounting
     - Final Allocation (is construction complete?)
     - Final Accounting (construction is complete)

1 Draft
Not Yet Approved By OMB

Reimbursement Procedure

- **Initial Allocation**
  - Deposited to individual treasury accounts
  - Commercial stations: up to 80% of estimated costs
  - Noncommercial stations: up to 90% of estimated costs
- **Progress Reports**
- **True-Up**
  - Broadcasters must submit documentation of actual expenses and estimated remaining expenses
  - FCC will distribute additional funds or reclaim remaining funds, as appropriate

Open Issues for Full Power/Class A Stations

- **How to Repack Broadcasters Within 39 Months**
  - Case-by-case exceptions for 39 months deadline?
  - Regional repack?
  - Pallone “Viewer Protection” bill would authorize Media Bureau to extend deadline so no station forced to stop broadcasting
- **Whether $1.75 Billion Will Cover Reimbursement Expenses**
  - Pallone bill would create $1 billion reserve
- **How to Account for Loss of Translators**

What's Next – LPTV/TV Translators

Event	
Limited Displacement Window • Priority for displacement DRTs • Last resort auction	After full power and Class A application windows
600 MHz Licensee Intent to Commence Operations	Notice at least 120 days in advance
LPTV/Translators Must Cease Operations or Reduce Power to Avoid Interference	Date specified in notice
LPTV/Translators Must Cease Operations in Guard Bands	39 months after reassignment PN

Open Issues for LPTV/TV Translator Stations

- **How Many "Vacant Channels" Will be Unavailable for Displacement?**
  - FCC Proposal: reserve one vacant channel for unlicensed use in all areas; two channels where a broadcast channel has been assigned to duplex gap
  - NAB vs. Google
- **How Long Will it Take for Wireless Operators to "Commence Operations"?**
  - FCC: Commencement occurs when "site commission testing" begins using "permanent base station equipment"
  - What effect will full power transition schedule have on commencement date?
- **Can the LPTVs win in court (and what happens if they do)?**

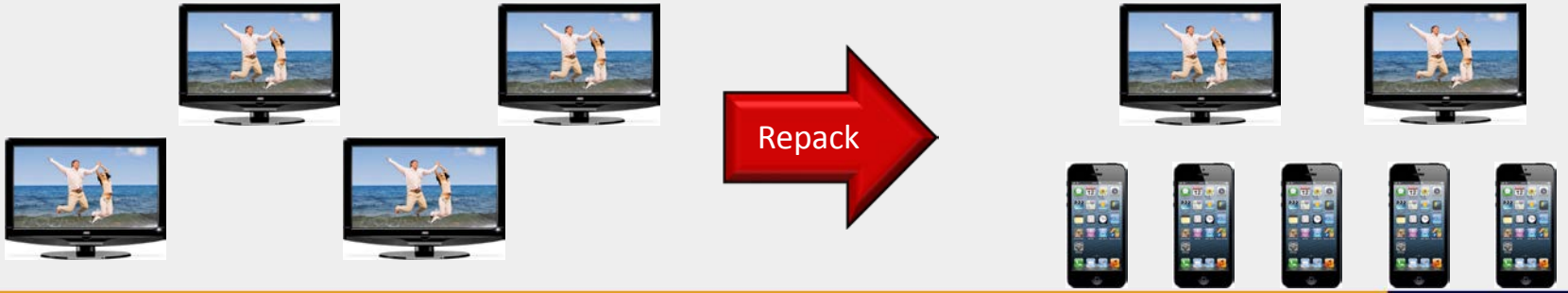
Television Spectrum Repack Impact, Process & Challenges

What is TV Spectrum “Repack”?

- FCC’s Definition of “Repacking”

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

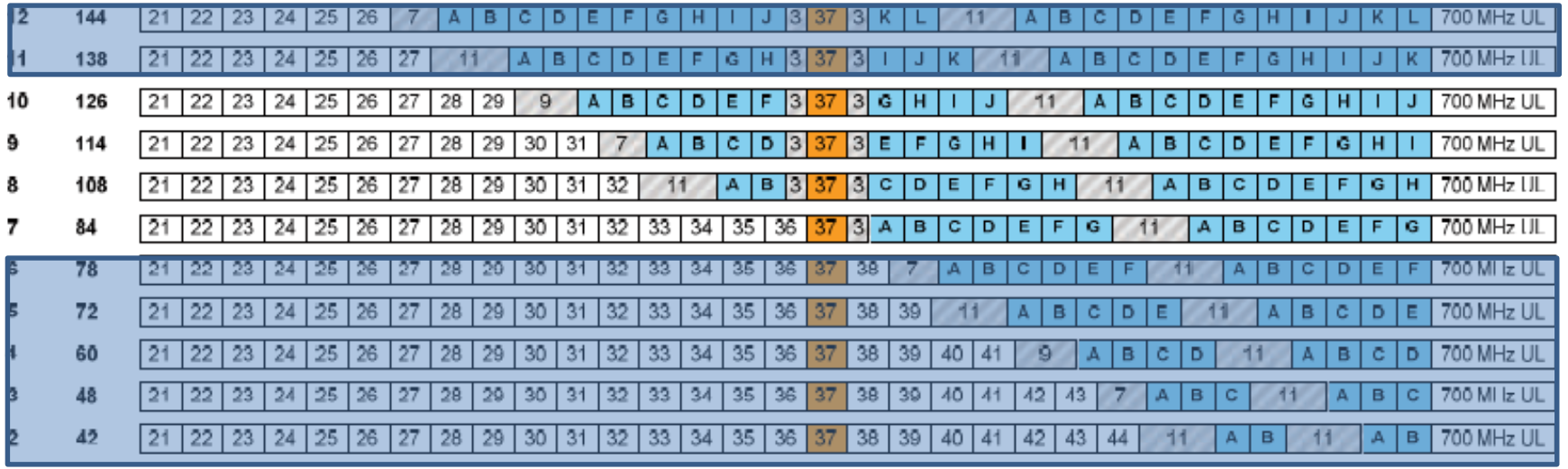
“Repacking involves reorganizing television stations in the broadcast television bands so that stations that remain on the air after the incentive auction occupy a smaller portion of the UHF band, thereby freeing up a portion of that band for new wireless services uses.”



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



- 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	Full Power Stations	Class A Stations	Total Stations Directly Impacted*
84	36	593	144	737
108	32	656	162	818
114	31	695	164	859
126	29	922	211	1133

Directly impacted stations are those currently assigned to spectrum that is to be cleared for wireless services

*Some will be participating in the auction thus reducing the number of directly impacted stations

Spectrum Clearing Impact For 126 MHz

Estimated Range

	LOW	High
Eligible UHF Stations	**1706**	**1706**
Stations Eliminated to Clear Spectrum	415	443
Stations Remaining On Channel	400	167
Stations Required to Repack	860	1065

- Estimated ranges based on DTC Study

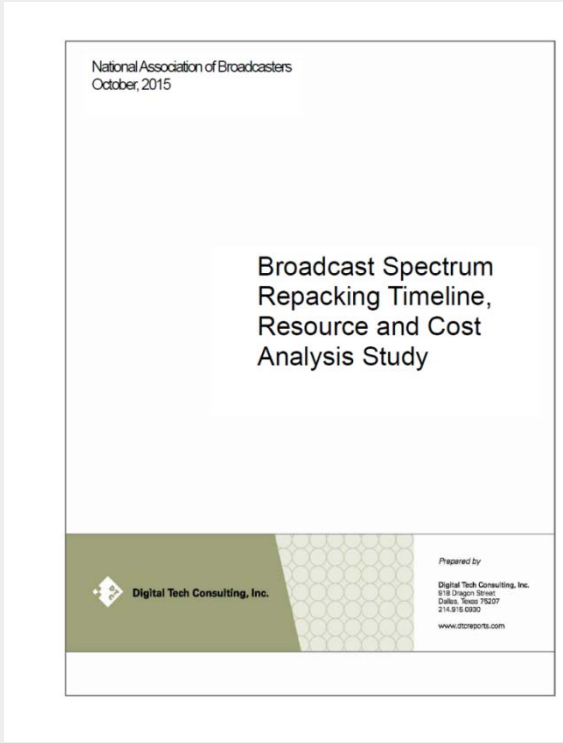
Spectrum Clearing Impact For 84 MHz

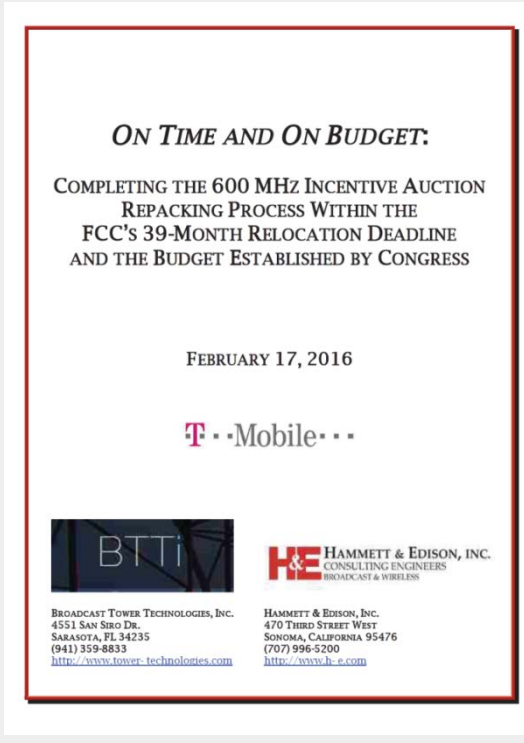
Estimated Range

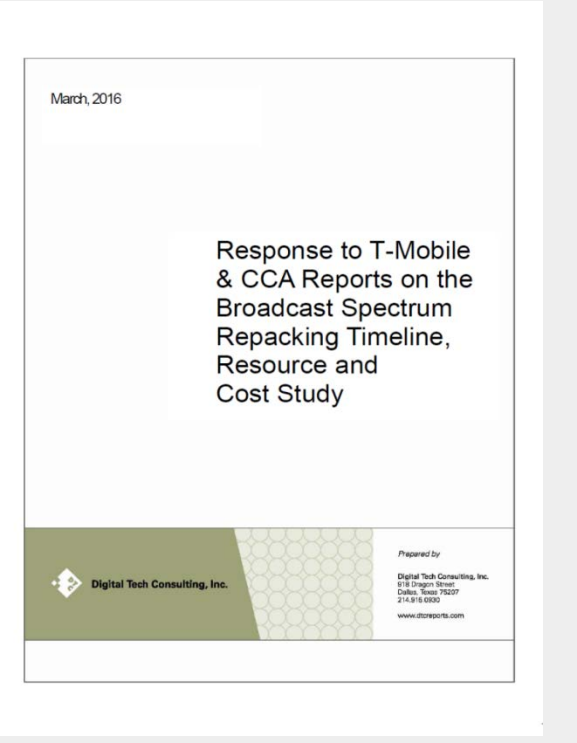
	LOW	High
Eligible UHF Stations	**1706**	**1706**
Stations Eliminated to Clear Spectrum	222	249
Stations Remaining On Channel	433	262
Stations Required to Repack	1020	1164

- Estimated ranges based on DTC Study

Repack Studies







Flaws in T Mobile Repack Report

- Failed to consider all steps in the repack process when analyzing the time required to implement
- Made an incorrect assumption that all panel antennas are broadband and capable of operating in remaining spectrum
  - 76 incorrectly identified antennas within clearing target
- Substantially over estimated the number of qualified, equipped and experienced tower crews capable of TV broadcast antenna projects
  - Lack of understanding of typical FP antenna weight and size

Flaws in T Mobile Repack Report

- Overstated available TV RF consultant resources
- Misrepresented the antenna manufacturing resources utilized by the majority of full power TV stations and their ability to ramp up production
- Makes no allowance for the large number of temporary antennas that will be needed to support the interim operations during the transition
- Assumes that the over optimistic Cramton analysis of the number of stations likely to be repacked is the actual number

Flaws in T Mobile Repack Report

- Assumes that many stations will move from individual slot array type antennas to shared broadband antennas
  - Yes, this will happen but it has many implications on tower structures, coverage, interference levels, the time needed to file applications and implement
- Lack of understanding on implementing major channel changes for IOT type transmitters
  - 723 of 1320 Full Power stations currently operate with this type of transmitter

Flaws in T Mobile Repack Report

- Failure to recognize resource utilization by stations moving from UHF to VHF
- Underestimated the total cost of repack based on a number of factors
  - Need for interim antennas and transmission line
  - Tower upgrades (Changes to antennas could change tower status)
  - Number of replacement transmitters needed
    - Main and standby
  - Number of main antennas to be replaced
  - Replacement of transmission lines
  - Optimistic number of stations to be repacked

How Likely Is Repack For My Station?

- UHF stations currently located within clearing target and not participating in the auction…..100%
- UHF stations participating in auction with election to move to VHF….100%*
- UHF stations currently located below clearing target and not participating in the auction…..> 20%
- VHF stations not participating in the auction…> 5%

* Assumes that bid was accepted

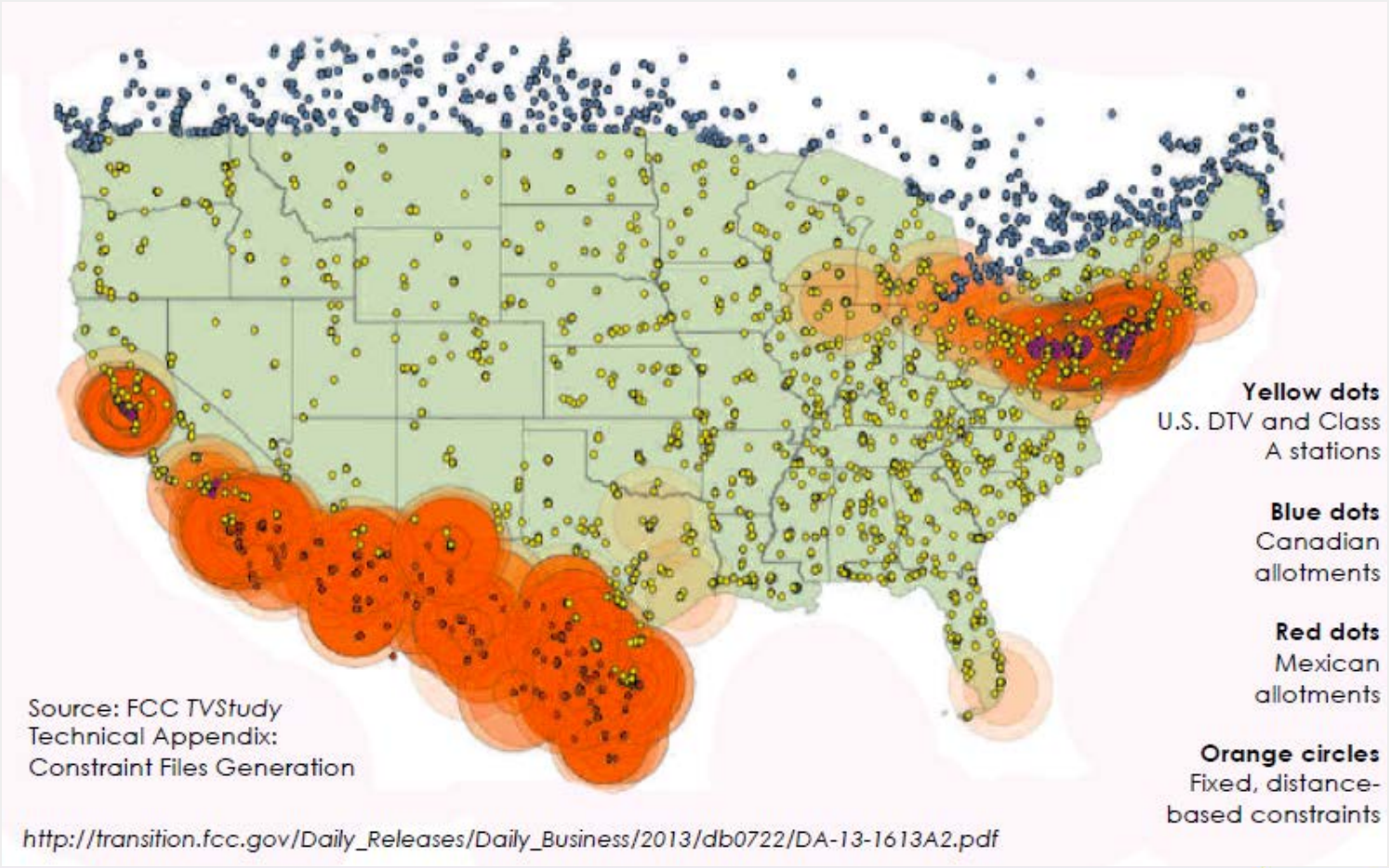
Will Stations Not Changing Channels Be Impacted?

- **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)**

Is Station Density an Issue?


Yellow dots
U.S. DTV and Class A stations
Blue dots
Canadian allotments
Red dots
Mexican allotments
Orange circles
Fixed, distance-based constraints
Source: FCC TVStudy Technical Appendix: Constraint Files Generation
http://transition.fcc.gov/Daily_Releases/Daily_Business/2013/db0722/DA-13-1613A2.pdf

A Regional Approach to Efficient Repacking

- Rather than a disorganized scramble, organize repacking by logical regions
  - Prioritize regions most needed by wireless carriers
  - Break interference “daisy chains”
  - Make efficient use of tower and equipment resources
  - Allow equipment orders to be staggered
  - Clear spectrum more quickly within a large region

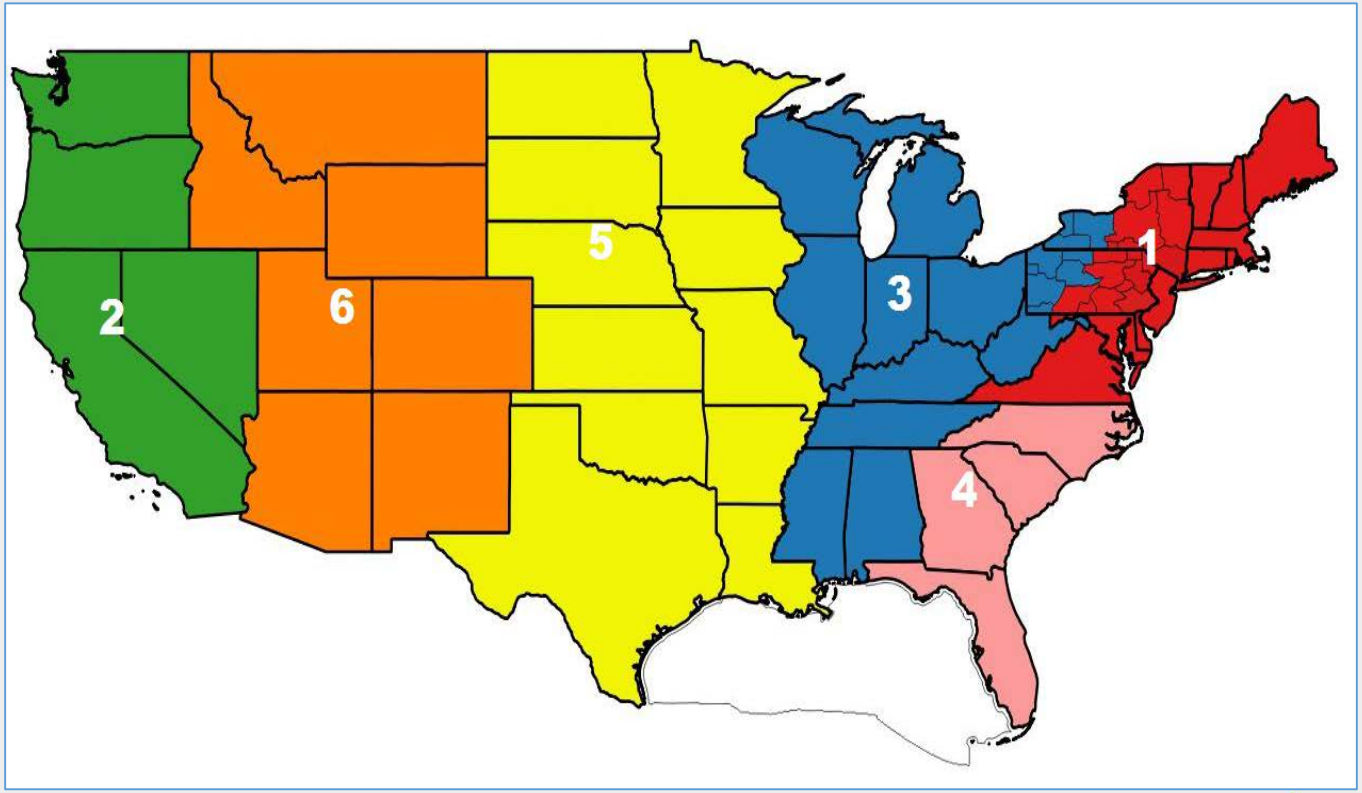
The Regions

- Regions should be large enough so that repacking and clearing meet needs of wireless carriers and facilitate efficiency
- Choose boundaries to avoid impacting major markets
- Geographic distribution of stations suggests some logical regional boundaries

The Regions

- Take advantage of terrain to limit inter-region interference
- Follow state boundaries where possible to facilitate resolution of local regulatory issues, such as zoning
- Where possible, regions are large enough to permit work during any time of year – i.e., work in the southern part of the region could take place in winter, work in northern portion in summer

An Example of Possible Regions



Organizing the Transition

- Stations receive channel assignments at the end of the auction – repacking commences as quickly as possible
- Stations in each region have staggered deadlines to submit CP applications

Region	CP Deadline (after channel assignments finalized)
1	3 months
2	6 months
3	9 months
4	12 months
5	15 months
6	18 months

Organizing the Transition

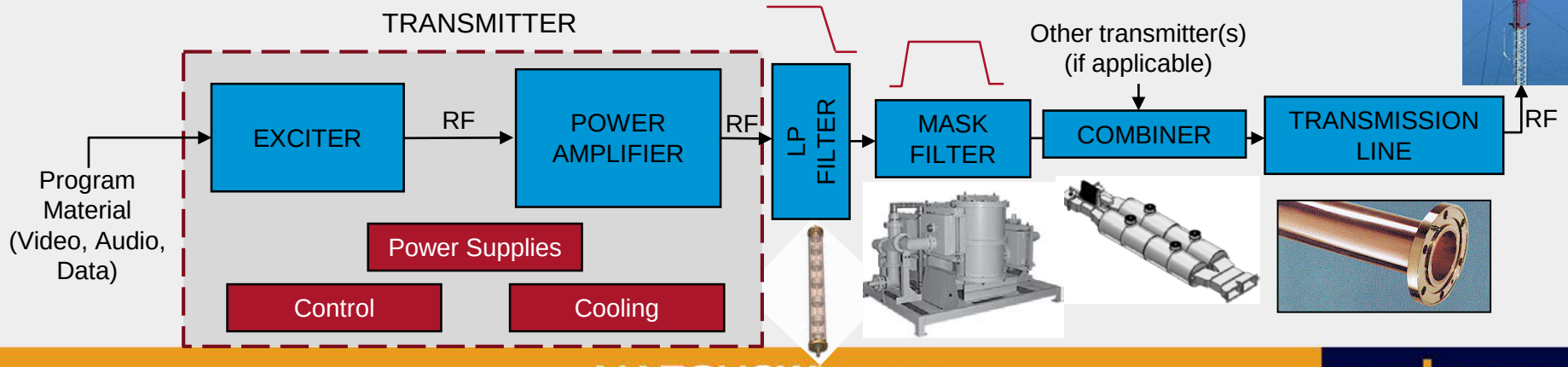
- CP processing schedule could allow regions to stagger equipment orders
  - Eliminate FCC backlogs
  - Minimize initial reimbursement delays
- Wireless carriers could be allowed to create some interference to DTV stations that have failed to timely relocate while those stations continue to operate in the 600 MHz band

The Transition

- A partial region is less useful for wireless deployment
  - Stations in a congested market cannot transition until all stations are ready to transition
  - Effects spill into adjacent markets as well
- Work could start in Northeast and West close to the same time, prioritizing clearing both regions

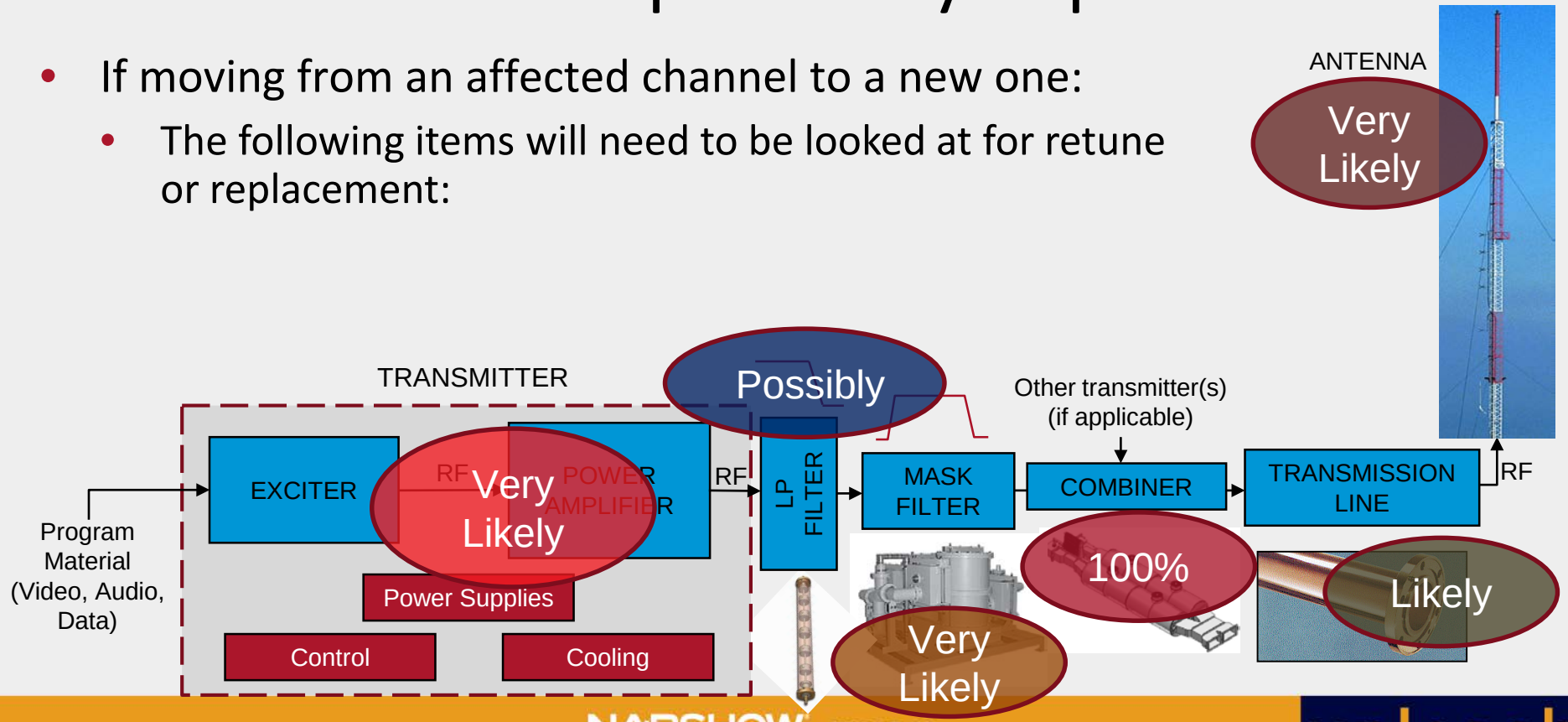
A Typical DTV Transmission Plant

- Basic transmission system blocks:
  - Transmitter, comprising:
    - Exciter
    - Amplifier
    - Power Supplies
    - Control
    - Cooling System
  - External RF Items:
    - Mask Filter
    - RF Combiner
    - Transmission line
    - Antenna



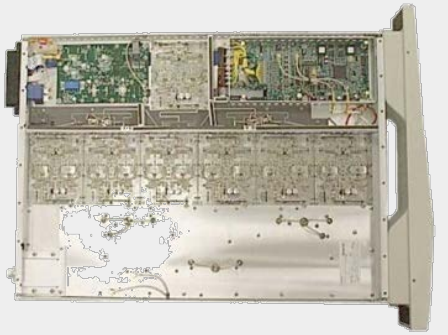
What's Impacted by Repack?

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



Transmitter Replacement is Likely

- Most transmitters are ~10 - 20 years old
- Older UHF transmitters designed around band segments
  - May require new amplifier pallets, combiners or driver modules - availability of obsolete devices unlikely



Example of PA & Circulator Bands

PA Module Channels

14 - 26

27 - 41

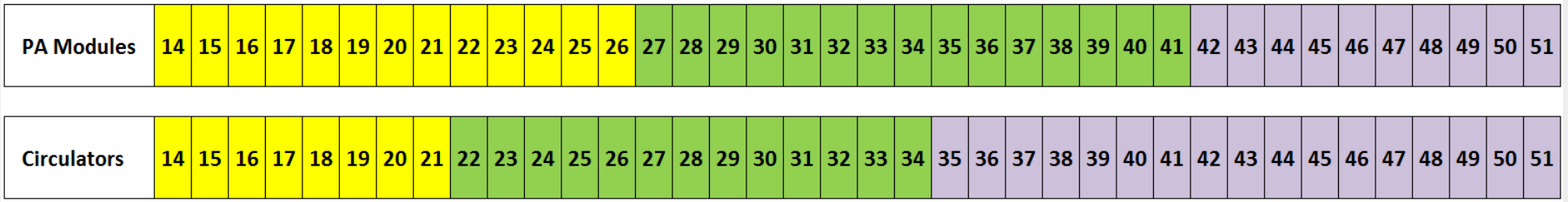
42 - 58

Circulator Channels

14 - 21

22 - 34

35 - 52



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
  - Serviceability – ease of maintenance
  - Long-term support
  - Tube prices and availability
  - Safety (low Voltage vs. High)
  - Future proof (ATSC 3.0 Ready)

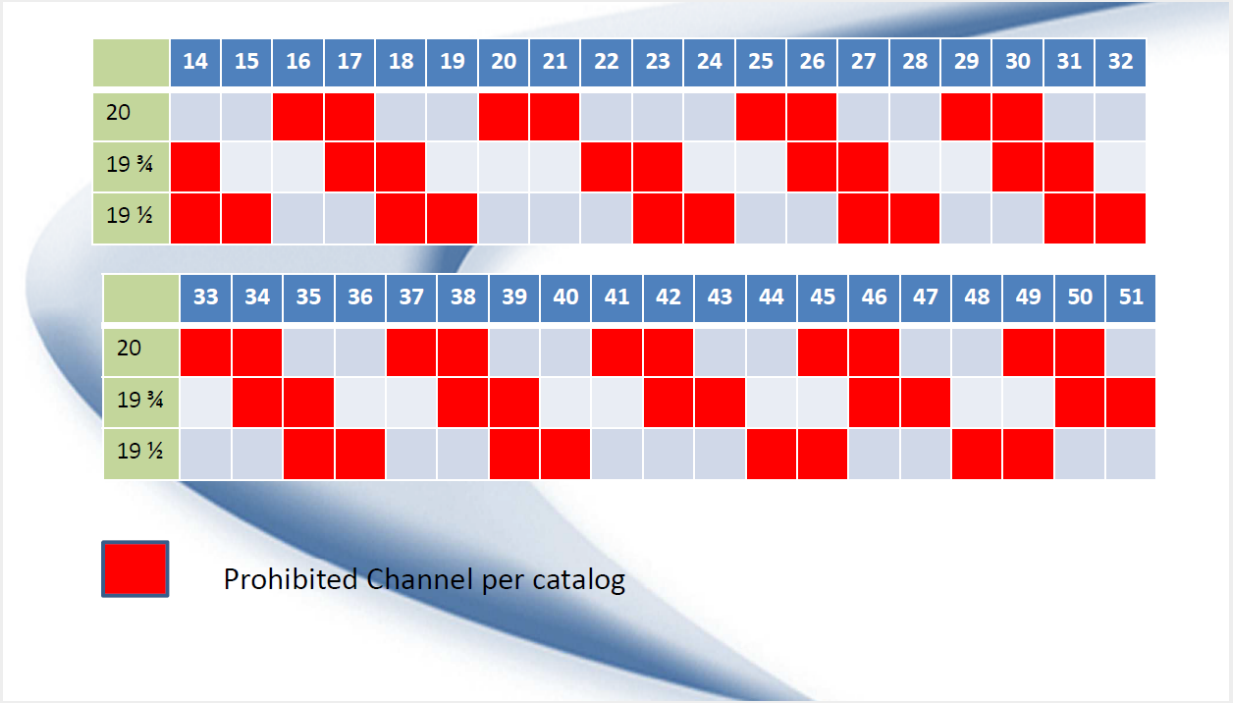
Cost Estimate Checklist:
Tx upgrade in-band
or - Tx upgrade out-of-band
or - New Transmitter
RF System Components (Mask Filter, etc.)
Antenna
+ Antenna change-out cost
RF Line
+ RF Line change-out cost
Tower Study & modifications (if needed)

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



Staying On Air During Repack

- Initial equipment and services requirements may be driven by factors such as the type of transition…ad hoc vs market or regional coordinated
- Your station will likely need a temporary antenna, transmission line and replacement or standby transmitter to maintain service while rebuilding the primary transmission system

Transition Scenario 1

1. Install temporary antenna and transmission line for existing channel or move to standby antenna if available
2. Transition current channel operations to temporary or standby antenna (Likely at reduced power and coverage)
3. Remove former main channel antenna and possibly transmission line
4. Install new main antenna and possibly transmission line
5. Install new transmitter and RF system
6. Commence operation at full power and coverage on new channel
7. Remove or retune old transmitter as standby

Transition Scenario 2

1. Install temporary antenna and transmission line for new channel
2. Install new transmitter or retune existing standby transmitter to new channel
3. Install new RF mask filter and RF system
4. Transition operations to new channel (Likely at reduced power and coverage)
5. Remove former main channel antenna and possibly transmission line
6. Install new main channel antenna and possibly transmission line
7. Commence operation at full power and coverage on new channel
8. Remove old transmitter if unable to retune as standby TX

Transition Scenario 3 (Shared Site)

1. Install temporary antenna and transmission line for current channel or rely on a backup antenna if available
2. Transition operations to temporary antenna orbackup antenna (Likely at reduced power and coverage)
3. Remove former main channel antenna(s) and transmission line(s)
4. Install new main multichannel antenna and transmission line
5. Install RF combining system for multiple stations
6. Install new transmitter, mask filter and RF system for each station
7. Switch all stations over to new channels
8. Remove old transmitter(s) or retune if possible as standby TX's

How To Prepare For Repack

- Conduct a facility review of the station's transmission plant and identify all items that might be affected by a channel change
- Update the transmission plant inventory
- Work with the transmitter manufacturer to determine if the transmitter is capable of being re-channelized; if possible, how long it might take and what is the cost?

How To Prepare For Repack

- Determine the current tower compliance, the capacity for added loading and the need for any tower structural modifications
- Sweep transmission line to determine what channels it will not support
- Determine what permits might be required for tower changes, building modifications, land use, etc.

How To Prepare For Repack

- Prepare initial estimates of cost for replacement transmitter, RF system, antenna, transmission line and other related costs as deemed necessary following the facility review*
- Develop list of resources and suppliers that will be needed during the repack

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

How To Prepare For Repack

- Line up commitments with suppliers and contractors such as RF consultants, tower crews, transmission equipment installers and other contractors that will be needed
- If transmission facility and tower is leased, begin discussions with owner
- If FM radio stations operate from the same tower, begin discussions on possible impact during construction

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 some additional equipment**
- The **time** allocated for **CP application and reimbursement filing** will **over burden industry resources**
- **Preparation** for repack should begin **ASAP**
- In some markets and perhaps regions, **cutover** will need to be **coordinated and carefully managed**

Chaos or Organized?

AT&T Urges strong, centralized, FCC leadership during post auction transition

Tuesday, March 15, 2016 | By Colin Gibbs

AT&T (NYSE: VZ) once again urged the FCC to lay the foundation for a smooth spectrum reorganization process following the upcoming incentive auction, saying that "strong, centralized FCC leadership on the transition will be essential."

The FCC later this month will begin a "reverse" auction that will eventually see it buy back unwanted airwaves from TV broadcasters. That spectrum will then be auctioned off later this year to companies looking to use it to launch mobile communications services.

But the spectrum will have to be "repacked" to make the licenses available to wireless network operators while TV broadcasters move to other channels. The FCC has proposed a 39-month timeline for repacking, although that schedule has come under fire by TV broadcasters who say it doesn't provide enough time.

AT&T didn't offer an opinion on the proposed timeline in its latest filing**, but it did cite the 800 MHz rebanding effort, which began in June of 2005 was expected to take 36 months but continues today.**

Strong Recommendation

- The FCC should quickly convene a repack summit with representation from all key stakeholders including broadcasters (NAB and APTS), major wireless spectrum bidders, vertical real estate owners (American Tower), primary equipment suppliers and service providers (NATE) & RF Consultants (AFCCE). The summit's goal should focus on developing a realistic transition plan and schedule that optimizes the access to the cleared spectrum in markets and regions where it is most needed while protecting the services provided by broadcasters to the American public.

Q & A