

Repacking of Broadcasters Can Be Completed in 39 Months or Less

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Summary

This study assesses whether it will be feasible to repack broadcasters within the FCC's timeframe of 39 months following the broadcast incentive auction. A few of the key elements of our analysis include determining the likely number of stations that need to change channels in the repack and the characteristics of those stations. Using the exact methodology that the FCC will use at the conclusion of the auction, we calculate the number of stations that need to change channels over a broad range of clearing targets. Our calculation is based on a full simulation of the broadcast incentive auction under realistic assumptions of broadcaster participation and bidding behavior. Our simulation model has been developed and tested over multiple years.² The simulation is conducted with two plausible participation levels, leading to clearing of 126 MHz or 114 MHz; for robustness we also consider a lower participation case that clears 84 MHz. Then we perform the combinatorial optimization to determine the number of stations that need to be relocated. In all cases, the total number of stations that must change channels ranges from 756 to 888, substantially less than the range of 860 to 1,164 stations that a recent Digital Tech Consulting, Inc. study (DTC study) sponsored by the National Association of Broadcasters (NAB) assumed would need to change channels. The DTC range is based on calculations that do not follow the FCC's optimization methodology and is based on old data. By contrast, our estimates follow the FCC methodology closely, with the most up-to-date FCC data, and use plausible assumptions of participation and bidding behavior. Our simulations predict that, regardless of the clearing target, the post-auction repack can be accomplished in 39 months or less. Our conclusion would hold even if the actual number of broadcast licensees remaining in the band were to greatly exceed our expectations. Simply adjusting for sources of efficiency found in the field, such as the deployment of broadband antennas, and employing more accurate estimates of the supply of manufacturers and service providers available to support the repacking process would, in our estimate, allow for the timely transition of more than 1,000 broadcast incumbents to a new band plan following the auction. We anticipate that the actual number of broadcasters requiring relocation support will fall well below this level.

In addition to using a flawed methodology, the DTC study also assumes that only a small number of tower crews are available and that there will be *only a modest increase* (from 13 to 16 crews) in the supply of crews to perform the channel changes. Based on these assumptions, the DTC study concludes that only 445 stations can be relocated in a 39-month timeframe. However, we understand that a soon-to-be-released engineering study finds a much larger number of qualified tower crews are available: 41 (39-Month Study

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² The model builds on our earlier work. See Peter Cramton, Hector Lopez, David Malec and Pacharasut Sujarittanonta, "[Design of the Reverse Auction in the Broadcast Incentive Auction](#)" and [Appendix](#), filed 15 June 2015 at the FCC (GN Docket 12-268).

2016). Further, if there is a shortage, we can expect service supply to increase to meet demand. The United States has among the most fluid and flexible workforces in the world. In this instance, the increase in demand is known well in advance of the need. This will provide ample time for service providers and broadcasters to gear up so that supply can satisfy demand. Indeed, this is a common feature of markets. When demand increases, supply increases to meet demand. That will happen here. Indeed, the tower companies that the DTC study cites are already posting job openings for tower workers. Meanwhile, the FCC is conducting workshops on tower safety and has introduced an apprenticeship program to further help supply meet demand. Finally, the FCC can dramatically reduce the amount of tall-tower work that is needed by taking station factors such as tunable antennas and antenna height into account as it optimizes the repack to minimize time and cost. These efficiencies are shown in Table 1. Over a wide range of participation assumptions, resulting in clearing targets between 84 MHz and 126 MHz, the number of channel changes requiring tall-tower crews ranges from 474 to 541.

| | Clearing Target | | |
|---|-----------------|-------|-------|
| | 84 | 114 | 126 |
| Total UHF Stations Post-Auction | 1,482 | 1,298 | 1,188 |
| Repacked on Same Channel | 716 | 411 | 315 |
| Remaining station count with in-range broadband antennas | 110 | 127 | 117 |
| Remaining station count with antennas <= 350' | 182 | 220 | 217 |
| Total stations requiring tall-tower crews for repacking work | 474 | 541 | 539 |

Table 1: Number of stations changing channels by clearing target and station characteristics. Numbers are averages of multiple simulations per clearing target.

With 41 qualified tall tower crews, the conservative DTC study estimate of eight jobs per crew per year yields the capacity to finish the estimated 470-550 tall tower jobs within only 20 months or more than 1,000 towers over a 39-month period.

Based on these facts, with careful planning and execution, we believe broadcasters can easily meet the 39-month deadline for changing channels post-auction.

Introduction

The repacking process is a large and critical undertaking. The benefits of repurposing broadcast spectrum to mobile broadband cannot be enjoyed until after the repacking and clearing of the spectrum from broadcast use has occurred. It is essential that the FCC resolve as much uncertainty about the repacking process as possible to encourage robust participation in the auction. Uncertainty about the repacking process significantly decreases value and increases risks to auction participants. This is why the FCC wisely set, and the United States Court of Appeals for the D.C. Circuit affirmed, a fixed 39-month deadline to complete the repacking process. The deadline creates value, reduces risk, and enables planning.

NAB argues that it would be better to set the deadline after the broadcast incentive auction, once it is known which stations need to be repacked. Such an argument fails to appreciate a basic fact about auctions. An ambiguous availability date damages the value of the spectrum and undermines business plans. The auction will be much more successful with a fixed deadline. It is much better to make best-estimates of what will be required and then set a schedule based on these plans. Of course the exact magnitude of the task is not certain in advance of the auction, but our simulations demonstrate there is excellent information about what needs to be done. The FCC's repacking plan needs to take full advantage of the information and then adjust as uncertainty is resolved.

A key purpose of our study is to explain why a fixed deadline is feasible and necessary. We begin by identifying the stations, both number and location, that likely require repacking into new channels. We then discuss how market forces will drive an expansion of supply of bottleneck resources such as tall-tower crews to meet demand. Then we describe how the repacking process can be optimized to clear the spectrum as quickly as possible.

Although the repacking task is a large one, it is modest relative to the DTV transition. Many stations do not need to move. Many stations have flexible antennas that can be retuned without replacement. And where replacement is needed, the shift is from new digital equipment to newer digital equipment, rather than a much larger shift from old analog equipment. Comparisons with the DTV transition are therefore inappropriate.

Identifying the stations changing channels

To identify the stations changing channels we need to simulate the reverse auction. To do this we build on our prior work (Cramton et al. 2015). We have updated this work with the latest FCC methodology and data.

A critical input in our analysis is the broadcaster participation model. Participation follows primarily from reservation values we established for each station—the lowest payment the station is willing to accept to clear. We use the same model as in our earlier work. The intent of the model is to yield realistic participation behavior and auction outcomes. To test the robustness of results we include random variation in each station's reservation value and consider alternative scale factors that apply to all stations. We can broadly group the simulation results into three categories by clearing target (high 126 MHz, medium 114 MHz, low 84 MHz). We view the high and medium scenarios as much more likely. The low scenario shows that our results do not change too much even when participation is much less than expected. For the clearing target to fall to 84 MHz, we had to scale up reservation values by more than a factor of five from our expected case. Increasing broadcaster reservation values to these levels would imply a very low willingness of broadcasters to participate in the auction – a scenario we regard as highly unlikely.

There are two main steps in the analysis. The first is the reverse auction simulation that identifies the stations that must be repacked. It begins with the optimization to determine the initial clearing target and then identifies the stations that are repacked in the reverse auction. The second is the optimization of the repacked stations to minimize the number of stations that must change channels.

Repacking methodology

We used a single-stage optimization variant of the methodology laid out in FCC DA 15-1183, Appendix E to repack channel assignments. We solved the problem of maximizing the number of stations assigned to their

pre-auction channel and broke ties between stations using scoring from Step 3 of the repacking methodology.³

For the “Broadband Optimized” cases, we maximized the number of stations matched to either their pre-auction channel or another channel within the range of their broadband antenna. In all cases the optimizations were not solved to optimality; suggesting there could be significantly better assignments than the ones we found.⁴ The reported numbers are upper bounds on the number of stations that need to change channels.

We included in the repacking analysis all full-power Canadian UHF station and all low-power Canadian UHF stations within 160 kilometers of the border. All of the numbers we report include all eligible UHF stations in all states and territories of the United States. All U.S. stations near the Mexican border were packed to accommodate the planned Mexican assignments. Like the DTC study, we assume all UHF stations will go off air rather than move to VHF.

Supply response

The United States is fortunate to have a highly adaptive market economy capable of responding to shifts in supply and demand. The repacking task creates a known large increase in the demand for the equipment and services that are needed to repack stations. Companies well-suited to supply these services are looking ahead to gear up for the surge in demand following the auction. Evidence of this is seen at industry trade shows, where many companies are presenting their solutions (Radio Frequency Systems 2014). Such a supply response is expected. The repacking task is an outstanding opportunity for these companies. It has not gone unnoticed.

A main flaw in the DTC study is its overly conservative assumptions about the availability of tower crews and the likely supply response. The study identifies tall-tower crews as a bottleneck in the repacking process. Yet they assume that the number of tall-tower crews is 13 and increases only by 3 to 16, in response to the huge increase in demand. Recent interviews with service providers (39-Month Study), suggest there are at least 41 trained and safe tall-tower crews—over three times the number in the DTC study. Further, a more realistic assumption is that supply will expand to meet demand. This is what we see in virtually all markets. We have no reason to believe that the market for the goods and services necessary to support the broadcast relocation will prove any different.

As an example, when there is a hurricane on the East Coast, skilled line crews work overtime and are dispatched from all over the country to restore electricity service. Mobilizing tall-tower crews can require more advance notice since the task is more specialized, but the repacking timeline provides that notice.

Indeed, the FCC’s fixed deadline is helpful in resolving demand uncertainty as it encourages service providers to increase supply to meet demand. Those providers that do will be rewarded with more

³ We used the following scoring system: 5 for full-power stations in a top 30 PEA, 3 for other full-power stations, 1 for Class A, +1 if on a tower over 1000 feet.

⁴ We approximated the full problem with a divide-and-conquer based approach: first repacking each PEA individually, then repacking each PEA including all stations that potentially interfere with a station in the PEA, continuing out to an interference distance of three with each PEA. As such, there are very likely global repacking changes that can be made to significantly improve the packing numbers with additional computing power and more refined optimization strategies.

companies that supplied these antennas remain in business with many continuing to actively solicit new orders through attending NAB trade shows (39-Month Study).

Optimizing the repack process

The FCC understands the importance of optimizing the repack process. The FCC plays an important role in coordinating the repacking and setting intermediate deadlines. There are many opportunities to optimize the repack process by taking into account station characteristics in developing a coordinated plan. We provide several examples.

Most importantly, the optimization that determines which stations change channels can be conducted to minimize the time and expense of the repack. The coordinated schedule will take full advantage of the stations that currently have flexible antennas that can be tuned to new channels without new antenna structures. Approximately 22 percent of stations have such antennas (39-Month Study from Schedule 381). Filters and other elements would have to be replaced just at the transmitter—not on the tower—and the antenna and feed lines could stay untouched on the tower, as long as the station was assigned a new channel in its range. By including the specific channel ranges of the existing broadband antennas, the number of stations requiring short- or tall-tower crews can be reduced by 20 to 30 percent. Table 2 shows the impact of counting in-range changes equivalent to same-channel changes.

| | Clearing Target / Broadband Optimized | | | | | |
|---|---------------------------------------|---------------------|--------|---------------------|--------|---------------------|
| | 84 | | 114 | | 126 | |
| | Normal | Broadband Optimized | Normal | Broadband Optimized | Normal | Broadband Optimized |
| Total UHF Stations Post- Auction | 1,482 | 1,482 | 1,298 | 1,298 | 1,188 | 1,188 |
| Repacked on Same Channel | 716 | 651 | 411 | 378 | 315 | 303 |
| Remaining station count with in-range broadband antennas | 110 | 202 | 127 | 175 | 117 | 153 |
| Remaining station count with antennas <= 350' | 182 | 173 | 220 | 215 | 217 | 212 |
| Total stations requiring tall-tower crews for repacking work | 474 | 456 | 541 | 531 | 539 | 520 |

Table 2: Including Broadband Antenna ranges within the optimization further reduces the number of stations needing short or tall tower crews.

Two results emerge from our analysis. First, the number of stations requiring tall-tower crews to repack is greatly diminished when we recognize that (1) many stations can be repacked on the same channel, (2) many stations that must change channels have in-range broadband antennas that can be retuned without substantial tower work, and (3) many stations that need to change are not on tall-towers. This results in 450 to 550 channels requiring tall-tower crews, and this number drops further when one considers the role

of tunable antennas in the repacking optimization. Second, the amount of tall-tower work does not vary significantly, even over a broad range of participation assumptions leading to clearing targets of between 84 MHz and 126 MHz. In all cases, we are within the 450 to 550 range on the number of stations requiring a tall-tower crew. This range can be readily repacked with existing tower crews in a 39-month timeframe, especially once all working crews are properly accounted for.

In many cases, moreover, there are multiple stations broadcasting from the same tower. Efficiencies can be gained by scheduling channel changes on the same tower at the same time, so that a single crew can manage the changes at the same time.

The coordinated repack schedule can move through the stations on a logical, geographically focused basis with the intent of both minimizing time and cost, but also freeing up as much of the most valuable spectrum in high-demand areas as soon as possible. Factors such as seasonal work flow are readily taken into account. Recent analysis indicates that the DTC study overstates the seasonality of tower construction operations (39-Month Study). While there are some exceptions, tower activity can and does occur throughout the year in all types of weather conditions. But there will be sufficient flexibility to allow for the possibility of conducting more work on northern stations in more mild months, whereas more work on southern stations can be scheduled in the winter.

The FCC should promote or establish an equipment exchange to help with temporary gear while stations are being repacked. The exchange would improve the availability of temporary and permanent equipment, saving both time and cost.

The FCC intends to hire a third party to manage the reimbursement process. As we understand it, this party also may work with the FCC to coordinate the repack process. This is an excellent idea.

Conclusion

We estimate that between 756 and 888 stations will need to change channels. Only some of these will need a tall-tower qualified crew because many broadcast from short towers or use antennas capable of operating across the full range of the UHF band. Taking these factors into account leads to a much more realistic estimate of the repacking task. With more than 40 qualified tall tower crews, using the conservative DTC study estimate of eight jobs per crew per year yields the capacity to finish the estimated 470-550 tall tower jobs within only 20 months or more than 1,000 towers over a 39-month period. With careful planning and coordination of the repack process, the FCC can assure the fixed deadline of 39-months can be met with high probability. A successful repack depends on (1) the FCC taking advantage of the numerous efficiencies that are enabled when the repack process is optimized to the characteristics of the stations, and (2) encouraging the natural supply response to meet demand, for example by announcing a fixed deadline.

The FCC understands the importance of the fixed deadline in the auction. Our analysis confirmed that even over a wide range of participation scenarios, the number of stations that need to change channels and require a tall-tower crew for the task is in the manageable range of 450 to 550 stations. Both the FCC and private industry appear to be taking the necessary advance steps to meet the deadline. We believe that the 39-month deadline can easily be met.

References

Cramton, Peter, Hector Lopez, David Malec and Pacharasut Sujarittanonta, [“Design of the Reverse Auction in the Broadcast Incentive Auction”](#) and [Appendix](#), filed 15 June 2015 at the FCC (GN Docket 12-268).

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Exhibit 1

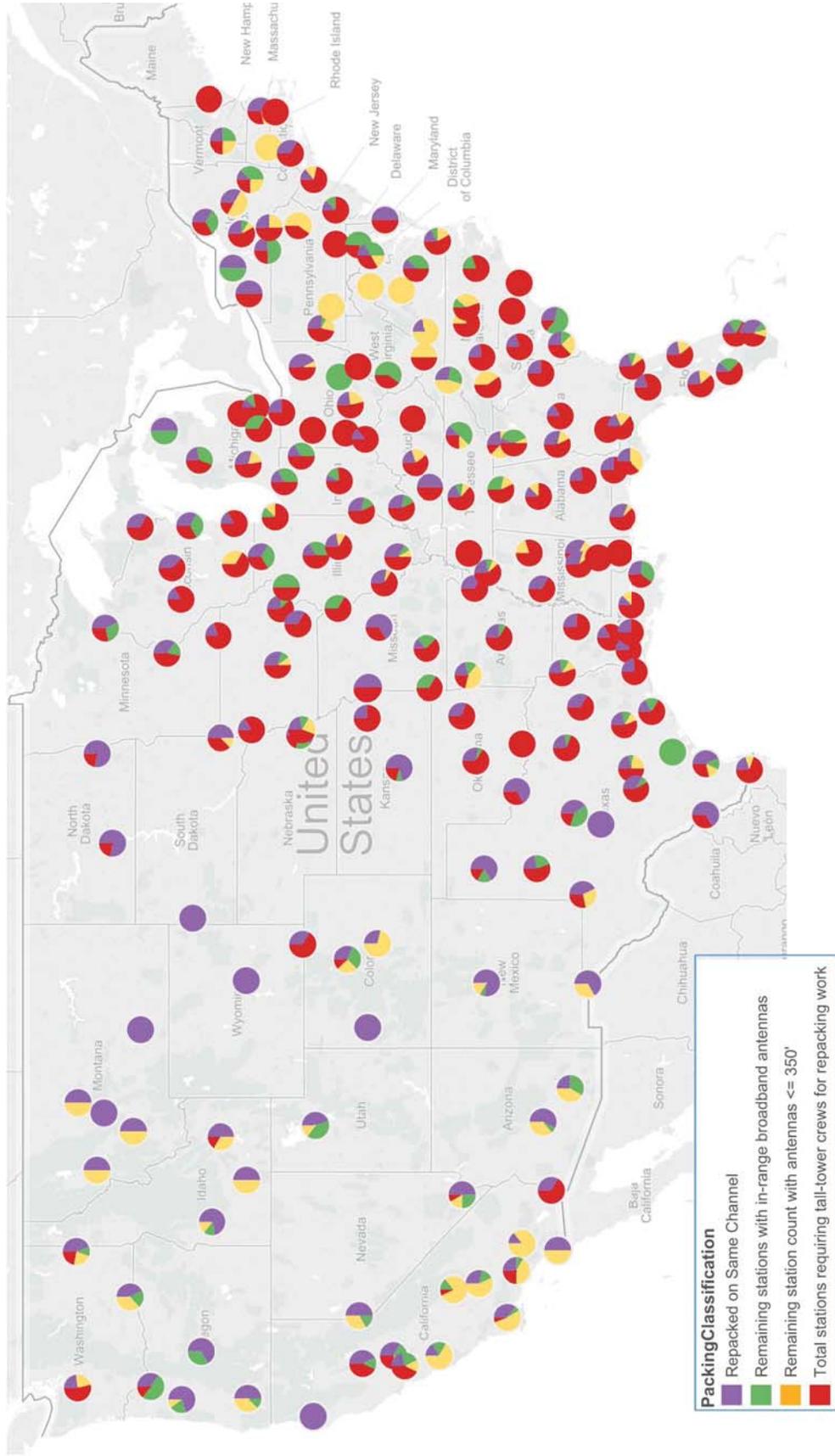


Exhibit 1: Breakdown of stations by estimated repacking status by PEA, for 126 MHz clearing target.