How Analytics Allowed the FCC to Save $7.3 Billion by Auctioning Underused Television Spectrum

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Using an auction informed by analytics, the US Federal Communications Commission reallocated underutilized portions of the television spectrum. The revenue from this auction exceeded its cost by $7.3 billion, which went toward US deficit reduction. Subodha Kumar summarizes the Kiddoo et al. report on this groundbreaking work which won the 2018 INFORMS Franz Edelman Competition.

Wireless devices use a range of radio frequencies (referred to as the radio frequency spectrum) to receive and transmit information. The Federal Communications Commission (FCC) manages the United States radio frequency spectrum by licensing various portions of these frequencies for specific uses. Because it can be used by many technologies, including wireless services and mobile broadband, the set of radio frequencies which has traditionally been allocated to television operators is extremely valuable. Meanwhile, advances in technology have allowed television providers to maintain the same quality of service while using a smaller portion of the wireless spectrum. Kiddoo et al.[1] documented how the FCC employed analytics to reallocate the underutilized portion of the television spectrum.

And $7.3 billion went back to the federal government to reduce the deficit. Beyond these tremendous financial benefits, taking control of a contiguous portion of the spectrum allows wireless services to increase their innovation as well as the capacity of the nation's wireless networks.

Over several years, beginning in 2010, the FCC conducted the world's first two-sided incentive auction between television broadcasters and the wireless industry. The wireless industry paid $19.8 billion for new licenses. Television providers received $10 billion to relinquish their licenses and $1.75 billion more to move to the new frequencies. And $7.3 billion went back to the federal government to reduce the deficit. Beyond these tremendous financial benefits, taking control of a contiguous portion of the spectrum allows wireless services to increase their innovation as well as the capacity of the nation's wireless networks.

The incentive auction worked by paying TV stations an incentive to relinquish their usage rights to wireless services. The portion of the spectrum which was repurposed and its price were determined through a series of *reverse auctions* (setting a price for the TV stations supply of excess spectrum) and *forward auctions* (determining the wireless carriers demand). The auctions also included a repackaging process which assigned bands to TV channels that did not choose to relinquish their bands.

The auction process was, of course, subject to many interdependent constraints. To overcome these challenges, the FCC used analytics. The commission had to find ways to repackage the remaining television stations into smaller spectrum bands without interfering with nearby stations, ensure international coordination throughout North America, and determine the clearing target (the total amount of spectrum to be reallocated). To do so, it designed a customized series of optimization models, decompositions, cuts, heuristics, and large neighborhood searches.

The FCC also used a feasibility checker to ensure good economic outcomes, determining whether any active bidder could feasibly be repacked with the existing and non-participating stations. They used a tool called a Sequential Model-based Algorithm Configuration which used machine learning, informed by the previous model, to select the best path forward. The FCC was thereby able to repurpose as much of the TV spectrum as possible while preserving the coverage of TV stations that chose to remain on-air after the auction and ensuring international coordination with neighboring countries.

In the end, the auction repurposed 84 MHz of the spectrum and produced a gross revenue of $19.8 billion. After costs, the roughly $7.3 billion surplus revenue was returned to the federal government in the form of deficit reduction. The auction also made critical bands of the spectrum available to meet the growing US demand for wireless data, which in turn helped to create jobs throughout the country.

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The size and complexity of this problem required the use of today's analytics and optimization techniques. Every step of the process, beginning in 2010, had to be documented and made available for public scrutiny. The public filed more than 12,000 comments on the auction processes. To lead such a diversity of interests, including consumers, policy makers, and industry, to agree upon and accept a solution without the use of modern analytical tools would have been nearly impossible.

This use of analytical tools has lasting implications and lessons for managers and policymakers, not only in telecommunications, but also in related industries. One of its key goals was to efficiently match supply against demand. Other industries, such as healthcare and hospitality, face similar apparent mismatches between supply and demand and might profitably employ a similar process.

The FCC first changed its auction practices in 1994, when it implemented simultaneous multiple-round auctions. Kiddoo et al. demonstrate that the FCC has continued to innovate. Its methodology in this case effectively redistributed excess resources from one industry to another in such a way as to benefit both parties, the country, and American society as a whole.

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Endnotes

1. Jean L. Kiddoo, Evan Kwerel, Sasha Javid, Melissa Dunford, Gary M. Epstein, Charles E. Meisch,Jr., Karla L. Hoffman, Brian B. Smith, Anthony B. Coudert, Rudy K. Sultana, James A. Costa, Steven Charbonneau, Michael Trick, Ilya Segal, Kevin Leyton-Brown, Neil Newman, Alexandre Fréchette, Dinesh Menon, Paul Salasznyk (2019). "Operations Research Enables Auction to Repurpose Television Spectrum for Next-Generation Wireless Technologies." *INFORMS Journal on Applied Analytics* 49(1):7-22.