TV Spectrum Repack Update

April 19, 2016
NAB Show 2016

Featuring GatesAir's
Jay Adrick
Technology Advisor
TV Spectrum Repack Update

Jay Adrick - Technology Advisor
GatesAir

Ari Meltzer - Communications Attorney
Wiley Rein LLP
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

CONNECTING AMERICA: THE NATIONAL BROADBAND PLAN

PUBLIC LAW 112-96—FEB. 22, 2012

MIDDLE CLASS TAX RELIEF AND JOB CREATION ACT OF 2012

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MIDDLE CLASS TAX RELIEF AND JOB CREATION ACT OF 2012
# Incentive Auction Timeline

<table>
<thead>
<tr>
<th>Event</th>
<th>Current Estimate</th>
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<tbody>
<tr>
<td>Reverse Auction Initial Commitment Deadline</td>
<td>March 29, 2016</td>
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<tr>
<td>FCC Announces Initial Clearing Target</td>
<td>Late April 2016</td>
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<tr>
<td>FCC Sends Confidential Letters to Applicants</td>
<td>April/May 2016</td>
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<td>FCC Holds Mock Auction(s)</td>
<td>May 2016</td>
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<tr>
<td>Reverse Auction Clock Rounds Begin</td>
<td>May 2016</td>
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<tr>
<td>Reverse Auction Clock Rounds End</td>
<td>June/July 2016</td>
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<tr>
<td>Forward Auction Begins</td>
<td>June/July 2016</td>
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Will the Auction Close in One Stage?

Final Stage Rule

• Part 1:

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<th>Clearing target ≤ 70 MHz</th>
<th>Avg. $1.25 MHz-pop for category 1 blocks in 40 largest PEAs</th>
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<td>Clearing target &gt; 70 MHz</td>
<td>$1.25 MHz-pop * 70 MHz * total category 1 pops in 40 largest PEAs</td>
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• Part 2: Forward auction revenues exceed costs (reverse auction + repacking + FCC costs)
# Why Stages Are Important

If auction closes in one stage:

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<th>Current Estimate</th>
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<td>Incentive Auction Ends / FCC Releases Reassignment PN</td>
<td>September 2016</td>
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If not:

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<td>Stage 2 Begins</td>
<td>September 2016</td>
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<tr>
<td>Incentive Auction Ends / FCC Releases Reassignment PN</td>
<td>???</td>
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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

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<tr>
<th>Event</th>
<th>Event Date</th>
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<tr>
<td>FCC Delivers Auction Proceeds</td>
<td>Rolling basis after forward auction licenses issued (~ 2-3 months after auction)</td>
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<tr>
<td>“Go Off-Air” Stations Must Cease Broadcasting</td>
<td>3 months after proceeds received*</td>
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<td>Channel Sharing Stations Must File CPs</td>
<td>4 months after proceeds received*</td>
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<td>Channel Sharing Stations Must Implement Sharing</td>
<td>6 months after proceeds received*</td>
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## What’s Next – Stations On the Move

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

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<th>Event</th>
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<th>Event</th>
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</table>
| 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
# How Many Stations Directly Impacted?

<table>
<thead>
<tr>
<th>Spectrum Recovered MHz</th>
<th>Highest Remaining TV Channel</th>
<th>Full Power Stations</th>
<th>Class A Stations</th>
<th>Total Stations Directly Impacted*</th>
</tr>
</thead>
<tbody>
<tr>
<td>84</td>
<td>36</td>
<td>593</td>
<td>144</td>
<td>737</td>
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<tr>
<td>108</td>
<td>32</td>
<td>656</td>
<td>162</td>
<td>818</td>
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<td>114</td>
<td>31</td>
<td>695</td>
<td>164</td>
<td>859</td>
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<tr>
<td>126</td>
<td>29</td>
<td>922</td>
<td>211</td>
<td>1133</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th></th>
<th>LOW</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible UHF Stations</td>
<td>1706</td>
<td>1706</td>
</tr>
<tr>
<td>Stations Eliminated to Clear Spectrum</td>
<td>415</td>
<td>443</td>
</tr>
<tr>
<td>Stations Remaining On Channel</td>
<td>400</td>
<td>167</td>
</tr>
<tr>
<td>Stations Required to Repack</td>
<td>860</td>
<td>1065</td>
</tr>
</tbody>
</table>

- Estimated ranges based on DTC Study
### Spectrum Clearing Impact For 84 MHz

#### Estimated Range

<table>
<thead>
<tr>
<th></th>
<th>LOW</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible UHF Stations</td>
<td>1706</td>
<td>1706</td>
</tr>
<tr>
<td>Stations Eliminated to Clear Spectrum</td>
<td>222</td>
<td>249</td>
</tr>
<tr>
<td>Stations Remaining On Channel</td>
<td>433</td>
<td>262</td>
</tr>
<tr>
<td>Stations Required to Repack</td>
<td>1020</td>
<td>1164</td>
</tr>
</tbody>
</table>

- Estimated ranges based on DTC Study
Repack Studies

Broadcast Spectrum Repacking Timeline, Resource and Cost Analysis Study

ON TIME AND ON BUDGET:
COMPLETING THE 600 MHZ INCENTIVE AUCTION REPACKING PROCESS WITHIN THE FCC’S 39-MONTH RELOCATION DEADLINE AND THE BUDGET ESTABLISHED BY CONGRESS
FEBRUARY 17, 2016

T-Mobile

Response to T-Mobile & CCA Reports on the Broadcast Spectrum Repacking Timeline, Resource and Cost Study

March, 2016
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?

UHF & VHF TV Station Signal Contours, Inc. Class A’s
Courtesy of the NAB
Source: FCC TVStudy
Technical Appendix: Constraint Files Generation

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

<table>
<thead>
<tr>
<th>Region</th>
<th>CP Deadline (after channel assignments finalized)</th>
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<tbody>
<tr>
<td>1</td>
<td>3 months</td>
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<tr>
<td>2</td>
<td>6 months</td>
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<td>3</td>
<td>9 months</td>
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<td>4</td>
<td>12 months</td>
</tr>
<tr>
<td>5</td>
<td>15 months</td>
</tr>
<tr>
<td>6</td>
<td>18 months</td>
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</table>
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

Program Material (Video, Audio, Data)

RF POWER AMPLIFIER

TRANSMITTER

EXCITER

POWER AMPLIFIER

LP FILTER

MASK FILTER

COMBINER

TRANSMISSION LINE

Other transmitter(s) (if applicable)
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

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Prohibited Channel per catalog
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 or backup 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
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.

Chaos or Organized?
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.