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Conference Report

Spectrum Hall of Shame: The Worst (and Best) Radio Policy Decisions

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Summary

The Silicon Flatirons Center for Law, Technology, and Entrepreneurship held the *Spectrum Hall of Shame: The Worst (and Best) Radio Policy Decisions* conference on September 6, 2018. In an era of rapid technological development and spectrum scarcity, successful spectrum policy is critical. There was unanimous agreement among the conference participants that in order to effectively construct successful policy, policymakers must first understand what successful spectrum policy is.

Panelists reflected on decades of spectrum history in order to define what counts as a spectrum failure or success. For spectrum success, panelists found the following factors relevant:

- Encouraging diverse opportunities for access to spectrum.
- Allowing existing rightsholders and newcomers the flexibility to innovate and iterate.
- Maximizing either "total welfare," economic output, consumer satisfaction, deployment of telecommunications capabilities, or evolutions in wireless technology.
- Seeking the "highest and best" use for a given spectrum allocation.

Conference speakers saw the following as hallmarks of spectrum failure:

- Letting spectrum "sit in a closet," or otherwise allocating in a way that promotes spectrum squatting or that disincentivizes efficient use.
- "Hardwiring" spectrum so that it is available only to a limited set of technologies or parties.
- Allocating spectrum so that rational markets are unable to invest in it.
- Repeating and not learning from previous spectrum mistakes.

Having defined metrics for evaluating success and failure in spectrum policy, speakers described many examples. Among these, unlicensed spectrum and the adoption of spectrum auctions were seen as characteristic successes. Conversely, conference speakers frequently referenced the 700 MHz band plan and Dedicated Short-Range Communications (DSRC) at 5.9 GHz as case studies of spectrum failures.

Finally, speakers looked to the future, discussing what tools policymakers should use for ensuring future successes in spectrum policy. These included:

- Bringing skillful attitudes to spectrum regulation. These attitudes include the willingness to act, to take risks, to learn from prior mistakes, and to transform past failures into future successes.
- Approaching spectrum decisions as interdisciplinary "systems engineering problems" at the nexus of economics, physical sciences, international studies, and law.
- Building "flexibility" into the regulatory process. This entails avoiding rigidity in allocations ("hardwiring"), encouraging spectrum allocations to accommodate a number of different technologies and a robust secondary market, and creating a healthy mix of licensed and unlicensed spectrum.
- Promoting sharing between federal and commercial spectrum, and establishing private-public partnerships for large-scale spectrum efforts.

Table of Contents

The authors and organizers acknowledge and thank Slate Herman
for his efforts with respect to this conference and report.

Introduction

On September 6, 2018, "spectrum geeks" from across the country convened at the University of Colorado Law School to participate in the Silicon Flatirons Center's conference, *Spectrum Hall of Shame: The Worst (and Best) Radio Policy Decisions*.[1] Speakers from academia, legal practice, industry, and government participated in four panels to share lessons learned from decades of experience in spectrum policy, and to share best practices for the future. The conference was bookended by keynotes from Federal Communications Commission (FCC) Commissioner Jessica Rosenworcel and from Department of Commerce Assistant Secretary and National Telecommunications and Information Administration (NTIA) Administrator David Redl.

In his opening remarks, Pierre de Vries (Silicon Flatirons; titles and affiliations of all participants are given in the appendix) noted that the conference's purpose was to synthesize successes and failures from the history of radio policy, and "to try and learn from these past policy decisions, and do better in the future." With this large-scale goal in mind, the authors of this report have collated participant and audience comments in a fashion they believe progressively builds to answering how exactly we can "do better in the future" of spectrum policy.

The structure and sequence of this report largely mirrors that of the conference.[2] Section I explains why analysis of decades-old radio policy decisions is critical for future decision-making. Section II synthesizes discussion from across the conference and seeks to establish exactly how one can distinguish spectrum successes from failures, and which metrics to use in doing so. This section recognizes that an airing of spectrum policy grievances, while perhaps cathartic, cannot be a driver of future successes in national spectrum policy unless we first define "success" and "failure." Section III applies the previous section's definitions and metrics, offering concrete examples of spectrum policy decisions and why they have become (in)famous

[1] Pierre de Vries, the conference organizer, frequently used the term "spectrum geeks" to refer to conference panelists and attendees alike. As far as the authors of this report can tell, the term is one of endearment.

[2] The conference's four panels were titled "Defining Success and Failure," "Successes," "Failures," and "So What?" The "So What?" panel was focused on leveraging lessons learned to make better policy decisions in the future.

as successes or failures. To conclude, Section IV investigates how to apply lessons learned from past decisions, and how to implement best practices that will drive future spectrum policy successes.

Interested readers can consult additional resources that supplement this report. The names and full titles for all the "*Hall of Shame*" speakers and panelists can be found in the Appendix. For an introduction to many of the radio technologies and policy decisions discussed in the conference, readers can refer to the Spectrum Hall of Shame and Fame candidate thumbnails.[3] The conference schedule, complete video recordings of the conference, and text transcripts for all panels and keynotes are available online.[4]

I. The value of examining successes and failures

Although the conference panels were charged with defining and then examining successes and failures in U.S. spectrum policy, all of them addressed the question of why it is important to have a conversation about past successes and failures. This section summarizes their answers.

Speakers largely agreed that, as noted by Assistant Secretary Redl, we care because "the future is wireless and mobility." He stressed that it has become clear in the past few decades that the spectrum industry is "advancing at a pace that is significantly faster than most traditional industries." New uses of spectrum are being proposed every year. Erin McGrath (FCC) added that policy decisions have a large part to play in determining the future of these new technological uses. While no one can predict the future, looking to the past can provide invaluable insight in formulating new policies.

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[3] *Spectrum Hall of Shame & Fame: Candidate Thumbnails,* SILICON FLATIRONS CENTER (Sept. 3, 2018), https://siliconflatirons.org/wp-content/uploads/2018/09/SpectrumHallCandidates.pdf.

[4] *See Spectrum Hall of Shame: The Worst (and Best) Radio Policy Decisions*, SILICON FLATIRONS CENTER, https://siliconflatirons.org/events/spectrumhallofshame/ (last visited Nov. 26, 2018)(Conference Schedule); *Spectrum Hall of Shame: The Worst (and Best) Radio Policy Decisions*, YOUTUBE (Sept. 10, 2018), https://www.youtube.com/watch?v=cNIb_-NOY3E&list=PLTAvIPZGMUXPbohP9Ix5Ftan5cQiB2DOn (Video Recordings); *Spectrum Hall of Shame: The Worst (and Best) Radio Policy Decisions Conference Transcripts*, SILICON FLATIRONS CENTER (Dec. 4, 2018), https://siliconflatirons.org/wp-content/uploads/2018/12/TranscriptSpectrumShameFame.pdf (Conference Transcripts).

As a prime example of this, Redl looked to the 2005 re-channelization plan for the 800 MHz band. Channel restructuring was supposed to provide a simple fix and reduce cellular interference to public safety operations, but "ended up taking more than a decade because of cost issues, and because of cross-border coordination issues with our northern and southern neighbors." He emphasized that, although the channelization plan could now be considered a spectrum failure, the U.S. ultimately learned "a lot about how to negotiate those issues with our border neighbors as well as how to ease potential interference." Moving forward, these lessons learned will "pay off in the future."

As Peter Mannetti (iSherpa Capital) pointed out, even if one cannot see the full implications of a decision at the time one makes it, if you "scan the marketplace" for analogous situations faced in the past, "you have the benefit of hindsight in almost everything that you do."

Robert Kelly (Squire Patton Boggs) stressed that leveraging experiences and lessons from our past policy decisions is going to be increasingly important moving forward, because physical limitations of spectrum are going to necessitate increased sharing. Larry Downes (Georgetown Center for Business and Public Policy) noted that the path forward will be accompanied by tradeoffs between users. While spectrum policy successes have great potential to facilitate monumental progress, the failures have an equally great potential for creating "cascading . . . problems." Panelists recognized that by coming together and having serious conversations about spectrum history, we can catch a glimpse of the future through the lens of the past.

II. Defining success and failure in spectrum policy

Speakers not only pointed out which landmark spectrum policy events were deemed worthy of inclusion in the Spectrum Hall of Shame and Fame, but also debated which criteria were relevant for entry into such a prestigious institution. Homing in on a workable definition for success and failure in spectrum policy was a difficult but necessary task for panelists. For instance, while there was broad consensus that setting aside 75 MHz of spectrum in the 5.9 GHz band for Dedicated Short-Range Communications (DSRC) had been a spectrum policy failure, panelists varied in their explanations of why DSRC had failed, and what metrics should be employed for

establishing DSRC's low standing on the success–failure sliding scale. Some speakers sought to establish objective quantifiers for spectrum success, e.g., economic output. Others looked to more functional proxies for success or failure, e.g., looking at whether a spectrum allocation incentivized efficient use, or promoted industry competition or innovation in technology. Across the board, however, panelists agreed that arriving at root meanings for success and failure was a prerequisite for moving forward.

Importantly, speakers did not just view individual regulatory decisions through the lenses of success or failure, but also passed judgment more broadly on styles of spectrum policy. Thus, when discussing spectrum policy decisions, one should address not only the success and failure of specific allocations or service rules, but the success and failures of regulatory frameworks more generally.

A. Don't let spectrum sit in a closet: Access, opportunity, and efficiency in use

In her opening keynote, Commissioner Rosenworcel used DSRC deployment stagnation as an example of a failure, especially in light of the enormous gap between initial expectations for the 5.9 GHz band and current reality. Rosenworcel noted that while we've been dreaming of automated and connected vehicles since 1926, fifty years will likely have elapsed between initial DSRC allocation (1999) and the time when a majority of cars employ V2X technology using DSRC frequencies.[5] When there is such a profound gap between expectation and reality, a spectrum dream deferred becomes a failure, especially if the spectrum merely "sits in a regulatory closet" while enormously valuable uses for the same frequencies are readily identifiable (e.g., Wi-Fi expanding to the 5.9 GHz band).

Commissioner Rosenworcel's sentiments were shared by many panelists. Thomas Hazlett (Clemson University) suggested that failure arises when targeted allocations result in inefficient use. Hazlett argued that overly-restrictive allocations are insulated from competitive pressures,

[5] V2X stands for "vehicle-to-everything" connectivity, which is a superset for smaller classes of information transfer between a vehicle and some other entity that may affect the vehicle. V2X includes V2V (vehicle-to-vehicle), V2I (vehicle-to-infrastructure), and V2D (vehicle-to-device) connectivity, among others.

and thus encourage spectrum squatting and disincentivize efficient use. Hazlett noted this is especially problematic where opening up restricted spectrum to alternative uses and competitive market dynamics would create value.

With similar logic, Peter Mannetti described spectrum failure as a "poor allocation": one that only benefits a handful of players while disadvantaging other potential users, innovators, and consumers. Blair Levin (Brookings Institution) offered an even simpler, "Wall Street" definition for spectrum failure. He argued that failures are spectrum allocations that "no reasonable person can invest in."

Steve Sharkey (T-Mobile) pursued a similar train of thought, claiming that failures arise by missing the spectrum forest for the trees, which occurs "when the Commission is listening to a company with a great idea that just needs a chunk of spectrum to make that happen, or carving out special cases that seem like there's maybe something there – but in the business case, it turns out to just not work out." Alternatively, Sharkey noted that catering to too many parties ("when the Commission tries to split the baby too many different ways") risks a spectrum anticommons that cannot produce significant value for any party.[6]

Noting that any technology will eventually become obsolete (which occurs faster and faster these days), Erin McGrath posited that earmarking spectrum for certain technologies often leads to failure. Jim Lansford (Qualcomm) agreed, noting that when technologies fail to flourish as originally envisioned (or merely reach inevitable obsolescence), technology-dependent "hardwired" regulations become a future barrier to successful use of spectrum bands.

In contrast to viewing failures as spectrum "sitting in a regulatory closet," or "poor allocations" that only put spectrum in the hands of few, Julius Knapp (FCC) defined successful policy as "creating a fair opportunity for providing access for spectrum," where "people have a chance to get out there and let the market decide." Knapp stressed that policy success is also contingent on policymakers "doing no harm." Furthermore, Knapp argued that genuinely creating spectrum

[6] An "anticommons" refers to a communal resource (e.g., a domain of frequencies) where numerous rightsholders, by asserting their rights simultaneously, prevent any given party from effectively using the resource.

opportunities requires the FCC to do more than meet numerical benchmarks for auctionable spectrum: freeing up fragmentized spectrum chunks ("5 MHz here, 10 there") cannot generate successes if markets are unable to utilize this spectrum effectively and create value.

Similarly, David Goldman (SpaceX) thought that successful spectrum policy is that which gives innovators "the most opportunities to try something and try to develop it," and that which creates "incentives to iterate." Charla Rath (Verizon) elaborated, stating that incentivization in spectrum policy is successful when individuals are pushed to maximize efficiency of their spectrum use, both technologically and economically.[7] Hazlett agreed that "opportunity creation" is a metric for success, but also thought that "maximizing welfare" was an appropriate yardstick for evaluating the success of a particular spectrum decision. Hazlett argued that successful spectrum policy occurs when regulation "strategically puts rights in the marketplace that allow for the re-evaluations, the discoveries, and the experiments that reveal new information," all of which eventually contributes to maximized welfare.

The majority of panelists agreed that flexible regulatory policies (e.g., technology-neutral allocations) contribute enormously to spurring opportunities and incentives for successful spectrum use. The converse is that rigid policies will often impede innovation—Michele Farquhar (Hogan Lovells) described the industry stagnation that results from "waiver-by-waiver" corrections to hardwired and inflexible regulations.

B. Economic output: An objective metric for spectrum success?

Many panelists agreed that economic output was a valid (and perhaps ideal) metric for spectrum decision-making success because it is one of the few metrics that is both universally applicable

[7] While many panelists brought up technological and economic efficiency, these terms were left undefined. In context of the conference discussions, one might have understood "technological efficiency" to mean maximizing spectral data capacity (e.g., bits/Hz) or population served for a given bandwidth ("MHz-POP"). Likewise, "economic efficiency" could have meant a number of things, including the maximization of return on investment or the minimization of front-end costs associated with providing a given communications service.

and readily quantifiable.[8] As an "objective" marker of success, economic output does not suffer from the abstraction or hindsight bias that might plague other metrics. For instance, while many agreed that the spectrum El Dorado of "the highest and best use" should always be sought, it remains difficult to know the direction toward "higher and better" when making a critical policy choice.

Larry Downes wondered if "highest and best use" was even conceptually divorceable from economics, and asked whether "highest and best" is merely gilded terminology for maximizing economic output. Charla Rath continued along this line of thought, suggesting light-heartedly that the "highest and best" use for a particular band of spectrum is whatever will generate the greatest auction revenue for the U.S. Treasury. Downes noted that we often have a gut sense of what constitutes the "highest and best use," providing the example of our recent trend in continuing to migrate spectrum away from analog broadcast and toward mobile broadband. To the extent that "highest and best use" can act as an internal compass while economic output can function as an objective and quantifiable marker, the two metrics can work in tandem for guiding spectrum policymakers.

While many panelists touted the usefulness of economic output, others asserted that non-economic indicators could also be primary metrics for spectrum policy success, and many questioned whether one misses the bigger picture when evaluating success purely via economic output. One audience member suggested that a spectrum policy decision should be deemed a success if the decision led to an evolution in wireless technology. Another questioned whether pure economics could adequately account for the societal value of some intangibles, such as radio astronomy research (which requires a diverse set of dedicated frequency bands). Michele Farquhar thought that universal service, efficiency of telecommunications buildout, and the dissemination of new communication technologies were all good proxies for spectrum success,

[8] Like efficiency, economic output was mentioned frequently, but panelists did not define what the relevant output would be for evaluating spectrum policy success. However, regardless of whether one uses contribution to GDP, rates of return on investment, job creation, total value of services provided to consumers (or something else) for the definition, all these outputs can be quantified. This quantifiability was central for panelists who saw economic output as an important metric for evaluating spectrum success and failure.

noting that the Communication Act's "guiding beacon" provides a foundational statutory metric for all FCC policy.[9]

Knapp also noted the tensions in employing pure "economic output" metrics for spectrum policy success—large costs associated with provisioning universal service and rural infrastructure buildout could be seen as failures under strict economic evaluations that do not account for broader societal goals. David Goldman suggested that purely economic visions of success might ignore ensuring "the best quality of service to consumers," which he argued is always relevant to evaluations of spectrum policy. However, he worried that by focusing too narrowly on consumers, one also risks policy myopia. Goldman noted that unimaginative consumer-centric models of success can ignore the value of certain spectrum allocations (e.g., satellite remote sensing) that offer significant, but not immediately apparent, downstream benefit to consumers. Goldman also wondered whether economic output and consumer benefit are not entirely separate, but rather intertwined within a larger framework for what constitutes spectrum policy success.

C. Success and failure in federal spectrum

In his closing keynote, Assistant Secretary Redl spoke about the different analysis required in federal spectrum policy for evaluating success and failure. He noted that "economic output" metrics of success are challenging to apply to federal spectrum because federal use is insulated from the market pressures that drive commercial spectrum development.

For federal use, Redl instead used workability as a chief metric for evaluating spectrum success. For instance, Federal Aviation Administration radars are successful when they work correctly, allowing air traffic to move safely; assigning frequencies to the FBI is successful when agents can discreetly and effectively communicate with each other during critical missions. Redl argued that success in federal spectrum policy can be measured by what doesn't occur: "non-events"

[9] §1 of the Communications Act of 1934 sets out the FCC's raison d'être and provides a framework for all the Commission's decisions: "*For the purpose of regulating interstate and foreign commerce in communication by wire and radio so as to make available, so far as possible, to all the people of the United States a rapid, efficient, nationwide, and worldwide wire and radio communication service with adequate facilities at reasonable charge…*" 47 U.S.C. §151 (1996).

demonstrate the benefits and successful implementation of spectrum policy, while "events" (e.g., Wi-Fi producing harmful interference in FAA radars) are seen as failures. For Redl, workability should be combined with the recognition that federal and non-federal spectrum uses need to coexist harmoniously and efficiently. Redl noted that the big question in 2018 becomes: "Is there a way for us to share, to do more potentially with more? Or to do the same with different?" Redl thought that federal/commercial bidirectional sharing schemes will be an essential ingredient of many future spectrum policy successes.

D. The life cycle of spectrum success and failure

Perhaps the most important takeaway from the conference was the idea that past failures in spectrum decision-making can be transformed into future successes. Erin McGrath noted that true failures only occur when we make "the same mistakes" as were made in the past. Jim Lansford went even further, suggesting that "there is no such thing as failure, only opportunities to learn," and that, "within everything that you could call a spectrum policy failure, in fact, you've learned something in the process." Circling back to Commissioner Rosenworcel's opening keynote, spectrum failures might only be those instances where we let spectrum "sit in a regulatory closet," unwilling or unable to "fail fast" and transform past mistakes into successful policy. To complete the full cycle, Robert Kelly noted that all successes are inherently ephemeral: "a success today will not always be a success as technology evolves." If all spectrum successes eventually suffer from obsolescence, we must not only learn from prior mistakes when making new decisions, but also think ahead to how we will facilitate regulatory "handoffs" to new generations of successful spectrum technology and policy.

III. Successes and failures in spectrum policy

While determining the criteria for spectrum policy successes and failures proved to be a difficult task, panelists faced less difficulty in deciding which policy decisions ultimately deserved a place within the Spectrum Hall of Shame and Fame. As examples of successes, panelists continually referred to Wi-Fi, and to the FCC's decisions to assign spectrum rights via auction. On the other side, panelists often referenced the shortcomings of Digital Short-Range

Communications (DSRC) in the 5.9GHz band, and the 700 MHz band to illustrate what constitutes a spectrum failure.

A. Unlicensed

The ability of unlicensed spectrum to foster innovation was highlighted throughout the conference. Commissioner Rosenworcel discussed how the U.S. pioneered the practice of allowing public access to airwaves through unlicensed spectrum, a significant departure from worldwide "command and control" models. Rosenworcel noted that public access (allowing easy entry and market scale) and flexible use (enabling innovation) of unlicensed frequencies was instrumental in the development of Wi-Fi.

David Goldman echoed this sentiment and elaborated, saying the FCC has done well in regulating unlicensed spectrum by taking the approach of "speak softly, but carry a big stick." By being a more passive enforcer of the flexible Part 15 rules, the Commission allows commercial parties to innovate on their own terms and avoids having to regulate "every time there's a technology change." However, the Commission also reserves the right to resolve conflicts between parties and apply more stringent rules, especially when unlicensed devices cause harmful interference to licensed incumbents. This specter of oversight incentivizes industry cooperation and encourages self-policing, while still promoting innovation. Goldman thought the FCC has been particularly successful with this regulatory style for both Wi-Fi and LAA (LTE over unlicensed) technologies. Rob Alderfer (CableLabs) also spoke of unlicensed frequencies' enormous success: "When we look at Wi-Fi as embodying . . . success . . . what we see is just a ton of innovation," and that it is "tough to imagine a day without it."

The panelists also underscored that a unique characteristic of unlicensed spectrum is its ability to embody several different definitions of success at once. Looking to Wi-Fi as a chief example, Jim Lansford noted that unlicensed spectrum has been an obvious success in terms of economic output. However, he also noted that unlicensed spectrum is successful because it creates opportunities for access, innovation, and diverse customer offerings. Lansford thought the

flexibility afforded to unlicensed spectrum was key in making Part 15 technologies successful by so many metrics.[10]

B. Auctions

Panelists also agreed that the adoption of auctions for allocating spectrum was a resounding success. Commissioner Rosenworcel noted that U.S. spectrum policy has "become a model for nations worldwide." Larry Downes agreed with the Commissioner. To him, spectrum policy's clearest success has been the FCC adopting economist "Ronald Coase's proposal for auctioning, instead of the more politically oriented and . . . command and control allocation of spectrum." Downes did, however, add a caveat to his praise of spectrum auctions—Coase proposed auctioning spectrum in 1959, but his idea didn't come to fruition until 1994. With this decades-long gap between theory and practice, Downes argued that, possibly, "lots of potential opportunities, …, job creation, and innovation . . . was lost."

While agreeing that spectrum auctions have been successful, Charla Rath added her own caveat: until the broadcast incentive auctions in 2016, other countries, such as New Zealand with its flexible-use auctions, were likely "more advanced in their approach to spectrum auctions."

Steve Sharkey and Erin McGrath also agreed that auctions were successful. McGrath added that auctions are a policy success because they help allocate spectrum to the "highest and most efficient use." Sharkey noted that incentive auctions in particular are effective because reallocating spectrum is an expensive process: the revenues from the incentive auction can help relocate incumbents and thus "helps the transition."

C. 5.9 GHz band

On the other side of the coin, there were several decisions that panelists agreed embodied the definition of failure. Policy decisions regarding the 5.9 GHz bands were discussed repeatedly. As Erin McGrath put it, the policy goal of having safe cars is clearly not controversial. The problem

[10] Unlicensed operation is covered by Part 15 of the Code of Federal Regulations, Title 47 (the FCC rules).

with the allocation of the 5.9 GHz band to DSRC then, as highlighted by both McGrath and Commissioner Rosenworcel, lies partially in the way the spectrum was initially allocated.

Jim Lansford commented that DSRC rules were written so that "you can't use anything else in that band." He noted that this was problematic because the prescribed use for the band has become obsolete. By hardwiring in a lack of flexibility, the Commission created an "impediment to successful use of the band." McGrath added that not only did the Commission adopt regulations that were far too restrictive, but it also dedicated far too much spectrum to DSRC in the first place (75 MHz). She pointed out that the exact amount of spectrum needed for DSRC functionality is debated, but the amount needed should be at most 30 MHz.

Furthermore, while the policy was problematic from the outset, panelists indicated that the Commission's failure to address the issue in the twenty years since the policy was adopted made it exemplary. As Rosenworcel indicated, failing to act can sometimes be worse than enacting bad policy in the first place.

D. 700 MHz Band

Another "Hall of Shame" candidate that sparked conversation among panelists was the 700 MHz band plan. Steve Sharkey noted that once the FCC had identified a portion of spectrum that could be cleared during the switch from analog to digital television, the U.S. Congress sought to raise money for balancing the budget, and adopted legislation that forced the FCC's early auction of 108 MHz of spectrum between 698 and 806 MHz.

Sharkey argued that the rush to auction 700 MHz resulted in an ill-advised band plan that has become a "long-term problem that continues to this day." Sharkey identified a number of problems.[11] He saw the "public safety allocation that was kind of put in the middle" of the band as disrupting the value of the 700 MHz spectrum for mobile use. Sharkey lamented that the band

[11] During their discussion of the 700 MHz band plan, panelists did not explicitly mention the device interoperability issues that have frustrated cellular consumers, hardware manufacturers, and licensees who acquired portions of the 700 MHz spectrum. *See generally*, Neal Gompa, *700MHz mobile spectrum: A sad tale of regulatory and interoperability failure*, EXTREME TECH (May 2013), https://www.extremetech.com/electronics/154655-700mhz-mobile- spectrum-a-sad-tale-of-regulatory-and-interoperability-failure/2.

"ended up with a bunch of guard bands to protect … public safety, [and] between upper 700 and lower 700." He also pointed out that by rushing the 700 MHz auction, the U.S. has ended up with a "very different band plan" from the rest of the world, and this disharmony has resulted in a "big interference problem with Mexico." Sharkey saw the 700 MHz band plan as a significant anomaly that stood out from general congruity of allocations between the United States and its immediate neighbors.

Erin McGrath, however, disagreed that the 700 band was a complete spectrum policy failure. While she admitted that "nobody likes the 700 MHz band plan," she maintained that no one would "actually consider 700 MHz to be a failure," because "cellular is very successful." To McGrath, the externalities resulting from 700 MHz's poor assignment structure were outweighed by the significant benefits (large economic output and deployment) that accompanied the 700 MHz band's transition from analog television to auctioned, cellular mobile use. Jennifer Manner (EchoStar) also hesitated to categorize 700 MHz as a large-scale failure but argued that the band plan was "not as perfect as it could be," and attributed this to shortcomings in the decision-making process.

IV. Tools for ensuring future success

The ability to leverage experience and facilitate future success in spectrum has become more important than ever. In today's increasingly congested and competitive spectrum landscape, making spectrum policy decisions is more difficult and more consequential. Spectrum decisions involve billions of dollars, affect future developments in wireless technology and their use, and influence the United States' competitiveness. Of course, while it is impossible to guarantee success for any one decision, by specifically investigating what separates spectrum successes from failures, and then reflecting on the strengths and shortcomings of past decisions, we are in a better position to move toward future successes in spectrum policy. This section investigates what perspectives, resources, and regulatory frameworks spectrum policymakers should employ when aiming for future success.

A. Attitudes: The willingness to learn, to act, and to take risks

To be successful, policymakers must bring skillful attitudes to the totality of regulatory work in spectrum. Commissioner Rosenworcel and Assistant Secretary Redl noted two of them: 1) spectrum success requires the willingness to learn from prior mistakes, to take action, and to transform past failures into future successes; and 2) spectrum policy will generate success only to the extent that decisionmakers are willing to take risks.

Commissioner Rosenworcel succinctly and emphatically stated what might be the conference's premier takeaway: regarding mistakes, prior failures, and even decisional mediocrity, "there is no shame in correcting course." Rosenworcel contrasted the many "innovative triumphs" in spectrum history with "airwaves that have become afterthoughts," but noted that it's always "within our power to change." Julius Knapp agreed. He suggested that successes are born from "lessons learned," and noted that, "we didn't get to the moon without some bumps in the road."

Pierre de Vries thought policymakers should do their best to constantly (re)evaluate their decisions, regularly scrutinizing what aspects of current policy are succeeding or failing. He supported the idea of "failing fast", and asked participants whether it was worse to risk something new in spectrum and fail, or to do nothing at all. The audience heartily agreed that inaction is the poorer course. One audience member stated that there is "nothing to learn from inaction." Bryan Tramont (Wilkinson Barker Knauer) concurred, arguing that federal spectrum decisions are made correctly in nine tenths of cases. He posited that poor decisions often require only minor adjustments to become successes, and decisions that result in larger shortcomings will still provide invaluable lessons for the future.

Assistant Secretary Redl spent much of his keynote exploring how the willingness to take risks is a prerequisite for "reaping great dividends" from spectrum. As a case study, Redl cited the FCC's 600 MHz incentive auction. There were risks that "the wireless industry wouldn't be interested at the prices you needed to clear broadcasters in the band," that "the FCC wouldn't have the resources to get it done," and that, "broadcasters wouldn't show up to participate." Each one of these risks could have proven fatal to the incentive auction, and the FCC lacked a crystal

ball to verify that all the moving parts would eventually come together. The risk paid off, however, and the incentive auction is likely to go down in history as an international model for achieving complex, interdisciplinary spectrum successes. Redl described the incentive auction as "one of our greatest innovations," indicating that the magnitude of success is often proportional to spectrum policymakers' willingness to be bold.

B. Background research and interdisciplinary analysis

On the road toward "Hall of Fame" spectrum decisions, a little background research and forethought will go a long way. Panelists detailed what kinds of "homework" policymakers should complete before making important spectrum-related decisions. Julius Knapp suggested that all potential decisions should be preceded by a careful analysis of whether taking action is even prudent. He proposed the following litmus test to be used at the outset of the decision-making process:

> First maxim: If you ever want to know whether spectrum is being used, just propose to re-allocate it. Suddenly, you'll have folks coming out of the woodwork you had no idea were there. And, second maxim: If you're sitting on spectrum that is not being used heavily, you can rest assured somebody else is looking for it.

When spectrum policymakers do decide to act, Assistant Secretary Redl suggested that all spectrum analyses should be viewed as "systems engineering" problems at the intersection of law, economics, and the physical sciences. As examples, Redl offered the 600 MHz incentive auction, and the dynamic exclusion zones that will protect incumbent operations in 3.5 GHz CBRS from harmful interference.[12] For extremely complicated efforts like these, Redl stressed that one needs thorough, multidisciplinary collaboration in order to succeed. Knapp thought similarly, suggesting that when spectrum decisions are viewed holistically as engineering problems, fierce inter-party debates ("One side is telling me no problem at all, and the other side's telling me that this vital service is going to be wiped out. Who do I believe?") can be resolved by finding a mutually beneficial middle ground.

[12] The Citizens Broadband Radio Service (CBRS) was established by the FCC to enable shared wireless broadband use of the 3550-3700 MHz band.

Redl also noted that spectrum policy decisions are better made when scientific research forms a basis for decision-making. Redl noted that the NTIA's Institute for Telecommunications Sciences (ITS) laboratories conduct independent research that "informs policy decisions and ultimately helps the ability of spectrum users to deploy advanced telecommunication technologies." As an example, Redl argued that measuring the changes in a college town's spectrum use will be instrumental for providing advanced communications capability there: "A college football Saturday is not going to look like a summer weekday in Boulder."[13] Redl suggested that by understanding the spectrum noise floor and how signals propagate in a certain environment, we are "enabling more devices, enabling more uses," and increasing the potential for "densification of networks."

Finally, several panelists suggested scrutinizing practices in other countries for lessons. For instance, Charla Rath noted that U.S. policymakers took inspiration from New Zealand's flexible-use auctions in the 1990s, later implementing new-and-improved versions of these auctions. Even though other countries can be a source of knowledge, panelists cautioned that U.S. policymakers should remain wary when looking abroad: the domestic applicability of foreign spectrum decisions may be limited because governmental structures or geographical contexts can differ significantly from our own.

C. Flexibility built into the system

While adopting suitable attitudes and conducting rigorous background research are prerequisites for spectrum success, panelists also discussed how concrete policy frameworks incubate future successes. Most importantly, panelists advocated for flexibility in spectrum regulation that allows regulators and rightsholders alike to be continually responsive to changes in markets and technologies. Michele Farquhar posited that "building flexibility into the system" is essential for

[13] *See e.g.*, Spectrum Sharing Innovation Test-Bed, NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION, https://www.ntia.doc.gov/category/spectrum-sharing-innovation-test-bed (last visited Nov. 26, 2018). ITS is running a test-bed in Boulder, Colorado. The experiments investigate how devices can employ Dynamic Spectrum Access technologies, using real-time geolocation and spectrum sensing in order to increase sharing opportunities between federal and commercial users in a band.

producing spectrum successes. Erin McGrath agreed—by adopting flexible, technology-neutral spectrum allocations, "the Commission doesn't have to regulate every time there's a technology change." As an example, Jennifer Manner spoke about how technological neutrality in CMRS (Commercial Mobile Radio Service) regulation has proven key to the evolution and ubiquitous deployment of cellular technology. She argued that the FCC would have failed had it dictated "what cellular technology looks like," imagining an alternate universe where regulations would force all cellular communications to use TDMA (Time-division Multiple Access).

McGrath further suggested that spectrum success lies in assigning flexible use rights through auctions while simultaneously allowing for a robust secondary market. She noted that allocations create more value and are more efficient when "companies actually have to come in and bid for what they want." This way, McGrath argued, companies bring their unique and innovative technologies into a flexible framework, rather than restricting entry to only those parties that will use a narrow (and possibly arbitrary) set of technologies. Larry Downes agreed that robust secondary markets were essential: "We want to make it as easy as possible for you to get rid of that license if it turns out your technology didn't work out, or it's outlived its usefulness." Steve Sharkey thought flexible allocations and accessible secondary markets are particularly necessary in today's communications era, where vastly different technologies (e.g., satellite vs. terrestrial providers) are all competing to offer consumers a similar service (e.g., broadband). Sharkey was particularly skeptical of allocating satellite-specific frequencies: "There should be an auction for spectrum under a flexible allocation with some general technical rules, because all too often what we've seen from the satellite community are very big promises with business plans that don't pan out."

Panelists also agreed that flexibility in spectrum involves creating a healthy mix of licensed and unlicensed frequencies, and encouraging spectrum licensees to maximize the efficiency of their spectrum usage. Jim Lansford stressed that highly flexible, unlicensed spectrum allows for innovation that cannot be anticipated in advance. For example, Lansford argued that 35 years ago, the prospective value of "plywood heater" frequencies in the 900 MHz ISM bands was not

very high.[14] Policymakers could not have anticipated the enormous value that unlicensed would later bring to 900 MHz. Looking toward licensed parts of the spectrum, David Goldman pushed for regulatory policies that compel incumbents to "share, bring in new people, and to be constantly innovating." Goldman advocated for flexible spectrum policy that provides rightsholders the incentives to iterate while also encouraging newcomers to compete when they can find "newer, higher, better uses for the spectrum."

D. Sunsetting and regulatory audits

While panelists agreed that flexibility should be built into spectrum policy, some were wary that too much deference to private markets or to incumbents' choices would inhibit future spectrum successes. For instance, spectrum policy should prevent incumbents from placing a chokehold on spectrum by "waving around that you have a couple of customers and are therefore protected forever," as David Goldman put it. Bryan Tramont suggested that all major FCC allocations could undergo systematic audits, on a five- or ten-year basis, to assess whether allocations were working to create value and promote efficient use. Tramont imagined a system where licensing regimes could "sunset after five years or have to be re-promulgated." Many panelists supported periodic oversight as a useful counterweight to generally flexible allocations, although Jennifer Manner worried that audits could prevent private-sector innovations (offering large-scale satellite operations as an example) that require many years of research, development, and experimentation before coming to fruition.

E. Tools for success in federal spectrum

In his closing keynote, Assistant Secretary Redl detailed what tools are necessary for success in federal spectrum. He stressed the need for harmonizing national spectrum policy between the FCC and NTIA, incentivizing efficiency of federal spectrum use, and investigating bi-directional sharing between federal and commercial use. Redl stated that, since the creation of the Spectrum Relocation Fund, efforts to maximize efficiency and beneficial use of federal spectrum will be

[14] Industrial, scientific, and medical (ISM) bands are radio frequencies reserved internationally for non-telecommunications uses. The ISM bands were originally designated by the International Telecommunication Union in 1947, and industrial microwave heating was originally envisioned as a principal use for the frequencies (including for the 2.4 GHz band now used by Wi-Fi).

accelerated. Furthermore, Redl saw future success in federal spectrum as inherently involving partnerships with the commercial market. He offered FirstNet as a case-study for future public-private collaboration: "the entire premise" of contracting out FirstNet infrastructure development to commercial players, "is to bring the commercial upgrade cycle and economies of scale of the wireless industry to bear on a small but very important user base."[15]

Conclusion

Throughout the "*Hall of Shame"* conference, speakers looked to the future of spectrum policy through the lens of the past. Analyzing decades of radio policy decisions, speakers first sought to define success and failure in radio policy. Economic output, efficiency of use, and consumer welfare were just a few of the proposed metrics for evaluating what constitutes successful spectrum policy decisions. Speakers then offered examples of spectrum policy decisions which belong in the Spectrum Hall of Fame and Shame. For example, many cited unlicensed use and spectrum auctions as successes, and the DSRC allocation in 5.9 GHz as a policy failure. Finally, participants discussed how to best leverage our experiences in past spectrum policy, allowing us to chart new territory in the spectrum landscape while transforming old failures into new successes. They saw interdisciplinary analysis, flexibility of regulation, and the willingness to take risks and to learn from prior mistakes as essential tools for ensuring future spectrum successes. As wireless technology becomes more important and more prevalent in our lives, conversations like those from the *"Hall of Shame"* conference will prove invaluable moving forward.

[15] The First Responder Network Authority (FirstNet) was created in 2012 as an independent authority within the NTIA. FirstNet's purpose is to establish, operate, and maintain a nationwide and interoperable public safety broadband network. In 2017, as part of a public-private partnership, AT&T was contracted to build out FirstNet. *See generally* FIRSTNET, https://www.firstnet.com/ (last visited Nov. 26, 2018).

Appendix: Speakers and Program

OPENING KEYNOTE

- **Jessica Rosenworcel**
  Commissioner, Federal Communications Commission

PANEL 1 – DEFINING SUCCESS AND FAILURE

Moderator
- **Bryan Tramont**
  Managing Partner, Wilkinson Barker Knauer, LLP

Panelists
- **Michele C. Farquhar**
  Partner, Hogan Lovells
- **Thomas W. Hazlett**
  H. H. Macaulay Endowed Professor, Clemson University
- **Julius Knapp**
  Chief, Office of Engineering and Technology, Federal Communications Commission
- **Peter Mannetti**
  Formerly Managing Partner, iSherpa Capital, LLC

PANEL 2 – SUCCESSES

Moderator
- **Robert B. Kelly**
  Partner, Squire Patton Boggs

Panelists
- **Rob Alderfer**
  Vice President, Technology Policy, CableLabs
- **Larry Downes**
  Project Director, Georgetown Center for Business and Public Policy
- **David Goldman**
  Director, Satellite Policy, SpaceX
- **Charla Rath**
  Vice President, Wireless Policy Development, Verizon

PANEL 3 – FAILURES

Moderator

- **Jennifer A. Manner**
  Senior Vice President, Regulatory Affairs, EchoStar Corporation

Panelists

- **Jim Lansford**
  Director, Technical Standards, Qualcomm
- **Blair Levin**
  Nonresident Senior Fellow, Metropolitan Policy Program, The Brookings Institution
- **Erin McGrath**
  Legal Advisor, Federal Communications Commission
- **Steve Sharkey**
  Vice President, Government Affairs, Engineering and Technology Policy, T-Mobile USA, Inc.

PANEL 4 – SO WHAT?

Moderator

- **Pierre de Vries**
  Spectrum Policy Initiative Co-director and Executive Fellow, Silicon Flatirons

Panelists

- **Robert B. Kelly**
  Partner, Squire Patton Boggs
- **Jennifer A. Manner**
  Senior Vice President, Regulatory Affairs, EchoStar Corporation
- **Bryan Tramont**
  Managing Partner, Wilkinson Barker Knauer, LLP

CLOSING KEYNOTE

- **David J. Redl**
  Assistant Secretary for Communications and Information and Administrator, National Telecommunications and Information Administration

In addition to this speaker list and conference schedule, additional resources for the conference can be found here.