Evidence-Based Spectrum Policy

Report on a Silicon Flatirons Spectrum Policy Initiative Virtual Conference
October 13 and 15, 2020

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Contents

Executive Summary

Evidence-based policymaking is the process of routinely using the most rigorous research to guide policy decisions.[1] This conference presented spectrum policy researchers and practitioners from industry, academia, and government the opportunity to ask: does the world of spectrum policy use evidence-based processes? Or is spectrum policy still adhering to the cycle of "policy-based evidence-making" as pressure to meet spectrum demand mounts and complex technological challenges proliferate? Panelists and speakers offered a variety of perspectives in answer to these difficult questions, and challenged each other to identify exactly what evidence-based spectrum policy might look like.

Panelists generally agreed that policy deliberations and decisions must be made on the best information available, but noted that inconsistent and irregular data collection often impedes the process. Most acknowledged that ad hoc generation of missing evidence has been the typical approach to spectrum policy generation in the past. But panelists disagreed among themselves that current approaches differed enough to be considered consistently "evidence-based."

Several panels focused on the methods used at the early stage of data collection. They recognized that communicating to policymakers what the data means is a crucial turning point in the policy process, and involves a regulator's assessment of the researcher's credibility. Participants with regulatory backgrounds confirmed that increased transparency, and information about the research beyond methodology, would result in a more efficient evaluation process.

Panelists pointed out that the process of developing evidence should be iterative, and that the addition of anecdotal user data could supplement data sets. Incorporation of this supplemental data could help researchers develop data sets that are more inclusive of user experience. The result would be data sets that inform policy outcomes in ways that are more aligned with user needs.

One major takeaway from the conference was the importance of effectively implementing quantifiable standards in spectrum. This highlighted the need for the evidence-based policymaking process to extend past lawmaking and into enforcement.

The speakers highlighted that one of the major challenges to consistently implementing evidence-based spectrum policymaking is the fact that technology develops quickly and unpredictably. This results in unique cases that often require quick policy decisions, without the opportunity for years of careful research. Several panels highlighted the need for

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[1] See Appendix C: Recommending Reading, CEP Final Report, p.1

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adaptability and flexibility in evidence-generating processes. This value of "timeliness" from the policymaking perspective was sometimes at odds with researchers' desire for more thorough data collection processes. A few panelists pointed out that the current approach to data collection is extremely project specific and sometimes must change dramatically from project to project. They recommended a shift to more thorough and consistent data collection over time regardless of specific policy goals, which could result in more stable evidence and policy outcomes in the long-term.

Although bias was accepted as a given in this process, panelists seemed to agree that transparency could be improved at each stage of the policymaking process. Several panelists with regulatory perspectives agreed that transparency would help decision-making, but pushed back on the idea that bias was a negative aspect of policymaking. Instead, they asserted that it was a necessary component of the regulatory system, and at times has enabled policymaking to move forward when research was too costly and slow.

Introduction

Although evidence-based policymaking has gained popularity over recent years, there is little indication that evidence is being incorporated into policymaking decisions in spectrum. Spectrum policy has shown itself to be curiously resistant to a shift towards more empirical, data-driven policy. The Silicon Flatirons Center held a virtual conference on October 13 and 15, 2020 to understand why there is such a lack of evidence-based spectrum policy.[2] Participants in the conference endeavored to find the best ways to approach this problem through the discourse generated by the various speakers.

This conference provided the opportunity for panelists to discuss the process of evidence-based policymaking, and the needs of different kinds of spectrum-dependent services: sharing between different "active" services (e.g., cellular and radar); sharing between services that are "active" and "passive" (e.g., Wi-Fi and radio astronomy or remote sensing); and services and systems dependent on Position/Navigation/Timing (PNT) (e.g., electric power distribution, finance). The workshop was split into two days, each beginning with a keynote speech followed by two panel discussions. The first day of the conference also included framing remarks from Dale Hatfield, Co-director of the Silicon Flatirons Spectrum Policy Initiative.

Panels included, in order: evidence-based policymaking in perspective, spectrum sharing policy among active services, spectrum sharing policy among active and passive services, and resilience in PNT. These panel topics and the inclusion of panelists from industry, government, and academia were designed to highlight that coexistence of various spectrum-dependent services all face evidentiary and policy challenges. Although each user, service, or sector advocates for spectrum policy outcomes for their own benefit, they struggle with both similar and unique hurdles in evidence-generation and policy implementation. The conference organizers hoped to encourage an ongoing discourse about the advantages and disadvantages of evidence-based policymaking, and its potential impact on the spectrum policy community as a whole.

This report summarizes the discussion in chronological order, and concludes with a summary of conference takeaways and speaker recommendations. Multiple appendices are included at the end of this report, including a list of names and affiliations in Appendix A, an event agenda in Appendix B, and the recommended reading list from conference organizers in

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[2] The conference was organized by Keith Gremban, Pierre de Vries, and Dale Hatfield. The author thanks them for their assistance in preparing this report.

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Appendix C[3]. A link to the event can be found on the Silicon Flatirons website,[4] which includes links to transcripts and video recordings of the conference.

Several articles about the event were published in industry newsletters. These include Communications Daily, PolicyTracker, TR Daily, and World Radiocommunications News, to name just a few.

Day 1 Keynote: Thyaga Nandagopal

The first day of the conference kicked off with a keynote speech from Thyaga Nandagopal from the National Science Foundation.[5,6] He set the stage for the conference by walking through a brief history of U.S. spectrum regulation, focusing on times when increasing knowledge about spectrum allowed for the implementation of new technologically-informed policy approaches.

Nandagopal argued that U.S. spectrum policy changes have always been driven by the threat of spectrum scarcity. Spectrum engineers today are exploring creative solutions to scarcity through sharing schemes and using never-before-accessed frequencies. Nandagopal's message was encouraging: "Yet as we have seen time and time again, technology has enabled us to tap into more spectrum that we otherwise thought was not available and not possible to use." This process can take time, and relies heavily on data to produce evidence that informs policy discussions. Bias inherent in the data, or bias coming from the regulators themselves, can lead to uncertainty, and stall progress.

Shared use in the 3.5 GHz CBRS band has encouraged a cultural shift towards new attitudes throughout the regulatory and user ecosystems. Nandagopal highlighted several manifestations of this contemporary shift in perspective: the current status of wired networks, multi-homed end devices, switched ethernet at the edge, carrier aggregation for 400 Gbps Ethernet, and interconnection agreements with multiple carriers . Highly resilient, self-aware networks that "learn on the fly" are now within the realm of possibility, as are devices that can self-identify the frequencies and power levels needed to get their data transmitted.

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[3] The author thanks Wilson Scarbeary, Research Assistant with Silicon Flatirons and Student at University of Colorado Law, for his collaboration on the recommended reading materials.

[4] Event webpage, https://siliconflatirons.org/events/evidence-based-spectrum-policy/

[5] Nandagopal, T. (2020, Oct. 13). *Spectrum Future(s): What do the airwaves foretell?* [Slide presentation]. Evidence-Based Spectrum Policy, University of Colorado, Boulder, CO, United States http://siliconflatirons.org/wp-content/uploads/2020/10/T.Nandagopal_SiliconFlatirons_Keynote_SpectrumFutures_Oct2020.pptx

[6] Speakers' full titles and affiliations can be found in the Appendix A: Speaker Information on p. 15.

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Turning to the future and a discussion of what spectrum progress will look like moving forward, Nandagopal acknowledged that both greater efficiency and increased frequency accessibility will require reassigning users to different frequencies. Reassignment of users will be limited by both economic and policy constraints, as they always are, but Nandagopal emphasized that the desire to make these reallocations and spectrum sharing a reality will prevail.

This all begs the question: how will we achieve these goals? Nandagopal suggests that continued research is the key, from organizations like the National Science Foundation, the Department of Defense (DoD), the Defense Advanced Research Projects Agency, and many others. With investment in data collection, the community can gather the evidence to shape the best spectrum policies for the future.

Panel 1: Evidence-Based Policymaking in Perspective

This panel began with a discussion of the evolving evidence-based policymaking movement, after moderator David Redl, from Salt Point Strategies LLC, asked panelists' opinions on whether U.S. spectrum policy today takes an evidence-based approach. The discussion that followed set the stage for the rest of the conference, challenging panelists to come with their own definitions as they sought to explore the potential benefits and practical disadvantages that evidence-based policymaking presents both researchers and policy advocates.

Panelist Blair Levin, with The Brookings Institution, pointed out that the converse of "evidence-based policymaking" would be "policy-based evidence-making," in which the government cherry-picks the evidence or data that supports its predetermined policy choice. He pointed out that when the process works, it starts with questions and not answers, and relies on data that is routinely and consistently gathered over time as opposed to a particular purpose. It also relies on cultural norms in institutions like a belief in challenging facts, the scientific process, and a willingness to make course corrections. Levin opined that political pressures push back on all these factors.

> *"People are always going to be able to come up with new data [to] support whatever they're trying to push."*
> *—Scott Wallsten*

Panelist Kate O'Connor (Chief counsel, U.S. House of Representatives Committee on Energy and Commerce) acknowledged that there will always be data available to support any side of a policymaking argument, but it matters how policymakers wield it. Scott Wallsten from the Tech Policy Institute pointed out: "The data is always out there. People are always going to be

able to come up with new data [to] support whatever they're trying to push." He stated that ultimately evidence-based policymaking in practice is thinking about things in a cost-benefit framework, but not necessarily economizing every factor involved. At its core, it's about questioning beliefs based on new information.

When asked about differentiating data or knowledge from evidence, panelists provided some interesting insights. Wallsten pointed out the importance of remembering that interested parties are inherently biased, including the government. To handle this mindset, Wallsten thought that the most important factor is transparency. Beyond knowing who paid for the research, he stressed having enough context to "interpret the work and understand the assumptions that they made …" Panelist Adam Scott (from Innovation, Science and Economic Development Canada) suggested that there is some truth to the old adage: listen to everything a company tells the regulator, and everything that they tell their investors, and split the difference.

When asked about times when evidence and politics are inherently at odds, Wallsten used spectrum auctions as an example. He pointed out that economic studies were emphasized in an attempt to insulate the auction design process from political interference. O'Connor underscored the importance of trying to figure out a way to isolate politics from spectrum decision making as key to future progress.

Overall, this discussion produced thoughtful and intriguing ideas that drove later conference discussions about the steps in the process of evidence-based policymaking, Panelists agreed that increased transparency throughout the process is a helpful goal for both researchers and policy advocates. While they seemed to agree that rigorous evidence was beneficial to the public good, they disagreed about whether evidence-based policy was always the most practical or achievable approach.

Framing Remarks: Dale Hatfield

The framing presentation was given by Dale Hatfield, Co-director of the Silicon Flatirons Spectrum Policy Initiative, and focused on harmful interference as a key issue in spectrum policy.[7] He discussed receiver performance standards, monitoring and measurement of noise and interference levels by regulators, and spectrum performance. Importantly, Hatfield indicated that evidence-based policymaking approaches would benefit from receiver performance standards. He opined that enforceable receiver performance requirements using concepts like interference limits would be extremely helpful in enabling an evidence-

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[7] Hatfield, D. (2020, Oct. 13). *The Spectrum Perspective*. [Framing Remarks]. Evidence-Based Spectrum Policy, University of Colorado, Boulder, CO, United States. https://siliconflatirons.org/wp-content/uploads/2020/10/D.-Hatfield_Framing-Remarks-As-Prepared-for-Delivery-101320.pdf

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based spectrum policy approach, but that industry has not yet followed through with these ideas.

Another area of spectrum policy he emphasized is the monitoring and measurement of noise and interference levels. Although this has been recommended by various advisory committees and scientists over the years, long-term and accurate measurements of radio noise and interference levels in different spectrum bands still do not exist. Hatfield pointed out that this has three implications: difficulty determining where or by how much interference is changing; not knowing what systems or devices are responsible for interference; and the absence of comprehensive databases to fuel emerging spectrum management techniques utilizing artificial intelligence. As Hatfield stated, "These are the very tools we need to be able to successfully identify, mitigate, and remediate intentional, unintentional, and incidental sources of noise and interference in an increasingly congested and complex spectrum environment."

> *"I think as we look at an evidence-based approach, yes, we're doing it today. But that doesn't mean we're doing it enough."*
> *—Russ Gyurek*

The final area of spectrum policy highlighted by Hatfield was spectrum enforcement. He emphasized that even if his concerns in all three aforementioned areas were met, evidence-based spectrum policymaking would not be useful if those policies were not enforceable. He suggested a potential way to compensate for the decline in resources devoted to interference management might be for the Federal Communications Commission (FCC) to delegate some of its statutory duties to private entities. He pointed out as an example that the Commission has pursued, or is pursuing, just such approaches in a number of important proceedings, including those in 0.6 GHz, 3.5 GHz, 4.9 GHz, and 6 GHz.

Panel 2: Active Services

Coexistence of active services has become a necessity as demand for spectrum grows, encouraging the growth of spectrum sharing approaches like 5 GHz DFS (Dynamic Frequency Selection) and CBRS in recent years. [8,9] Prompted by moderator Renee Gregory from Google, panelists discussed their interpretation of the current available data on spectrum sharing approaches, and the current trajectory of policy adoption. They also discussed the specific kinds of evidence that policymakers are (and should be) considering during the decision-making process, as well as recommendations for policymakers and scientists working in this space.

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[8] FCC's 5 GHz FAST plan, https://www.fcc.gov/5G
[9] CBRS, https://5ginsider.com/news/cbrs-band-in-high-demand-at-fcc-auction/

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Patrick Welsh from Verizon Wireless said that successful spectrum management requires an effective enforcement regime. In order to identify, mitigate, and remediate interference, Welsh pointed out that "[m]aking sure that the enforcement mechanism is baked into the framework from the beginning really helps to prevent intractable interference problems in the future." Russ Gyurek, from Cisco, stated: "I think as we look at an evidence-based approach, yes, we're doing it today. But that doesn't mean we're doing it enough."

On the subject of potential biases in development of evidence, Paul Kolodzy noted that even within science there are confirmation biases. He suggested that if one approaches the initial research in a more focused and direct way, one could potentially get to some solutions more quickly. Kolodzy says that one of the major problems is "follow[ing] that [initial research] process through to complete an argument before moving on to the next one."

Giulia McHenry of the Federal Communications Commission stated that, although politics is inherently biased, from an agency perspective the goal is "performing as neutral an analysis as we can, understanding our biases, understanding the other biases that are out there, trying to sort of provide the most holistic view, and offering that analysis up with its flaws." When asked about determining credibility of evidence, she explained that when researchers show their work, the agency can do its own analysis: are the assumptions realistic, and if not, how does that change the analytical outcome?

In summary, this panel highlighted the problems of inherent bias in interpreting evidence, and discussed approaches to recognizing, understanding, and minimizing bias.

Day 2 Keynote: Eric Burger

The second half of the conference started with a speech by Eric Burger, from the White House Office of Science and Technology Policy (OSTP). Burger's keynote focused on how a specific policy goal tied to evidence resulted in the unprecedented transfer of 100 MHz of prime mid-band spectrum from government use through what he called the AMBIT process (America's Mid Band Initiative Team). The result was the fastest time-to-auction to date. He acknowledged that in the past, four years between the identification of a potentially usable band and an eventual commercial auction was an acceptable time frame. But in the case of AWS-3, after an additional six years post-auction, the NTIA (National Telecommunications and Information Administration) was still attempting to clear federal users off the band. Burger asked, "[I]s that the best we can do?"

Burger offered the example of CBRS, where the NTIA identified that the relevant bands would have potential commercial use. Then DoD found a way to share the band with private sector priority licensees when DoD wasn't using it, an example of temporal sharing. In addition, unlicensed users got access to spectrum at times when neither DoD nor priority

licensees were using it. This sharing scheme was the result of the question, "How can we allow commercial users to share the federal spectrum without harming the incumbent user?"

In November 2019, the president charged the administration to make 100 MHz available for commercial use by 2021. Burger insisted that changing its approach was key to making this DoD's fastest transition yet from federal to commercial spectrum use. The new question was, "If federal users cannot fully vacate the band, how can they change their operations to get out of the way of commercial users?" This approach necessitated an agile and adaptable solution, because instead of requiring federal users to vacate the band, the team was trying to make spectrum available by minimizing the impact of federal use on commercial users.

Burger closed by highlighting the important takeaways from the 100 MHz challenge: a more collaborative effort between government and commercial users will result in a larger amount of spectrum available for commercial users. This would yield a commercially viable offering without forcing out the incumbent. The 100 MHz proceeding demonstrated evidence-based policymaking that started with a policy goal, mobilized a team to generate evidence-based on that goal, and achieved their goal in record time.

Panel 3: Active and Passive Services

Spectrum policy is especially complex when active and passive services are expected to share spectrum. Because passive services often support scientific research, issues arise when their utility is compared to more directly commercial active services. Passive users face difficulties in communicating the value and importance of creating reliable shared space in our spectrum resources. These difficulties are compounded by a lack of public understanding and prioritization by policymakers.

"Unfortunately, what we often see from policy makers… is a somewhat subjective choice of what they choose to view as fact-based."
—Jennifer Manner

Panelists responded to questions from moderator Doug Kinkoph (NTIA) about how evidence-based policy can yield the greatest public good. The subtext of their discussion pointed to a need to better inform policymakers about the value of passive services, which serve the public in less direct ways than the services provided by many active services. The panel recommended altering the current approach to prioritization of spectrum usage by commercial and non-commercial actors.

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Chris Tourigny from the Federal Aviation Administration pointed out that as "data-driven" becomes a more common phrase, it is starting to get overused; we now need to focus on how to refine data into evidence through a validation process.

Ashley Zauderer of the National Science Foundation used radio astronomy as an example of a passive service that has increasing utility in everyday life. She stated that it's important to remember that "[w]hen we think about sharing between active and passive, every active transmitter actually has a receiver that is passive to actually detect that signal." She emphasized that this was an important element of Hatfield's remarks the day before, because researchers can glean important information about interference from passive services that also applies to active services.

The panel was asked about the impact of sharing regimes on passive services. Zauderer pointed out that many passive services have protected bands because those frequencies have special properties, and sometimes those frequencies are not optimal for commercial use. As "quiet zones" and other strategies become less viable, astronomers are solving this issue with temporal and geographic sharing models. Often, coexistence in spectrum is facilitated by a symbiotic relationship between active and passive users.

> *"Modeling is the beginning, not the end, of the discussion."*
> *—Dana Goward*

Jennifer Manner (EchoStar) said that with sharing, transitioning from a "yes or no" mindset to a "maybe" has been an exciting shift. There is a new willingness by all users to engage in collaborative problem-solving, and make more efficient use of spectrum. Chris Gregory of HawkEye 360 pointed out that governments need to recognize this hurdle early and start investing now, or risk falling behind in enforcement. Manner, Gregory, and Tourigny each voiced concerns about aggregate interference as the next hurdle for industry to overcome.

In summary, the panel was optimistic about enabling spectrum sharing through informed collaboration between stakeholders in active and passive services.

Panel 4: Position, Navigation, and Timing

Positioning, Navigation, and Timing (PNT) technologies have become crucial components of our daily lives. Examples of PNT systems include the Global Positioning System (GPS) and LORAN (LOng RAnge Navigation). Along with increased demand for spectrum access comes mounting concern about resilience of PNT technologies. Panelists tackled questions about the kinds of evidence that could best inform PNT policy; their thoughts on the current

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approaches to presenting evidence in PNT cases; and difficulties faced by practitioners attempting to both generate and present PNT policy arguments.

Moderator Keith Gremban (Silicon Flatirons) opened the panel by asking panelists which PNT services are most crucial to our lives; PNT is synonymous with GPS navigation for many people, but includes much more. Panelists shared that PNT is used in payment systems, logistics, electrical and cellular networks, weather forecasting, precision agriculture, national security, and rideshare applications. Jade Morton (University of Colorado Boulder) pointed out that space weather forecasting, reflectometry, and other types of sensing of GPS signals are important to modern science.

When asked about what kind of evidence could (or should) inform policy proposals with potential impacts on PNT, panelists agreed that evidence should include field data collection, controlled experiments, and physics-based modelling. Stefanie Tompkins with the Colorado School of Mines stated that given the dynamic complexity, data collection has to include information from users, in order to determine "…what the impact might be, so that the modeling, data collection, and [anecdotes] can [build on] each other in order to get as much information as possible."

In addressing model validation, panelists recognized that assumptions about signal propagation were often not correct; modelling is an iterative process. Dana Goward with the Resilient Navigation and Timing Foundation stated, "Modeling is the beginning, not the end of the discussion." He emphasized that partnerships between government and industry can go a long way to increasing the efficiency of PNT systems, as mentioned in his white paper on the same subject.[10]

When asked what PNT resilience looks like, Morton answered that one needs to address vulnerability on multiple fronts, including making systems (and particularly receivers) more robust. Tim Godfrey (Electric Power Research Institute) pointed out that GPS timing synchronization is essential in operating bulk electric power systems in North America. For example, the Institute for Electrical and Electronic Engineers and the International Electrotechnical Commission are collaborating on a project to improve the precision and resilience of time-sync networks.

The panel clearly stated the importance of PNT to modern life, and the need to develop mechanisms to increase the resilience, and hence reduce the vulnerability, of this resource to interference.

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[10] Weiss, M., Diamond, P., & Goward, D. (2016). A Resilient National Timing Architecture: Securing Today's Systems, Enabling Tomorrow's [White paper]. Resilient Navigation and Timing Foundation. https://rntfnd.org/wp-content/uploads/Resilient-National-Timing-Architecture-16-Oct-2020.pdf

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Summary

Several themes emerged from the panel discussions and speeches. Discussion of the "evidence" aspect of evidence-based policy was dominant, with ample focus on optimal data collection and communication of research findings to policymakers. The subtext in exchanges between researchers, policy advocates, and regulators was that evidence-based policymaking, while an admirable goal, cannot always be the primary source of information for policy decisions due to economic and temporal constraints. There was also acknowledgement that the implementation of evidence-based policy relies, at least in part, on the regulator's ability to enforce those policies. Overall, there was a disconnect between researchers and policymakers concerning consistency in approach. Researchers favored increased consistency in the kinds of data that should be used to generate evidence to drive policy. On the other hand, policymakers insisted that there cannot be a "one-size-fits-all" approach to determining what evidence will be most useful for each case. Transparency in the policymaking process was discussed several times as a recommended improvement from both camps.

Panelists generally agreed that past U.S. spectrum management processes have often been "policy-based evidence-making"— acquiring the required evidence once a course of action had already been determined. But panelists and speakers were not necessarily in agreement that this process was always problematic, or that evidence-based policymaking was a necessary (or even desirable) approach in all spectrum policy situations. Although proceedings like DoD's recent 20 MHz spectrum clearing utilized evidence, that example highlighted some of the tradeoffs between a general evidence-generating regime and a spectrum policy approach motivated by specific political goals. Panelists with regulatory perspectives acknowledged that truly rigorous evidence-generation can be costly. Because of the high cost, cost-benefit analyses from policymakers may be hindering expansive evidence-generation in contemporary policymaking.

Panelists generally agreed that one can develop more accurate evidence-based arguments by emphasizing consistency, and longer timeframes for data collection. Panelists called attention to the fact that the political process does not necessarily incentivize standardization in data collection. Those with a regulatory point of view pointed out that rapidly changing technology necessitates flexibility in the research methods used for each unique spectrum policy challenge. This difference in views highlighted the direct contention between the researchers, who preferred establishing a standard for generating data sets, and the policymakers, who preferred less definite standards for data collection in order to use that data flexibly to approach policy advocacy.

There was overall agreement that defining harmful interference continues to be a pressing issue in spectrum policy. Although quantitative criteria have been proposed, they have not

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been implemented in U.S. spectrum policy. Related discussions in multiple panels suggested that enforcement, and not just policymaking, requires a more evidence-based approach to succeed. For example, shifting to more automated spectrum management systems will require quantitative inputs to train and operate machine learning systems. There were several recommendations on how to improve resilience and robustness, with a focus on increasing the breadth of the data collected during the initial evidence-generation in order to encourage more inclusive policy outcomes. Panelists also emphasized the importance of identifying assumptions made while developing evidence.

Several speakers spoke about risks of policy being motivated by ideology, as opposed to starting with evidence, because of the instability and inconsistency it presents for spectrum policy generally. Increased transparency was the solution offered in several panels that was agreeable to both researchers generating evidence and policy advocates who seek to apply that evidence. Panelists agreed this would enable both researchers and advocates to maintain credibility with regulators, and improve the iterative process of evidence development.

Appendix A: Speaker Information

Eric Burger, Assistant Director of the Office of Science and Technology Policy, Executive Office of the President

Tim Godfrey, Technical Executive, Electric Power Research Institute

Dana Goward, President, Resilient Navigation and Timing Foundation

Chris Gregory, Vice President of Engineering, HawkEye360

Renee Gregory, Senior Regulatory Affairs Advisor, Google

Keith Gremban, Senior Fellow, Silicon Flatirons Center, University of Colorado Boulder

Russ Gyurek, Director of Internet of Things, Office of the Chief Technology Officer and Industries, Cisco

Dale Hatfield, Spectrum Policy Initiative Co-director and Distinguished Advisor, Silicon Flatirons

Doug Kinkoph, Associate Administrator performing the Delegated Duties of the Assistant Secretary of Commerce for Communications and Information, National Telecommunications and Information Administration

Paul Kolodzy, Independent Telecommunications Consultant, Kolodzy Consulting

Blair Levin, Senior Fellow with the Metropolitan Policy Program, Brookings

Giulia McHenry, Chief, Office of Economics and Analytics, Federal Communications Commission

Jennifer Manner, Senior Vice President, Regulatory Affairs, EchoStar

Jade Morton, Professor, Aerospace Engineering Sciences; Director, Colorado Center for Astrodynamics Research; Head of the Satellite Navigation and Sensing (SeNSe) Laboratory, Aerospace Engineering Sciences Department, University of Colorado Boulder

Thyaga Nandagopal, Deputy Division Director, Division of Computing and Communication Foundations, Computer & Information Science and Engineering, National Science Foundation

Kate O'Connor, Chief Counsel for Communications and Technology, U.S. House of Representatives Committee on Energy and Commerce

David Redl, Founder and Chief Executive Officer, Salt Point Strategies

Adam Scott, Director General of Spectrum Policy, Innovation, Science and Economic Development (Canada)

Stefanie Tompkins, Vice President for Research and Technology Transfer, Colorado School of Mines

Chris Tourigny, Electronics Engineer, Federal Aviation Administration

Scott Wallsten, President and Senior Fellow, Technology Policy Institute

Patrick Welsh, Assistant Vice President, Federal Regulatory Affairs, Verizon Wireless

Ashley Zauderer, Program Director in the Division of Astronomical Sciences, National Science Foundation

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Appendix B: Event Agenda

October 13, 2020 — Day 1

10:00 am – 10:10 am	**Welcome and Introduction** Amie Stepanovich, Keith Gremban
10:10 am – 10:30 am	**Opening Keynote Address** Thyaga Nandagopal
10:20 am – 11:15 am	**Panel 1: Evidence-Based Policymaking in Perspective** David Redl, Blair Levin, Kate O'Connor, Adam Scott, Scott Wallsten
11:15 am – 11:30 am	**Break**
11:30 am – 11:45 am	**The Spectrum Perspective and Framing Remarks** Dale Hatfield
11:45 am –12:30 pm	**Panel 2: Spectrum Sharing Policy Among Active Services** Renee Gregory, Russ Gyurek, Paul Kolodzy, Giulia McHenry, Patrick Welsh
12:30 pm – 1:30 pm	**Virtual Breakout Rooms**

October 15, 2020 — Day 2

10:00 am – 10:10 am	**Welcome and Introduction** Keith Gremban
10:10 am – 10:30 am	**Keynote Address** Eric Burger
10:30 am – 11:15 am	**Panel 3: Spectrum Sharing Policy Among Active and Passive Services** Doug Kinkoph, Chris Gregory, Jennifer Manner, Chris Tourigny, Ashley Zauderer
11:15 am – 11:30 am	**Break**
11:30 am – 12:15 pm	**Panel 4: Resilience in Position, Navigation and Timing** Keith Gremban, Tim Godfrey, Dana Goward, Stefanie Tompkins, Jade Morton
12:15 pm – 1:00 pm	**Virtual Breakout Rooms**

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Appendix C: Recommended Reading

The following list was prepared for conference attendees.

CEP Final Report: The Promise of Evidence-Based Policymaking
https://cep.gov/report/cep-final-report.pdf
Author: Commission on Evidence-Based Policymaking
Date: September 2017
Key material – Executive Summary and Recommendations: pages 1-6
Total Length: 128 pages
Relevance: This final report from the Evidence-Based Policy Commission "envisions a future in which rigorous evidence is created efficiently, as a routine part of government operations, and used to construct effective public policy." The report details numerous ways in which evidenced-based policy could be used to facilitate more effective and fair data privacy protections. There are recommendations for: improving secure, private, and confidential data access; modernizing privacy protections for evidence building; implementing the national secure data service; and strengthening federal evidence-building capacity. The Commission identifies specific problem areas that evidence-based policymaking processes would address, and gives examples of major societal questions that cannot currently be answered without better access to relevant data.

What is wrong with evidence based policy, and how can it be improved?
https://www.sciencedirect.com/science/article/pii/S0016328717300472
Author: Andrea Saltelli, Mario Giampietro
Date: August, 2017
Key material – Conclusion: page 70
Total Length: 8 pages
Relevance: Encouraging the widest variety of perspectives in the evidence-based policymaking process is crucial to the success and continued implementation of this approach. In this article, the authors point out that current approaches to evidence-based policy practices are potentially biased, and attempt to correct this methodological bias by focusing on the point in the data-gathering and analysis process where evidence is presented. They highlight certain forms of quantification (like risk analysis, cost-benefit analysis, and extensive mathematical modelling) that tend to be presented in a way that distracts from what the authors call "alternative readings," which can result in a dramatic narrowing of the wide range of worldviews held by stakeholders, and erodes their trust in the institutions involved. They suggest an alternative approach of "quantitative story-telling," followed by an attempt to refute each framework in turn to analyze if it violates constraints of feasibility, viability and desirability. By using this method alongside tools like mathematical models and quantification, scientists can address potential policy biases and avoid prematurely eliminating legitimate policy options from their consideration.

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Getting evidence into policy: The need for deliberative strategies?
https://www.sciencedirect.com/science/article/pii/S0277953611000888
Author: Kathy Flitcroft, James Gillespie, Glenn Salkeld, Stacy Carter, Lyndal Trevena
Date: February 11, 2011
Key material – Discussion and Conclusion: pages 1044-1045
Total Length: 7 pages
Relevance: The authors analyze the implementation of a cancer screening program by the Australian federal government, and identify institutional limitations to incorporating evidence into policy through "filtering." They propose that this happens at three levels of national government: at the health department level, between government departments, and across the broader government structure. The authors suggest three alternative models to traditional knowledge utilization approaches based on "deliberative strategies," which facilitate more participation from a broader range of policy perspectives and increase distribution of decision-making authority. This article highlights the importance of focusing on integrating deliberative strategies into evidence-based policy implementation in order to address issues within an existing system of governance. The authors believe that a stronger sense of "public reason" will result, allowing for evidence to be better integrated into the policymaking process through improved public trust.

Evidence-Based Policymaking: A guide for effective government (Pew-MacArthur)
http://www.pewtrusts.org/~/media/assets/2014/11/evidencebasedpolicymakingaguideforeffectivegovernment.pdf
Author: Pew-MacArthur Results First Initiative
Date: November, 2014
Key material – Key Components and Conclusion: pages 4-18
Total Length: 25 pages
Relevance: Analytical reports from academic institutions are an important contributor to the ongoing evidence-based policymaking conversation, because these institutions operate as both colleagues and checks to government institutions. This report offers a simple framework for implementing and evaluating evidence-based policy in the federal government within the legislative and executive branches. This framework has five key components: program assessment, budget development, implementation oversight, outcome monitoring, and targeted evaluation. There is a focus on economic factors that drive current barriers to implementation of evidence-based policymaking, and attempts to use the proposed framework to address each of these barriers. The report also discusses the growing support for evidenced-based policy to reduce spending, expand innovation, and strengthen accountability.

Robert Shea on Evidence Based Policy's Impact and Potential on Two Think Minimum
https://techpolicyinstitute.org/2020/06/29/robert-shea-on-evidenced-based-policys-impact-and-potential-two-think-minimum/

Silicon Flatirons

Author: Robert Hahn and Robert Shea

Date: June 20, 2020

Length: 25 minutes of audio

Relevance: This podcast from the Technology Policy Institute (TPI) features Robert Shea, a former Commissioner on the Evidence-based Policy Commission and current policy principal at Grant Thornton. Along with host Dr. Bob Hahn, Dr. Shea discusses his personal experience and takeaways on evidence-based policy as it is currently being implemented in the United States. Their discussion touches on evidenced-based policymaking as it relates to relevant, topical events like the U.S. government's response to the coronavirus pandemic. Shea also offers some insight into how politics and procedural architecture impact the implementation of evidence-based policy methods.