

Recording available at:

<https://www.youtube.com/playlist?list=PLTAvIPZGMUXNVhIOoXZBAF49k505QGno4>

[Music]

[00:00:13]

Female: Silicon Flatirons is a research center at Colorado Law School. We work with students to give them the tools they need to pursue careers in tech, law, policy, and entrepreneurship.

[00:00:25]

Male: When I started Silicon Flatirons, it was an experiment. It was me and some students putting on a few conferences without really a plan where it was going to go. My initial motivation was because I didn't believe you could have impactful policy discussions unless you brought people together across different disciplines. Silicon Flatiron has given me an image of what a team can look like.

[00:00:25]

Female: And it really made Boulder into a location that was seen as on par with DC, or Silicon Valley, and other places around the country that are leading thought centers in the field of law and tech.

[00:01:01]

Male: What excited me the most is to see it grow. But not only just grow in terms of the number of people attending our different events but growing in terms of the different areas that we have been involved in.

[00:01:15]

Male: When a law student says, "I've got a passion for understanding the intersection of technology and law, but where do I get started with that?" What Flatirons provides is [Inaudible 00:01:25] for a job during their second summer where they're actually going to get to be involved directly in setting tech policy and advocating around tech policy.

[00:01:36]

Female: The Silicon Flatirons community is incredibly unique in how close it is and how people are willing to band together to move conversations forward.

[00:01:47]

Female: It's one thing to be sitting in a room by yourself reading articles, and it's very much another thing to actually be sitting at a table, talking to somebody about their daily experiences of trying to navigate compliance with a complex new law.

[00:01:57]

Male: We're all a community of friends who enjoy spending time with one another.

[00:02:04]

Female: The people we engage with through here are very much thinkers and thought leaders, so they're contributing to whether it's our strategy or our resources in really meaningful ways.

[00:02:14]

Male: Silicon Flatirons has changed the dynamic between Colorado law and the surrounding community, as well as the national community.

[00:02:22]

Female: One of the great joys of my profession is talking to people who are really early in their careers and helping them get excited about what you're excited about.

[00:02:30]

Male: We get the types of people in the room that everyone thinks should be talking to one another but often are not.

[00:02:38]

Male: I get to work with students. I get to work with attorneys. I get to work with policy makers at the intersection of all these issues.

[00:02:44]

Female: Students are first and foremost. So, everything is generally student driven.

[00:02:50]

Female: And it is centered around people who are wanting to engage with students.

[00:02:55]

Male: I've seen students come into Silicon Flatirons just having a little interest in it. You know, in year one. And by year three, they're passionate about it, and they've found their career.

[00:03:05]

Female: And I think that that really helps the standing of the university more broadly, and it also attracts lots of really interesting and talented speakers.

[00:03:14]

Female: I think what I'm excited to see happen with Silicon Flatirons in the next 5, 10, even 20 years is for it to blend continuity with change.

[00:03:25]

Female: It's not enough to have smaller conversations anymore. The world is all connected, and Silicon Flatirons is going to reflect that global nature of the internet as we move forward into 20 years in the future.

[00:03:40]

Male: I hope it continues to operate with the same spirit of experimentation, of adventure, of seeking out new challenges that we've done over the first 20 years.

[00:04:04]

Vanessa: Hi. Good morning, everyone. Thank you so much for joining us. My name is Vanessa Copple [Phonetic 00:04:11]. I'm the senior events manager for Silicon Flatirons. As we kick things off today for day one of the annual Spectrum Conference, I just have a couple quick housekeeping notes. We are in the Zoom webinar format, so that means if you're an attendee, we cannot see or hear you. Don't worry about your microphone or your video. Just enjoy what we show you on screen. We are offering CLE credit today with all of the panels.

So, if you're interested in that, the affidavit will be sent with the survey after the event. CLE materials are available from the event webpage, under the resources tab. And if you don't know what CLE is, that's okay. You might not need it. After the panels today, we are meeting over at Air Meet, which is a browser-based platform to preserve the hallway track so that speakers, and students, and attendees can all mingle and talk together. So, we hope to see you there. All of the information is on the event map, which I will chat to you. And without any further ado, I'll turn things over to our executive director, Amie Stepanovich.

[00:05:18]

Amie: Thank you, Vanessa. I want to offer a huge thanks to Keith Gremban, Pierre de Vries, and Dale Hatfield for putting together such an amazing conference. And I'm going to hand things straight over to Keith to give an introduction for today.

[00:05:49]

Keith: Hello, everyone, and welcome to our Silicon Flatirons conference on evidence-based spectrum policy. I'm Keith Gremban. I'll be the host for your conference. I'm a senior fellow at Silicon Flatirons and a research professor in engineering and applied science. We're pleased to have everyone here today, and I think we've got a great program prepared. And we're all looking forward to some great discussions. First, let me reintroduce Amie Stepanovich, the executive director of Silicon Flatirons. Amie has spent a career at the intersection of law policy and technology and has been actively engaged in protecting human rights, and laws, and policies involving technologies and their use. She is also a nationally recognized expert in domestic surveillance, cyber security, and privacy law. So, Amie, some opening remarks? Over to you.

[00:06:41]

Amie: Thank you, Keith. And thank you, again. It's so really great to be here with you all today. In addition to my thanks earlier to Keith, Pierre, and Dale, I want to give a thank you to our staff. Vanessa, who you just heard from, Heather, Nate, Sarah, and Catherine for all they do to make these events possible, as well as to two really special students. Rachel Anderson and Wilson Scarbery whose help has been truly invaluable in getting to today. Before I go any further, I want to step back and begin by acknowledging that wherever you're tuning in from, we are meeting on the land of first nation's peoples. The traditional peoples of the land in Boulder are the Cheyenne, Arapaho, and Ute nations. And I'd like to pay particular respect to their elders, past, present, and emerging, who lead these communities.

At Silicon Flatirons, we elevate the debate around technology policy issues, support and enable entrepreneurship in the technology community, and inspire, prepare, and place students throughout all of these important areas. There are few things that we believe in more here at Silicon Flatirons than the power of community and of interdisciplinary coordination. And I believe this conference is going to be a perfect showcase of both of those values. Today and on Thursday, you'll hear from technologists, policy makers, and experts from academic, government, and the private sector. You'll also see students engaging with the material, asking questions, as well as during the breakout groups, which I hope you will all attend. And you'll find more information about those in your reminder emails.

During this event, I want to pose one challenge for all of you – to truly open yourself up to one new idea that you either hadn't heard before or perhaps had been actively hostile towards. We live in difficult and cantankerous times. But at Silicon Flatirons, our goal is to rise above and provide space for people to come together and for new thoughts to emerge. So, before I turn it back over to Keith, two final thank yous. One to our supporters. Even during these harsh economic times, the supports have held us up and given us the ability to provide programs for our entire community, and we are deeply grateful. And finally, thanks to all of you for tuning in and for learning with us, and for engaging all throughout our conference today and Thursday. And without further ado, back to Keith.

[00:06:41]

Keith: Thank you, Amie. Today's conference on evidence-based spectrum policy is the second of two conferences we've held here in Colorado in the past few months concerned with the issues around ensuring reliable and secure access to wireless services. The first event held in August was the 2020 International Symposium on Advanced Radiotechnology or ISART. This was jointly sponsored by the National Telecommunications and the Information Administration, the National Institute for Standards in Technology, and the University of Colorado. ISART focused on identifying the challenge for assured access to spectrum in a zero-trust environment. Now, spectrum of course is finite resource, and spectrum sharing is a major policy tool for enabling reliable secure access to spectrum. So, our conference today and Thursday

builds on ISAR by exploring the policies required for spectrum sharing. And in particular, we'll examine the role of evidence in spectrum policy making.

Our conference takes place over two days – Tuesday and Thursday this week from 10 AM to 1 PM Mountain Time or noon to 3 PM Eastern. The format is roughly the same each day – a keynote address, panel discussions to explore the issues concerning evidence in spectrum policy, Q and A following each panel, and then virtual breakout rooms at the end of day. Please attend the breakout rooms. We're trying to capture the hallway experience that you have in a face to face conference by setting up these virtual environments to give attendees the opportunity to interact with the panelists and moderators. So, everybody who registered, you should have received a link to the breakout rooms and the instructions for joining.

A couple of reminders to our moderators and panelists – Silicon Flatirons follows the Weiser rule, that students get to ask the first questions. And a reminder to everybody to apply the no acronym rule. Remember that the audience and panelists may be from very different domains, so please define all your acronyms on first use. And so now I'm going to hand off to one of our law students, Rachel Anderson. Rachel is a second-year law student that we managed to infect with the spectrum bug. She interned this summer with the National Telecommunications and Information Administration this last summer and helped out as a volunteer for both ISART this summer and today's conference. So, Rachel, over to you.

[00:11:43]

Rachel: Thank you so much, Keith. I'm extremely honored to introduce our first speaker of the day, Dr. Thyaga Nandagopal. Thyaga is the deputy division director of the Computing and Communication Foundations Division in the Directorate of Computer and Information Science and Engineering at the National Science Foundation. It's a long title. He oversees an annual budget of 200 million dollars devoted to advancing the theory and foundations of computing and communications. You can find more details in his conference bio online. But for now, I'll cede the floor to our first keynote speaker, who we're very grateful to have with us here today.

[00:12:22]

T: Can you see my screen?

[00:12:29]

Rachel: Yes.

[00:12:29]

T: Okay, wonderful. All right. First of all, I want to thank Silicon Flatirons – Keith and Rachel – for inviting me over here and for giving me an opportunity to share some of my thoughts about Spectrum and what the future holds for us in this space. So, thank you. As Rachel mentioned, I am at the National Science Foundation. And in my vantage point,

I get to oversee much of the Spectrum and wireless networking and communications research that the National Science Foundation funds. And just for context for those who are not familiar with what the National Science Foundation does, in the field of computing and communications, the National Science Foundation funds nearly 85% of research that is done in academia in the United States.

So, just for context. That kind of tells you the kind of important role that we play. And also the fact that by virtue of funding all of these...majority of ideas that is in some sense carried out in academia, we get to see a lot of ideas that are coming and all the things that we don't see that we kind of thing of as probably not appropriate enough or ready enough to fund. So, with that mind, I want to kind of make a small caveat here, which is that in this particular talk, I am going to be talking about my perspective. And this is not something that you should construe as conflicting the views of the National Science Foundation. I will talk about some programs that NSF supports in this case. But again, I'll be very clear in indicating when that's NSF [Inaudible 00:14:08] is going to be my own opinion in some sense. So, take it with that huge grain of salt. And also many of these ideas are not new.

I remember discussing some of these...actually most of these ideas in some sense in 2015 with a new program officer at DARPA at the time. Many of you may know him by now, [Inaudible 00:14:34] And we saw a lot of synergy in our shared opinions, and we had some very interesting collaborations that came up as a result of that. So, with that, let me get into what I would like to kind of start off with. Before we get into the future, we need to kind of... It's helpful to look at the past a little bit. And here, I want to use my tinted glasses. I'm going to use...do a very select history of how spectrum has come to be used and regulated with the view of kind of sharing where I think the future is heading. For the students of history, this may be old news, but in the 1900's, radios were first used on ships.

And the sinking of the Titanic kind of made it clear that there is a lot of commercial interference in radio traffic, and there is no regulations really per say that were guiding which ships should operate on which channels. And the fact that you need to have a [Inaudible 00:15:38] between [Inaudible 00:15:40] transmissions was something I appreciated very much. And therefore congress passed the Radio Act of 1912 that proposed the first regulations of Spectrum in that sense. But then by and large, things were going along. It was kind of the ungoverned kind of the wild west in some sense. There were some regulations but not very well enforced. And by and large, broadcast... Again, when I talk about broadcast, I'm talking about radio use for communications.

Public radio broadcast [Inaudible 00:16:08] and other matters of disseminating content was largely self-regulated and self-governed. And there was a lot of interference. People complained, and then they just kind of adjusted the [Inaudible 00:16:22] and so forth. Very hands on [Inaudible 00:16:25] And then of course in 1927, there was an update of the radio act, and the Federal Radio Commission was established. And the notion of

creating radio licenses, Spectrum licenses, came about. So, that was a big jump. And then in 1934, the Communications Act of 1934 was passed that kind of made the [Inaudible 00:16:46] into the FCC [Inaudible 00:16:47] to not just look at radio but also communications as a whole. This [Inaudible 00:16:52] wired and wireless, and broadcast, and everything.

And content. That's important. And so we started looking at everything. So, that, in some sense, is a large [Inaudible 00:17:05] history. But then very interesting things happened in 1941 and 1945, which I won't go into the details of. People can read up in history books on this [Inaudible 00:17:17] But a few important code cases and technology trends made it an established fact that, oh my gosh, spectrum is scarce, and therefore we need to be really careful how we use it. Now, again, remember, at that time, the spectrum that they're talking about was a few hundred megahertz. That was it. And back then, they said, "That's it. It's very scarce. You cannot lose it. There is not a lot of it to go around, and therefore we need to be careful in allocating spectrum."

Of course we know that's not true anymore. It's no longer a few hundred megahertz. You're talking about thousands and thousands of it. And gigahertz in fact. But then the other thing that happened in that timeframe was there was this initial thing that, oh, yeah, spectrum is scarce, but so we need to be careful about how we use it. So, with that in mind, the FCC at that point embarked on an effort to reallocate and place limits on how spectrum can be used. So, AM stations for example, the dominant spectrum use category at that point, they forced some stations to relocate to different bands. And at the same time, they used some kind of studies they had done on interference from solar flares and other effects, like [Inaudible 00:18:31] effects, to place limits and constraints on where FM could operate.

Now, there are some controversies about the validity of that study and what really motivated those. But, again, the point that I would like to make is that these two principles that govern us today in some sense... Well, yes, frequency is scarce, and relocation is possible. But it's a lot of work. Kind of [Inaudible 00:18:54] at that point and that timeframe. Right? And of course there's a long hiatus. Things were moving along. Evolutionary progress, little by little. But by and large, the allocation's licenses, the principles didn't change much. And of course 1994, the FCC decided to embark on let's monetize spectrum, and they started auctioning spectrum, which was a huge shift in how spectrum was used.

And then there is a big jump, which many of you who remember recent history are well aware came about when [Inaudible 00:19:28] were relocated. There was a [Inaudible 00:19:31] in some sense. I mean incentive driven of course. [Inaudible 00:19:36] were asked to relocate, and the resulting white space was relocated. So, that was a big shift. And of course a much bigger [Inaudible 00:19:46] that I think many of us in the spectrum policy world would love to kind of go back and do case studies on is the fact that we had this three tier access system for the CBRS band that came about after a

really lengthy...it lasted almost three years...discussion process. And then which continued to get refined over time. Even as late as last year, we had some actions kind of [Inaudible 00:20:11] some of these use policies around [Inaudible 00:20:14] So, keep this in mind. Okay, so the reason I want to go through this is because I want to kind of hit up on a few common themes that has in some sense dictated how we use spectrum until now and why it may or may not be a hinderance for us going forward.

And I think the first thing is spectrum is scarce. This is a principle that keeps going and kind of guides our discussions. Every [Inaudible 00:20:45] spectrum starts off by saying we don't have enough spectrum. Spectrum is scarce. 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. And the more recent example is [Inaudible 00:21:04] Until I think ten years ago, it was completely ruled out for land communications, [Inaudible 00:21:14] and yet now that started as a big space where 5G can flourish. So, that's one example. The other thing that I think is important to keep in mind is yes, moving spectrum users around is hard. But despite that principle, it says, well, when we really want to make it happen, we really have a value around a certain spectrum and we say, "Well, we don't want these people in that band. We need to move them someplace," it happens almost by magic. It seems to be limited by economic and policy constraints, but is that really the case? It's not clear. But people think it's hard. It is not impossible. It can happen.

And the third important theme is regulators are always willing to try new methods of spectrum allocation. Yet it takes a lot of time to make it happen. And a key reason is that they would like to make sure that no harm comes to an [Inaudible 00:22:15] for example or someone who is [Inaudible 00:22:17] And in order for that to be satisfied, they require data from studies. And from the inception of radio, this has been an issue that we do not get unbiased sources of data that regulators can rely on. The data seems to always come from folks who have a very clear stake in the game, in a certain policy approach one way or the other, which creates problems. It creates uncertainty, number one. It delays things further. So, that's one. So, anyway. So, those are the things. So, where are we today?

So, we have been living in a world of fixed frequency assignments. Again, many of these have been said for many years ago. We have unlicensed spectrum bands, but these tends to be governed by emissions rules. Mainly it [Inaudible 00:23:06] by a desire to coexist and be nice to each other. But, again, it may or may not have a desired impact of being useful. It limits use in some sense. And we are seeing innovative use coming up, for example, in the 3.5 gigahertz and maybe more to come. The 6 gigahertz. Proceedings for example is something of interest as well. So, t his is where we are now. And the way I would like for us to think about...if you draw an analogy to wired communications, the fixed frequency [Inaudible 00:23:38] each company got a dedicated circuit. I want to connect [Inaudible 00:23:43] circuit. And an unlicensed spectrum band is like [Inaudible 00:23:48] It can't go too far. It's limited by the length of the cable. But, hey, it works.

You don't have to have a big, fancy [Inaudible 00:23:56] for it, and you can use it. And shared use in some sense...

The three-tier [Inaudible 00:24:01] system [Inaudible 00:24:03] that yes, I can ask for the capacity if it's available on demand. I can relinquish it when I don't want it. So, I have this on demand shared circuit kind of analogy. But in the wireless world... This is the state of the art today. In the wired world, that was like 1993. We are almost 23...around 30 years behind the curve as to where wired world is today now and where we are in the wireless world. So, this is a gap that we need to bridge, and where do we need to be today. So, if you imagine how your wired networks operate today... [Inaudible 00:24:39] cell phones that can connect to multiple networks. Multi-homed end devices. Again, it could be through my wired internet. If you're in the office, for example, [Inaudible 00:24:51] network provider would have multi-homing between multiple networks, back-end networks. [Inaudible 00:25:00] internet is no longer the shared medium. It's almost like a switched network that there's no connection. [Inaudible 00:25:06] And you can use carrier aggregation and achieve fantastic speeds. 400 gigabytes is standard now, and you can go even higher now.

And you can...at the back end, you can have interconnection agreements with multiple carriers, and you can negotiate these fairly quickly. So, what is the wireless equivalent of this? So, this is a question for us to consider. We are very comfortable with our data networks of today. We don't see a problem there. So, why can't we get to that kind of a state with the wireless world? So, here is where I would like to pause. And keep in mind this is my opening, and this is a spectrum future. This is one possibility. There are endless possibilities, and this is one that I'm going to postulate today. Imagine us having a set of unlicensed, unrestricted frequencies. Now, again, unlicensed and unrestricted being key. Spanning all bands – low, mid, and high frequency bands. I'm not saying that everything should be like this.

I'm saying let's imagine that we had a set of these bands that give us enough flexibility to [Inaudible 00:26:12] Each of them had their own [Inaudible 00:26:15] characteristics and so forth. And devices that in some sense want to communicate with each other, they can self-identify the desired slot of frequencies, and [Inaudible 00:26:27], and the time slots to get their data transmitted. Let's assume that's possible. Now, these devices in some sense will require...they'll have to be part of self-aware networks that can learn on the fly what a status is, when they can communicate and when they should be quiet. These networks can be highly resilient because you're no longer limited to a band. Nobody can spam you anymore. Nobody can [Inaudible 00:26:53] on one level. You can just hop, and skip, and do what you want. And you can figure out a way to reach across any kind of [Inaudible 00:27:04] that may come up.

So, you can create a very highly resilient network. It may not be highly optimal in terms of its capacity or efficiency of the spectrum use, but it's highly resilient. And unregulated. It has potentially some sense...it doesn't have the restrictions that you

normally operate under. And you can adapt based on the demand that you see for the communication needs that you have. Now, again, I am not saying that... When I say communication, one may think that this is all about data. This is not necessarily about data. You may have wireless devices that do not use data communications. We may have radars and others existing in the space. And this is a future that incorporates all of those. They may be passive users who are just simply listening for certain frequencies at very low power levels. You have in some sense incorporated all of those devices into this future.

Okay, so imagine this future. This is important to have. Now, is this a crazy idea? Now, again, I want to go back to what Amie said earlier at the start of this event. Keep an open mind. There is dogma that prevents us from considering the possibilities out there, and more so in the spectrum world. And I have seen this enough with every conference [Inaudible 00:28:27] every time I hear somebody say, "This cannot be done." I keep thinking, "Why not?" And this future that I have outlined earlier is within the realm of possibility. And why do I say that? There was a DARPA spectrum collaboration competition, the SC2 challenge, which as I mentioned earlier, [Inaudible 00:28:47] was the program officer who ran that challenge at that time.

And this particular competition kind of tested boundaries. It took a very small, narrow band, 50 megahertz. And it just tried to do what I just said there by creating some constraints around a common collaboration channel and creating a common information exchange mechanism and so forth. So, while it was very preliminary and a primitive attempt at doing this [Inaudible 00:29:14] future, the outcomes of it show that it is feasible to do this kind of distributed coordination and still achieve seamless operation and also get efficiency gains as well in many instances. Now, what was the key issue that they identified? Self-awareness. Being able to learn on the fly and trusting the data that you learn. Whether it's reliable or not and having a measure of how much can I rely on it. Having that awareness in some sense is the primary challenge needed for a network or device to operate in such a future.

And an interesting outcome of that and something becoming more and more clear now to many folks in the community is that artificial intelligence in some sense can help us realize that self-awareness goals. And there was a workshop that was held last year in August [Inaudible 00:30:14] in Rome where there was an interagency workshop where this was focusing on artificial intelligence in the intersection of techniques used there with how wireless spectrum can use benefiting from that. And this became very clear, that AI can be used in many ways to realize that kind of a future where you can create self-awareness, which in some sense can in turn help achieve the automation goals that many have dreamt about but in some sense have been prevented by existing assumptions on how [Inaudible 00:30:48] should be.

So, what we really need there is flexible radios. What I mean by flexible is radios that can hop and span multiple bands. And you need computation at the radio, at the device.

This is something that is missing today. And more and more experimental researchers are realizing that you need to do a lot of computation at the radio device itself. And these devices should be able to accommodate diverse wave forms. Because if you are going to pick and choose the right time, and band, and all those to communicate, you need to be able to use the appropriate wave forms as well. So, that's from the hardware side. Now, in terms of policies... So, you need distributed consensus protocols – how do I achieve a way to identify what should we use, and how do we prevent us from interfering with somebody else who is also using the channel who is nearby at the same time. So, you need distributed consensus protocols.

And this is something that needs to be done. This is not... There is no uniform single protocol that can do this right now. And we also need [Inaudible 00:31:55] So, you want to kind of let this...what do you call it...? I wouldn't call it anarchy because that's a term that's been used to kind of [Inaudible 00:32:04] such frameworks in the past. You need to keep a loose hand, a light touch on the system. Have some high-level constraints, but let the system evolve by itself. So, that's the protocol policy level. And then of course at the mechanics or the practical level, you need situational awareness and continual learning, an inference that is happening at the ground level. Both at the radio device, environmental level, as well as the macro level where somehow the knowledge of what's happening in the network can propagate, and communicate, and inform the ground level [Inaudible 00:32:39]

So, how to do it. And again, I come from the National Science Foundation, and this is... Now I'm going to put my NSF hat on. Not just my personal opinion. I would say that we need a lot of research in this case. Distributed consensus protocols for example is alone I would say [Inaudible 00:33:00] 30 or 40 [Inaudible 00:33:02] There's so much interesting research that needs to happen there. And clearly the NSF, the Department of Defense, and the Defense Advanced Research Projects Agency, and many others are pumping money into this problem right now. The fact that 5G and what happens, what comes after 5G is at the forefront of the national conversation means that hundreds of millions of dollars, maybe even a billion dollars over the next ten years, is at play right now.

And that's a big amount of investment. And I would like to call particular attention to some of the programs at the National Science Foundation. In particular the spectrum innovation initiative calls for a center scale investment in wireless spectrum research. And this is a 25 million dollars over five years effort, which we really, really hope can address this kind of spectrum future. Not necessarily [Inaudible 00:33:53] from my specific idea but the kind of interesting ideas that would come about that can help us get past the dogmas that have plagued the spectrum community from its inception over a hundred years ago.

So, that's the research part of it. And we also have funded some fantastic platforms. Just platforms. Because remember you need this hardware that I talked about. Flexible radios, diverse wave forms, and [Inaudible 00:34:18] And these currently exist at the

three platforms that we [Inaudible 00:34:23] on advanced wireless research. [Inaudible 00:34:26] as well as the [Inaudible 00:34:31] emulator that we work with DARPA for the Spectrum Collaboration Challenge that is now hosted at the Northeast University in Boston.

It's available as well. And these can in some sense provide the place where you can test out some of these very interesting concepts – the kind of futuristic scenarios that we would like to see in the spectrum world. And of course NSF has now embarked on the concept of national radio dynamic zone. Again, there is not time to go over it today, but you can definitely look it up. Google search will get you there. And we have lots of research programs in wireless that are looking to kind of harness the ideas that are out there in the community. And many of you right now sitting here in the audience may be thinking, "Wow, okay. This is great. How do I participate?" I would say keep an open mind.

And I would say look at what this particular conference is trying to do, which is data driven decision making. And what is AI relating on? AI relates on data. And in some sense, that's what we need. If you can figure out how to marry the data, how to get the data, and how to marry that to affective decision making, and how to use the affective decision making to kind of [Inaudible 00:35:45] spectrum allocation use then please send me your ideas to these programs. So, in conclusion...

I'm going to wrap it up by saying the current spectrum allocation model is not working [Inaudible 00:35:58] and there's a clear need to innovate. Everyone says this as well. We really need to have creative thinking, and I believe that artificial intelligence and data driven learning, as well as inference is going to be extremely helpful and critical to make it happen. And I think this conference is on the right track for stimulating the discussion, and I'm looking forward so much to hearing what the panelists have to say about this.

And I would say I besiege everyone to leverage their current R and D programs. This huge tidal wave of investment is coming into wireless spectrum and use this. Because this is an opportunity we're not going to get maybe in another ten years. [Inaudible 00:36:34] after ten years or so. And a billion dollars or more going into these programs is good money to waste if we can't solve all these problems today. So, with that, I am happy to stop now and take questions.

[Pause]

[00:37:00]

Rachel:

Thyaga, I have a question for you. So, very early on in your slide deck, you were talking about being able to move spectrum users mostly being attributable to a desire to make that happen, which gets me thinking about incentives. And I was just wondering if there are any lessons that we could be learning from the international arena in terms of how

other countries who incorporate that aspect into their spectrum policy very regularly...if we could be learning a lesson about incentivizing that from them?

[00:37:39]

Thyaga:

Right. I absolutely agree. There is a lot to learn from different policies. But also there is a caveat that what happens outside is not always applicable here. And I would defer to a lot of colleagues from the Federal Communications Commission and National Telecommunications and Information Administration who are in attendance today. And I'm sure they have a lot to say there. One observation that I have felt always has been a challenge for the spectrum allocation viewers is people use the spectrum allocation that they have been given as their birthright. They kind of say, "Oh my God, I had this allocation. How dare you give it to somebody else." They don't understand it's just a lease. It's an option given by the government. It's public airwaves that they are essentially getting the option to utilize for their benefit. And it can be taken at any given time. And that message needs to be reminded time and time again. That it's not a right, and it's just a facility that's being granted as a matter of convenience to make things better for them.

The economic cost of these have to be incorporated indefinitely. I think that's something that [Inaudible 00:38:44] interdisciplinary research. But I think often the cases for, "Oh my God, this is going to be so expensive. This is going to cost billions of dollars," are mostly oversold, I think. I think that there is a need definitely for more realistic practical assessment. Not just looking at the cost of transition, which is always what the studies tend to focus on, but also to kind of offset what is the cost of transition being offset by. It is the gains of operating in a newer spectrum with more [Inaudible 00:39:17] equipment which are much more efficient, for example. So, I think that wholesome analysis... Not just focusing on the transition per say but focus on the gains that are realized after the transition and use it to offset the current cost. That's something that needs to happen as well. I see a question there. I don't know if you want to take that, Rachel. I'll defer to you.

[00:39:44]

Rachel:

Sure. So, we have a question in the Q and A. The question is 'the concept sounds good for consumer and perhaps enterprise needs but worrisome for public safety and critical infrastructure industry users. How can you guarantee quality and reliability in any shared spectrum scheme?'

[00:40:04]

Thyaga:

Right. And here is... This is one of the other dogmas that kind of plague us. It's the assumption that, "Oh my God, anything shared means that you are going to lose quality and reliability." I will go back again. Your office networks today rely on internet. And you are having Zoom calls and everything on these calls. Right now I'm currently on the ethernet. I'm using Wi-Fi right now to talk to you all. And so are most of you. And yet we are able to talk and communicate with each other. And yes, there are some times when

there are glitches. But often more often than not, it's not necessarily just your network at fault. It could be other factors at fault. And this is on a best effort service.

Wi-Fi is a best effort service. And to say that a shared spectrum scheme cannot provide [Inaudible 00:40:50] I think it's a false claim. I think there are ways to make it happen. It's just a question of us coming to a common understanding as to what different classes of users [Inaudible 00:41:04] exist and making sure that they get priority access when they communicate. So, I think that's one of the assumptions we need to kind of be very wary of and not make the assumption all the time.

[00:41:18]

Keith: Okay, I'm going to jump in here. Thank you very much, Thyaga. We appreciate your comments and remarks, and I hope you'll be available for the breakout session.

[Crosstalk 00:41:28]

[00:41:28]

Thyaga: ...end of the day, yep.

[00:41:29]

Keith: Great. Great. Now I'd like to introduce our first moderator for our first panel. Our first panel addresses the basics of evidence-based policy making, and I couldn't think of a better moderator for this panel than David Redl. I had the pleasure of working for David when he was the NTIA administrator, and I was the director of NTIA's laboratory. Prior to a stint with NTIA, David served as chief counsel for Communications and Technology Majority Staff of the US House Committee on Energy Commerce, and I should add David is a senior fellow with Silicon Flatirons. Over to you, David.

[00:42:05]

David: It'd be nice if I actually started my video so I could be on camera. Thank you, Keith. It's good to see you. It's nice to see all of your faces, to my Colorado friends who I have not gotten to see since I haven't been on a plane in the last seven months. But thanks for joining us today, everybody, for the kickoff panel of Silicon Flatirons event, Exploring Evidence Based Spectrum Policy. As Keith mentioned, I'm David Redl, founder and CEO of Salt Point Strategies and a senior fellow at Silicon Flatirons. Spectrum policy continues to be among the most important topics for tech and telecom policy makers. And as this group knows, understanding the implications of spectrum policy are rarely simple and far from intuitive for those that haven't made it their career. Facts, knowledge, precedent, and history, research, and yes, evidence are all part of making the case for specific policies, but they can be maddeningly complex [Inaudible 00:43:07] with far reaching consequences.

Since we have been asked to set the stage for this important topic, I'll take a high-level look at what makes for evidence-based policy making, why it's important to our

increasingly spectrum dependent world, and how it can be best employed to make good policy. Our panelists today have spent their careers making, influencing, and honing spectrum policy. And we're thrilled to have their experience on this panel. In lieu of opening statements, I'll briefly introduce each of them and ask them what is evidence-based policy making to you, and how is it different or is it than what we think of when we look at how policy is made now. First up, Blair Levin. Blair is well known in communications policy circles, so I'm going to give you all the lightning round version of his resume. Chief of staff to FCC chairman, Reid Hunt, national broadband plan, Brookings, Gig U, Aspen, [Inaudible 00:43:57], and now policy advisory at New Street Research. Blair, I left out so many of your accomplishments, so please forgive me. But thank you for joining us. What is evidence policy making?

[00:44:07]

Blair:

Thank you very much, David. And I just want to confirm that I'm no longer muted. You can hear me, right? Great. So, I always start by thinking about what's the opposite in this case of policy-based evidence making, which is often the way governments, agencies act when they want to adopt a particular policy. And [Distortion 00:44:31] make up the evidence to justify that policy or cherry pick the data. And that is a very common practice on a bipartisan basis. I would say that evidence-based policy making...a couple of key things to me when I've seen it work. Number one, it starts with questions, not answers. That's the absolute criteria. But of course no one was ever elected by promising the American public that they would ask certain questions.

Rather they're elected on the basis of the answers they give. So, there's a lot of political emphasis on just coming up with the answers that we're essentially already promised. Second, it relies on data that is routinely gathered as opposed to data and information that is gathered solely for the purpose of getting a certain result or addressing a certain question under the APA or something like that. In any event, again, the APA process tends to focus people on certain things. Everyone knows what the options are. And the evidence is not coming out of kind of standard routinized efforts but rather very focused ones.

And then finally I would say it relies on the cultural norm in an institution that believes in facts, believes in science, which involves by the way challenging facts and testing certain things. And I also believe some course corrections. I think all of those things are hard because of political pressure, but nonetheless, it does happen. I'm sure we'll be talking more about it. But let me just close the intro by noting that a couple days ago, our little world... Oh, and I should have mentioned what the APA is. That's the Administrator Procedure Act. Our little world I think celebrated really a tremendous accomplishment, which was a Nobel Prize in economics to two of the economists who not only worked on the first spectrum auctions in the mid 90's but also played a key role in other auctions around the world, as well as the incentive auction that the FCC did in 2016. And their getting that award in some sense is a tremendous reaffirmation of the FCC in terms of its own ability to do auctions.

If those auctions had failed, I don't believe they would have gotten that award. But I do want to make the point that both the theoretical work that they did was not evidence based because there was no evidence before they did it. Nothing... These things hadn't been done before. And further, there was a lot of work that the FCC itself did where they were guessing, and we'll talk later about some failures. But some of the failures are because we were trying things. And I'll be happy to admit what they were. We were trying things that hadn't been tried before. So, when it comes to that which surrounds spectrum policy, not the interference issues but kind of the allocation issues, it's sometimes difficult to do evidence-based policy making because there is none. You're on mute again.

[00:47:44]

David: Thank you. Was that a land line I caught in the background?

[00:47:48]

Blair: That was the land line, yeah.

[00:47:51]

David: How quaint.

[00:47:50]

Blair: How embarrassing.

[00:47:52]

David: A landline. How wonderful.

[00:47:55]

Blair: [Laughs] Well, we're very nostalgic here.

[Laughter]

[00:48:00]

David: Old habits die hard, Blair. Thanks for your opening on that. And I'll move to our next panelist. Our next panelist is Kate O'Connor. Kate is the chief counsel for Communications and Technology with the US House of Representatives Committee on Energy and Commerce. Kate previously worked at the National Telecommunications and Information Administration for an astounding assistant secretary and later an outstanding acting assistant secretary of commerce. In her time there, she worked on legislative and communications policy issues affecting spectrum and broadband, and later served as chief of staff. Prior to joining the NTIA, she worked at the US Senate for Senators Mark Kirk and later Senator Dan Sullivan. Kate is very second city, hailing from Chicago, and later attending the University of Chicago. Kate, thanks for joining us. What is evidence-based policy making to you?

[00:48:45]

Kate:

Thanks for having me, David. As you mentioned, I did have the pleasure of working with you and Keith during my time at NTIA, so that was entertaining. So, obviously now working for Republican Leader Waldon has been a great honor. I've been there for about a year at this point. And during his time on the Hill, he really has been a leader in communications policy. I would say especially this year, it's been a very interesting year to start a job working in this role on the hill given the current climate of everything that's going on. But especially in light of COVID, I think the demand for connectivity has been seriously emphasized. Everybody is working from home remotely.

Carriers are upgrading their services, making sure that people can stay connected. Even before this crises, Ranking Member Waldon has always tried to find ways to make more efficient use of spectrum and make more spectrum available. And so when we're talking about evidence-based policy making, he... Blair covered a lot of it, but Ranking Member Waldon was really the author of the incentive auction, which has been a resounding success in making spectrum available. But that was a unique model, and it had never been done before. So, when we're looking at evidence-based policy making, especially in this role, being on committee in the House of Representatives. You really have to take a holistic look at all of the evidence that's out there, look at where the demand is, where the incentives are to make those policy decisions, and then what is actually achievable and what will work in your boss' best interest.

So, I don't know... It's always great to have data when there is data there, and I think it's important to look at all of the data. But it maybe... You may sometimes have to make a decision based on certain numbers or statistics that might be there. But also the economics of the decision that you're going to make, or what the projective economics might be. And those factors are always changing, so there's really at any point in time... I would say the facts are different, and you just constantly have to reassess the information that's available to you. So, I know we're going to get more into it, and I guess I'll leave it at that for now.

[00:50:58]

David:

Great. Thanks, Kate. From the US government, we'll now turn to our neighbors to the north. Our next panelist is Adam Scott. For almost 20 years, Adam has been advising the Canadian government on a variety of telecom policy issues. He is currently the director general of spectrum policy where he sets broad direction for Canada's spectrum regulatory framework and is also responsible for running the Canadian spectrum auctions. Adam, since you share the name of the actor who played Ben Wyatt on "Parks and Recreation," I promise this will be my last Pawnee, Indiana Joke. Adam, thanks for joining us. What is evidence-based policy making to you?

[00:51:32]

Adam: Thanks very much, David. And thanks to all the organizers as well. Even though I'm far away, I can still feel the Colorado hospitality. So, I'll confess that the first thing I thought of when I heard that evidence-based policy making was the theme of the conference was actually the TV show "Law and Order." And I know it's a little bit ridiculous at an evidence conference to rely instead on such an analogy. And maybe even a flawed analogy rather than evidence. But we've all seen the show. And we know that it revolves around the process of discovering, assessing, and interpreting evidence in an attempt to uncover the truth. And that eventually a decision has to be made. A judge rules at the end of the show, and that decision is going to affect real people in real ways.

So, the judge needs to get it right. And so I think the analogy is useful. Over the next few days, we're going to be talking about things like witness testimony and credibility. We'll be talking about motive, supporting evidence, scientific evidence, where it can come into play and where it might have some limitations. And I would suggest to everyone if at any point during the conference or when you're back at home, or school, or work, and you're struggling with a particular aspect of spectrum policy that might prove difficult or challenging to try reimagining it as a procedural crime drama and see whether or not that might help you shed any additional light on your struggles. Thanks very much.

[00:53:06]

David: Thanks, Adam. I guess that makes me a poor man's Sam Watterson right now. I would kill for his voice though. I appreciate your perspective. And with that, our final panelist is Scott Wallsten. Scott is president and senior fellow at TPI, the Tech Policy Institute. And is also a senior fellow at the Georgetown Center for Business and Public Policy. Like Blair, he was part of the US National Broadband Plan Team as economics director and has held numerous scholarly positions in economics doing research on competition, regulation, and tech policy. Scott, thank you for joining us. What is evidence-based policy making?

[00:53:40]

Scott: Thanks, David. Thanks for having me here. So, it's kind of funny, first of all, to think that this is sort of a new idea. If we're only starting to think about evidence-based policy making now, what were we doing before? And like Blair said, often it's policy-based evidence making. But really evidence based policy making is about thinking of issues in sort of a...in a cost benefit framework, I think. That doesn't necessarily mean monetizing everything but recognizing that you're weighing often tradeoffs, and benefits, and costs. And it's not just following the data, but it's a willingness to allow data and experimentation to guide the right way to achieve particular policy goals. But it means that you have to be willing to try new ideas and be willing to admit when an approach isn't working. And that's hard for people.

People become sort of invested in their ideas. It's natural to be. But you have to be willing to see when things don't work and stop doing them. And to try new things. And I

think that's what's very hard to implement in policy. And Blair mentioned the economists who just won the Nobel Prize for their auction work, Paul Milgrom and Bob Wilson. And of there were a ton of people at the FCC and otherwise who helped put their ideas into action. And that was an example of where there wasn't a lot of evidence beforehand. This was a way of trying to create an incentive compatible mechanism to create evidence on where spectrum was actually going to be the most valuable. Whereas before, it was mostly people arguing about it. Although they used different kinds of evidence. But so there are different ways to define and think about evidence, but I think the most important part of it that makes it useful is when people are willing to question their priors and rethink ideas based on new information.

[00:55:58]

David: Thanks, Scott. I think you all sort of touched on a little bit of what we wanted to get to in terms of how evidence based is a little bit different. I will say before we turn to our question, a few housekeeping matters. We will be taking audience questions at the end if we have time. So, if you have a question for the panelists, please use the chat feature to ask your question. And thank you to my colleague, Fiona Alexander, who I volun/told to help me in fielding the questions in the chat. So, much appreciate, and thanks, Fiona. Now onto the questions. So, Blair, I'm going to come back to you, I think, with the first question to start with just because it's been the longest since we heard from you. So, you touched on this, as has everyone else. How is evidence different than just data or knowledge? Because anyone who has participated in either an industry candidate consultation or an FCC rule making knows, there is plenty of data that's provided. At what point does that start to become the evidence for evidence-based policy making?

[00:57:02]

Blair: It's a really hard question, and I love the analogy to "Law and Order," a TV show I actually have not watched very often. But thinking...

[Crosstalk 00:57:11]

[00:57:11]

David: Blair, it was on for like 97 seasons. How did you miss it?

[00:57:14]

Blair: [Laughs] Well, let's just put it this way. There's so much on television these days.

[Laughter]

[00:57:23]

Blair: One has to make choices. As Scott said, it's cost benefit, tradeoffs, all of that. But I do think it does a great job of telling the public as to... When we were [Inaudible 00:57:34] reading Sherlock Holmes or Encyclopedia Brown, or whatever those books were, but how do you interpret a number of different things and how people interpret things

differently. And of course we see this with every FCC proceeding we've ever seen. There is a different in my mind between those things which are fundamentally matters of law in which you're deciding kinds of precedence and interpreting words and those things which are particularly in the spectrum realm a matter of which you might consider more scientific evidence. Particularly on the question of interference. And I think interference is one of those things that is a little bit different than a lot of what policy makers do but maybe one of the most important things that the FCC does.

And frankly I think one of the things it does best. The Office of Engineering and Technology has really done a very good job under...in a very bipartisan way of looking at what we might think of as real evidence. Or another way of saying it is evidence is what remains after the decision maker discounts all of the data and information. In other words, what are they going to rely on. But it's really different. One of the most important issues that was brought up this year, the trial judge in the T-Mobile Sprint deal basically based a decision on evidence presented by the CEO for T-Mobile saying, "We're not going to raise rates because I promised not to raise rates."

Traditionally under anti-trust, you would look at economist models, and he basically discounted those and relied on his... And did a very long piece in his decision talking about how judges determine who is telling the truth and who is not. I don't mean to either criticize it or praise it, simply to say it was a very surprising kind of thing for a judge in an anti-trust case to do. But I think what that demonstrates is how one person's evidence is often different than somebody else's evidence. So, I'm not sure we have a clear definition other than it's what the decision maker thinks is most probative of what the final result should be.

[00:59:52]

David:

Scott, if I can pivot over to you for a second. I think Blair teed up another item that I think we all want to talk about, which is often times the record in these proceedings particularly on technical matters become dueling engineers on the record. Each side gets an engineering firm to do a study with certain assumptions that makes their case, and the perceived value of those can be higher or lower depending on who has done the work. And I don't mean the firm. I mean which side of the argument has presented it. Does it matter whether it was a private party or the government that produced the evidence in these kinds of policies? And should it?

[01:00:38]

Scott:

Well, when you have interested parties, they're not going to submit a report that does not support their point of view. But that also includes the government, which often also has an interest. I think the most important thing in that is transparency, to know not just who paid for the work but that you can also interpret the work and understand the assumptions that they made and what went into it. And then you might look at it as if it were in a legal setting then everyone has the right to make their case. And then someone is supposed to judge between those two. And so both could be making correct

arguments, and then it falls to whoever is the ultimate decision maker to decide which ones...how they place value on the different sides.

But I think a key... The reports have to be done with enough information that the reader can figure out sort of where the rabbit went into the hat – what helped them get the results that they got in the end. And then that helps you figure out how much weight to put on it. But it also gets to the point... And Blair was raising this point. That someone has to set the question initially, and that's the question then that this evidence is supposed to help answer. And setting that question is often much harder because that's about different preferences. And policy makers from different areas legitimately have different policy preferences. And so sometimes the evidence-based part is about how to most efficiently get to a particular outcome. And so it's harder to move the evidence part to setting the policy objective in the first place, I think.

[01:02:39]

David: Fair enough. Adam, I'm going to turn to you for a second. As you look at these, you see these come into the record on consultations. How do you look at dueling engineering studies when you're trying to make good evidence-based decisions?

[01:02:56]

Adam: Yeah, that's a good question.

[01:02:56]

David: And/or how does the person you have read them for you look at them and help you understand them as the case may be?

[Laughter]

[01:03:02]

Adam: Yeah. And I'm pretty blessed to have some pretty good people helping me out. One of the things I liked about your set up is that it almost implies that information coming from the government has some inherent credibility. I'm glad to see there's some people who still think that – at least to some extent. It's not something that we take for granted or that I think we should take for granted, and we actually work pretty hard not to just be able to understand that evidence but to be able to produce evidence of our own that is actually credible. But yeah, to your question, when I was coming up, the simplistic rule was you listen to everything that they tell the regulator. Then you listen to everything that they tell their investors.

And you split the difference, and therein lies approximately the truth. But it does get into, again, to kind of stretch the analogy of it... You're looking at their motive. You're looking at their narrative. Where does this lead? Where are they trying to lead you? And it's a question of credibility, which I think we all acknowledge requires a certain amount of judgement, which comes with experience, comes with time and patience to do your

homework. You absolutely can't take this stuff for granted. Yeah, I don't know that there's much more to it than that. The reason we dedicate our careers to this stuff is because you need a couple decades worth of judgement to really sit down with some witnesses who appear credible and compelling, and put a ton of evidence on the table. It's not easy at all.

[01:04:35]

David: Kate, to you. Often times in contentious rule makings in Washington DC, the parties cry to Capitol Hill to try to get things moved the way they would like to go. When you're working for Mr. Waldon and the members of the subcommittee, how do you look at this, and how do you sort of look at each of these pieces as they related to being fact versus evidence?

[01:05:00]

Kate: That's a great question. So, something that I have realized in working on the Hill especially is that nearly every party can find data to support their argument. So, no matter what the position is getting pushed, whether it's somebody says an apple is green, and another person says it's red, there will be data to support those facts. So, I think it really is important to listen...to look at all of the data that's out there and really look at it in a holistic way. But I also think that especially in the communications space, it's very unique in that it is so new when it comes to the policies that are getting enacted and some of the challenges that we're facing today. 20 years ago, the spectrum crunch wasn't nearly as real as what we're dealing with today.

And in different ways, I guess. The federal government had significantly more assets versus today. A lot of industry has assets and consumers rely on that spectrum for their connectivity and their services. But also in 2012, First Net was an unproven concept, and now if there were to be another case where there's something like that, there's evidence that that is working, and that model has worked. So, I think it's difficult. It's always difficult. But looking at evidence...

The evidence is constantly going to change. The data is always out there. People are always going to be able to come up with new data, support whatever they're trying to push. And it kind of goes back to what I said in the beginning. When you're looking at it in a holistic way and then looking at whatever new evidence is actually coming based on previous policies that have been enacted, you'll eventually end up at a place that you find is best for your boss that's actually achievable and that can hopefully achieve the outcome that you're trying to get.

[01:06:40]

David: Great. Okay. Well, you've given an example. So, in deference to our government friends and letting them off the hook for not having to dance around being mean to their employers – good, bad, and ugly time for the nongovernment panelists. Blair, what are some examples where it's worked, where we could have used more evidence to come

up maybe with a better outcome, or an example where we just straight up ignored the evidence and did what needed to be done for a specific policy outcome.

[01:07:12]

Blair:

So, when it comes to spectrum policy, I would argue that kind of on the scientific realm of interference, we've actually done a pretty good job. And I would even go father and say in some of the allocations stuff, I don't look at there being any disasters. The disaster that I would note because it's my nature to do would be one that I was involved in making. Which was the C block auction in the mid 90's spectrum. And the problem there was that we responded to the congressional director to get new enterprises involved in auctions, had a block that was all about new enterprises, but we didn't want them to spend all their money on the spectrum auction. So, we essentially gave them installment payments. The problem was... And this is an example of... The economists deserve the Nobel they won, but they didn't tell us everything.

And one thing about installment payments and by having everybody essentially bidding on them is they were essentially bidding on option value, not real value. And that led to just some incredible problems. And of course as some people might remember, a lot of that auction then...the buyers, the winners, went into bankruptcy. And the spectrum was tied up for many, many years. So, that was a case of bad spectrum policy making. But I don't think it was a failure of evidence. The other thing I would just note, again, about policy making... To me, two of the more recent ones where I would say that was too bad was both the incentive auction in the C band. But what was too bad was not the final decision but was the time it took to get to the decision. I'm delighted that Kate thinks that Congressman Waldon was the father of incentive auctions.

There's that old saying that victory has a thousand fathers. Defeat is an orphan. Ordinarily I would be simply proud of the fact that someone else thought they were the father of it, but I have to point out since we're at Silicon Flatirons that Phil Weiser actually wrote a paper for Brookings in 2008 proposing the idea. We of course picked it up on the National Broadband Plan. But our view was that we wanted to do it in a way that everybody could claim credit. Having said that, it was too bad in my opinion that it took so many years. And David, I'm sure you would disagree since you were there. To do what I thought was a simple idea that could have been done in a sentence. But it took time. And I think that demonstrates how politics can interfere with good policy. We all [Distortion 01:09:49] legislation. Another example is C band where I think the FCC got to the right place, which was [Distortion 01:10:02] that point.

And then I think that put us behind. So, I would distinguish between those things. A final point I would make is there is an asymmetry in terms of FCC spectrum policy, which is FCC has a lot of control over the transmitters of data but much less over the receivers of data. And the transmitters can be... You can course correct with those folks. But once the radios receiving it are in the field, there is an embedded cost. It's very difficult to change those out. And a lot of different spectrum proceedings in my opinion have gone

awry in terms of the amount of time it's taken or problems with certain bands still being lying fallow when they shouldn't is because there is that embedded base of frankly crappy receivers that are more susceptible to interference. So, that's some of the good, bad, and ugly.

[01:11:04]

David: So, in the interest of... I realize we are running towards the end of our panel. I'm going to advance quickly through the remainder of the things we want to get out there, so we can get to the student question. I let Kate and Adam off the hook. So, I will let either one of you raise your hand, whichever one would like to say... Do you have an example of a time where you don't think evidence-based policy making would work? Adam, I think is that something that you would be able to address?

[01:11:30]

Adam: Yeah. Far be it for me to say evidence doesn't work. But I think... And Scott suggested it a bit earlier, too. There are certain types of questions that invite evidence. So, I think maybe an important point to make is that how we ask the question can really frame whether a conversation is useful or not. And an example I like to point to is a question that comes to me all the time, phrased a lot of different ways. So, some people will ask, "Should we make high speed internet connectivity a human right?" As a bureaucrat, I don't like that question. It's important. Absolutely.

I want to see people connected. Whether or not it's a human right is really more of a philosophical conversation. Distinguish that to a question phrased as what are the social and economic benefits of connecting a community that hasn't previously been connected. That's the kind of question where we can really dig in with a ton of evidence and do some really constructive work. Extremely evidence based. Look at global models, look at all kinds of different fields of study, and produce a really constructive evidence based that's going to drive us towards something concrete. So, I think that answered at least half the question. But the way we phrase our questions...

[01:12:45]

David: No, I think you did. And I appreciate that. I'm going to jump ahead. I know we have a student question we want to get to. Gabe Rudin is the CU student who is up with the first question from the audience for our panelists.

[01:12:59]

Gabe: Hi. Can everybody hear me?

[01:13:01]

David: Yes.

[01:13:01]

Gabe: All right. Well, first I'd like to thank everybody for your time and your insights. It's really appreciated. So, yeah, my name is Gabe Rudin. I'm a one L here, so I'm a member of the class of 2023. And I have a question for Mr. Levin. And my question is as follows – in a recent conversation between yourself and another one of our panelists today, Scott Wallsten, on the Two Think Minimum podcast, you reflected on the successes of the 2010 national broadband plan. And in evaluating what that plan got right, you attributed your team's accomplishment to the practice of asking do we have the right information. But in addition to that, you lamented about the FCC's data collection deficiencies, and you additionally expressed a desire for that agency to have capabilities similar to that of the Bureau of Labor Statistics but for communications information. So, my question is as follows – with profound advancements in spectrum technologies on the horizon such as a true 5G rollout and the immerging IOT ecosystem, what types of data do you believe we should be collecting to create an affective spectrum policy?

[01:14:18]

Blair: That's a great question. [laughs] As an American studies major, a liberal arts kind of guy, I would defer to a lot of others. I can make the policy argument that decisions are better when you have better data. And certainly by the way, there is a bipartisan consensus in congress on almost nothing except for the fact that the FCC has not done a good job of collecting data, and they passed the broadband data improvement act. But I might defer to Scott Wallsten on that except it simply say that I do think that having 70 real experts who are used to looking at data made the plan a lot better as to what kind of data should be collected now. I would love to hear a lot of experts like Julius Knapp, who used to run the Office of Engineering and Technology, addresses that question. Scott, do you have an answer to that?

[01:15:24]

Scott: Yeah. Well, first, nobody should have let Julie retire.

[Laughter]

[01:15:29]

David: Also, Blair, why do you begrudge him a retirement? Let the man rest for God's sake.

[Laughter]

[01:15:35]

Scott: No, where does the data come from question I think is important. And what do we collect. Those are really important. And a lot of the way we still collect data on broadband and other issues at the FCC is very old. The census did a census of telephones in 1896 where they actually counted each phone. There was a census. And we've just continued to do it. And so that's sort of the way the rest of the world now counts its lines – number of connections. But we really need to be supplementing that or if we even need to continue that sort of thing at all with surveys, the type that BLS

does because they do it really, really well. And they do have a computer and internet supplement part of the current population survey. And I think we need to be doing more things like that. And it would be nice to see the FCC and BLS work together more on those data issues because they're both really great. BLS and BEA know how to do surveys better than anyone else.

And the FCC knows the broadband, knows the data, and what they're looking for better than everyone else. And we all criticize the FCC data, but it's not like we're all saying anything that the FCC doesn't know. Those people, the people that work with that data, know the problems with it better than anyone else. But we have to be willing to change the types of data that we collect, too. And there is a related issue, too, that it's good when we collect similar data over time so that we can see trends. That's very important. But also the kinds of questions that we ask may change every time, and that can require different kinds of data, too. And so somehow you want a combination of that. So, if you look at Off Com, they often have these very interesting reports, and there will be a different report every couple of years on a different topic. Whereas at the FCC, they'll put out the same report every year. And each of those has particular advantages. In the FCC and the broadband report, you go to table 3.5...

[Crosstalk 01:17:48]

[01:17:49]

Scott: Yeah, sorry.

[01:17:50]

David: Just to pause for those in the group that don't know. Off Com is the UK's Office of Communications. It's a regulator in the UK.

[01:17:56]

Scott: Right. And absolutely. That's a good point. A good time to interrupt me because I was just sort of rambling. But there are lots of different ways you can collect data and lots of different ways to present it. And they all have different advantages and disadvantages. And it's hard to always get that right. And just one quick thing to add. In one of the questions, David Robertson pointed out that... He said, "So, do we want data-based policy...?" Basically that evidence-based policy could also mean data that we don't have and that we should be prepared to do experiments. And that's something I talk about a lot. I think experiments are really important, particularly in areas that we don't know much about.

[01:18:35]

David: Going to audience questions, I'm going to paraphrase Tobey Uell's [Phonetic 01:18:38] question from the chat, which is asking basically evidence and politics can sometimes be at odds, and the government decision making process is inherently a political one. Can

you set up institutions that are doing policy to discount politics in favor of evidence?
Anyone can choose to jump in here.

[01:19:05]

Blair: Well, I'll simply say yes. And one example of that is spectrum policy in terms of auctions. Let's fact it, congress fundamentally wanted to maximize the amount of revenues. The great insight of Milgrom was the winner's curse. And so the auctions are actually designed not to produce the maximum amount of revenue. There were other issues in terms of concentration and stuff. And we, in a very conscious way, tried to insulate the auction design process in '94 and '95 from political interference. And I think we largely succeeded. It helps that it was such complicated auction theory that most of the members of congress kind of gave up or they just...

They didn't understand what we were doing. But I do think that that point of isolating and insulating certain kinds of cultural institutions from political interference is a doable thing, but it requires commitment to do it. And I would say without going into a partisan rant here, I think one of the things that historians will look back on is how the CDC became corrupted during the COVID crises as one of the worst things both in terms of its immediate outcomes but also in terms of the long-term ability of the United States to respond to public health emergencies. So, it's really important that some institutions are isolated. But obviously you can't do that with everybody, nor should you.

[01:20:50]

David: I'll grant you the tenuous link since CDC also technically does a study on wireless only households in the United States. So, I guess there is some telecom ties in there. But in the last few seconds we have... And I realize we are bingo time here. Crystal ball time. What decision pending or that is on the horizon do you think would most benefit from the sort of evidence-based approach we have described here? Scott, we'll start with you.

[01:21:16]

Scott: Yeah, I think we still need a way to decide an evidence-based approach to deciding whether spectrum should be allocated to unlicensed or licensed. Because that is still left at a regulatory debate level, and we don't have good ways of making that decision.

[01:21:33]

David: Fair enough. Kate O'Connor. You're on mute, Kate.

[01:21:39]

Kate: Sorry. I think honestly trying to figure out a way to isolate politics from spectrum decision making or at least mitigate some of that is definitely going to be something that we're going to have to focus on going forward. Especially as these decisions become more difficult and the demand for spectrum is growing.

[01:22:00]

David: Adam Scott.

[01:22:03]

Adam: For us, looking at some of the millimeter wave bands where there's so much spectrum, and there's so much potential, which could support all kinds of different business cases. But there is still so much unknown on how exactly that plays out. I think it's going to be super interesting to watch.

[01:22:18]

David: Blair, you get the last word.

[01:22:20]

Blair: Of course the one that everybody is focused on right now is the DOD 5G one. But I think the sleeper issue for the next FCC is going to be 12 gigahertz, and it'll be interesting to see how they resolve some of those conflicts.

[01:22:34]

David: And I guess we'll leave it at that. There are certainly panels that will be going into this as we see the next two days of panels and discussions on this topic. I want to thank our panelists for being with us today. You have been wonderful and tolerated my bad jokes, so thank you very much. Thanks to Silicon Flatirons for hosting. And with that, I'll turn it back to Keith.

[01:22:58]

Keith: Thank you, David. And thank you to all the panelists. That was very interesting. Right now we'll take a short 15...well, roughly 15-minute break, let everybody refresh a little bit. Get a fresh cup of coffee. And let's be back here at 11:30 Mountain Time, 1:30 Eastern. And we have a special talk at that point. Thank you.

[01:23:30]

[No dialogue]

[01:36:22]

Keith: Here we go. Welcome back, everybody. We're ready to kick off the second half of our Tuesday session here. We've got a special speaker right now to give us some perspective on evidence-based policy. Rachel, I believe I'll turn it over to you to introduce him.

[01:36:47]

Rachel: Sure thing, Keith. So, I have the honor of introducing our next speaker, Dale Hatfield. Because Dale's list of accomplishments in this field is about a mile long, and he's always staying busy, I'll let you know what he's currently up to. He's currently an executive fellow at the Silicon Flatiron Center for law, technology, and entrepreneurship at our

very own C of Boulder. He is also currently serving on the Federal Communication Commissions Technology Advisory Council. That's TAC. And on National Telecommunications and Information Administration's Spectrum Management Advisory Committee. That's SISMAC or SISMAC depending on how you pronounce it. And in addition to everything that's already on his very full plate, he also has a new puppy. So, without further ado, Dale Hatfield.

[01:37:41]

Dale:

Thank you very much, Rachel, for the introduction. And thank you, Keith, for the opportunity to present some framing remarks for this Silicon Flatirons conference. In the time I have, I'm going to reflect back over my almost five decades of involvement in spectrum management, but I will do so in the context of the subject of this conference, namely evidence base spectrum policy. In particular, I will focus my attention on what I regard as spectrum policy and regulatory short comings in four areas – harmful interference, receiver performance, noise and interference measurements, and spectrum enforcement. Before I turn to the first area, I should mention that I'm going to talk a lot about radio frequency or RF interference. In the interest of time, I won't bother to give a long, formal definition of RF interference. A definition which I'm sure is familiar to most of you and has been touched on and remarked so far.

What I'm talking about is natural and manmade activities that cause disruptions to often vital wireless communication services. Examples include disruption caused by some intentionally or unintentionally transmitting on a channel for which they are not licensed or by somebody deliberately jamming GPS for nefarious purposes. Or disruptions could be produced by vagaries in radio propagation that sometimes cause radio signals to travel far beyond their intended distances. There are many other examples, but I'll stop there. With that very brief background, I will turn now to the first of the four areas I want to address. Namely harmful interference.

One of the most fundamental issues in the spectrum policy realm is deciding what constitutes harmful interference in a given situation. But the truth is we do not have a quantitative definition of that term. Hence two questions come to mind. First, why waste a lot of time and evidence collecting evidence when it is essentially useless in making one of the most fundamental decisions in the field. That is does this measured level of interference constitute harmful interference or not. Second, how can we possibly improve spectrum management in an increasingly complex field using badly needed automation and artificial intelligence and machine learning techniques without an accepted quantitative definition of the term. In short, automated decision making requires information that is evidence if you will...requires the evidence to be quantitative.

Moreover, turning to the second area, receive performance, even if one can decide whether or not a given level of interference constitutes harmful interference in a particular situation, how does the governing structure attribute responsibility for

interference in an objective way when we essentially have no enforceable receiver performance requirements. Again, two questions come to mind. Who is to be blamed or sanctioned if the harmful interference is caused by poor receiver system design, implantation, or maintenance? Why should the operator of a radio RF emitter be penalized when it is the susceptibility or fragility of the receiving system that is at fault? While I'm addressing receiver performance, I will add parenthetically that I support strongly the notion of interference limits as a less regulatory way of dealing with receiver performance issues.

The idea of interference limits was proposed several years back by our esteemed colleague, Pierre de Vries. With a significant danger of oversimplifying the concept, interference limits would allow the use of receivers or more properly receiving systems regardless of their susceptibility or resilience to interference. However, under the concept, an enforceable claim of harmful interference could not be made unless the [Inaudible 01:43:07] level of interference energy exceeded a measured threshold. Despite the amount of tension given it to in the spectrum research community including real world modeling of the concept, there has been precious little progress in actually adopting Pierre's idea even on a trial basis. Speaking very bluntly and personally, one of my biggest professional regrets is that we have made so little progress in adopting enforceable receiver performance requirements during my many decades that I have been involved in spectrum management, both at the FCC and NDIA, in the private sector, and in academia.

The third topic on my list of four issues is noise and interference measurements. My comment...really my concern here is that despite some strong recommendations from advisory committees and other engineers and scientists over the years, the government still does not make, nor have access to geographically extensive long-term accurate measurements of radio noise and interference levels in different frequency bands. Let me pause here and say the information I'm talking about is radio interference information. It's not the sort of coverage information or people getting cellular coverage in a particular area. This goes through interference information or measurements. Now, there are at least three drawbacks associated with a lack of such measurements.

First, the lack restricts our ability to determine in general whether noise and interference pollution created by billions of RF emitters is getting worse or even better for that matter. And if it is getting worse, how much worse? We are focused in this conference on evidence-based spectrum policy, but we lack the comprehensive data necessary to answer a very simple question – are things getting better or worse. Second, if it is getting worse, what systems or devices are responsible either because their RF emissions, or their susceptibility to noise and interference. Where do we focus our time and resources if we don't know what systems or devices are most responsible for the deterioration? Anecdotal information is useful but not dispositive.

Third, as I touched on earlier, automation and artificial intelligence/machine learning techniques hold out significant promise or dealing with the challenges that are presented by the growing demand for digital capacity. Growth is associated with increasing heterogeneous wireless networks that now connect with over four billion people and tens of billions of devices worldwide. However, by their very nature, such techniques require the acquisition and curation of large comprehensive databases to be successful. So, to summarize this point, the lack of comprehensive well curated noise and interference measurements not only denies us the data sets that is the hard evidence we need to address foundational issues in spectrum policy and regulation, it limits our ability to develop automation in AI/ML tools.

But 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. The fourth and final topic on my list of issues is spectrum enforcement, which includes the identification, mitigation, and remediation of harmful interference. Even if one assumes that the first issues, three issues I raised, quantifying harmful interference, establishing receiver performance requirements, and creating and gaining access to properly curated measurements of radio noise and interference... Even if you assume those are adequately address, evidence-based policy making may well prove futile without affective rule of law-based enforcement.

But the fact of the matter is that the number of people that the FCC has outside of the Washington D.C. area devoted to the technical aspects of interference enforcement has declined drastically over the past few decades. As a result, it is my understanding that only the most egregious cases of harmful interference to public safety services are now pursued on site. Now, one way of compensating for the decline in enforcement resources and the exponential increase in RF emitters and receiving devices is automation and AI/ML techniques. However, the full benefits of automation cannot be realistically achieved under current conditions for all the reasons that I talked about a moment ago. As an aside, one of the ways of compensating for the decline in resources devoted to interference management is for the FCC to delegate some of the statutory power of the commission to private industry. Indeed the commission has pursued and is pursuing such approached in a number of important proceedings, including TV white spaces, the CBRS 6 gigahertz and 4.9 gigahertz.

While shifting some statutory requirements to the private sector may well be a justifiable response to the agency's lack of resources in an area that is so critical to our economic and social well being and to the national defense and homeland security, it does raise two significant concerns. First, it appears to me as a non-lawyer anyway to raise questions about the legality of such a delegation under current statutes. And secondly, it brings to mind rather serious questions about transparency. A hallmark of good governance. For example, does a delegation to private entities reduce the ability

of the public to access the information that is the evidence, the subject of the conference, used in making important spectrum policy making decisions?

My time is up, and I want to leave time for questions or comments. So, I will close now by stating my strongly held belief that pursuing evidence-based policy making may well prove futile if sufficient resources are not put into the four areas I mentioned at the outset. Namely, defining harmful interference in a quantitative fashion, establishing enforceable receiver performance requirements, three, creating or otherwise acquiring and providing access to curated geographically extensive long-term accurate measurement of radio noise and interference both in terms of sources and levels, and four, ensuring that adequate resources, public and private, are devoted to spectrum enforcement including the identification, mitigation, and remediation of harmful interference when it occurs. Thank you very much for your attention.

[01:52:26]

Taylor:

Hi, Dale. I had a question for you. So, my name is Taylor Hartley. I'm actually an MBA student, but I have a good deal of experience in spectrum as a navy veteran. But more so on the reconnaissance front. Dale, thank you so much for speaking to us today. I know that you are very busy. You brought up some great points. And you discussed these four shortfalls in the collection of evidence and policy regulations. However, you didn't offer any action that the government might take to resolve these problems. So, what, in your opinion, is the next step?

[01:53:01]

Dale:

Well, I would answer in general is first, for both the government and the private sector just to take action. If we were to take an action on receiver performance back when I was at the FCC in the 1970's, if we had tightened up receivers then a lot of the problems we've had today would be gone. So, I say get started. In terms of for example the need to create databases of interference incidents, that's something that's been talked about a lot. And we have carriers gathering information. We have other government agencies gathering interference information.

And I say there's no depository, no way that we can use that for example in the academic world to develop better techniques because you can't find in a single place information that you need to develop better techniques. And enforcement is a particular concern of mine, as I mentioned. And I see too often the situation today that we take a policy direction in spectrum, and we only think about then enforcement later on. We don't have what I would call a national architecture for enforcement. There is adversaries now that would like it disrupt our communications very badly. And we need to think about enforcement from the get go and not until after we've made fundamental architectural decisions in these wireless systems themselves. So, thank you for your question.

[01:53:01]

Keith: Thank you, Dale, for a very stimulating and intriguing talk. I'm sure we're all going to be thinking about a lot of these issues moving forward. Now I'd like to move on to our final panel for the day. Our last panel for the day is on evidence and spectrum sharing policy among active services. And the moderator is Renee Gregory. I first met Renee when she worked at the White House Office of Science and Technology Policy, and she is now the senior regulator affairs advisor at Google. So, over to you, Renee. Good to see you.

[01:55:53]

Renee: Good to see you, too, Keith. And I only wish I could see everyone else who is in the virtual room. But perhaps next year we will all hope. So, thank you, Keith, to you and all of your colleagues, and to the previous speakers of course. It is no small task to put together a virtual conference or one that has gone as smoothly as this one. So, thanks very much. I also wanted to take just a moment to congratulate Paul Milgrom and Robert Wilson on their Nobel Prize. It's not every day when there's a direct link between spectrum and the Nobel Prize, and I personally was thrilled to see their work recognized. And moving on to this panel, I will briefly introduce the four speakers and also remind everyone that like the first panel, we'll plan to leave some time at the end for questions. So, please think of questions as we're going along and drop them into the Q and A box as you have them.

Starting off, we have Russ Gyurek. He is director IOT CTO and industries at CISCO. He has more than 25 years of networking related technology experience. His range of expertise includes IOT, connectivity of things, 5G, O-RAN, analytics and big data, Cloud, Optical Networking Technologies, broadband architecture related technical policy, and emerging market development. That's a lot. Russ also leads an FCC working group of industry SMEs on 5G, IOT, and ORAN. Next is Paul Kolodzy. He is an independent telecommunications consultant to both the government and commercial clients. His areas of expertise include the development of advanced component, device, and system technology, advanced architectures, interference analysis, and spectrum policy, regulation, and acquisition. He has been active in broadcast, cellular, including 700 megahertz, AWS1, and 3, and 4, and public safety spectrum policy and regulation.

Giulia McHenry is chief of the FCC's office of economics and analytics. And she is an expert in the economics of the internet, telecommunications, and media. OEA is a relatively new office of the commission that is responsible for expanding and deepening the use of economic analysis and FCC policy making, designing and implementing FCC auctions, and implementing consistent and effective agency wide data collections, practices, and policies. Before the FCC, Giulia served for three years as chief economist of NTIA, the National Telecommunications, and Information Administration. Last but certainly not least is Patrick Welsh, who is the vice president of federal regulatory and legal affairs at Verizon where he focuses on spectrum and technology policy. He has worked at Verizon since January 2012. Before joining Verizon, Patrick spent nine years with T-Mobile working in various capacities on their federal regulatory and legislative

affairs teams. He has also served as an adjunct professor at the Catholic university, Columbus School of Law.

I thank all of the panelists for joining. And I think we've already seen today a lot of great discussion, and teasing up some of the important questions around evidence policy and how it relates to spectrum sharing. So, I'll dive right into the topic of this panel, which is spectrum sharing among active services. And to set the stage for a discussion, particularly for some of you who might not be quite as familiar with spectrum, it would be helpful to make this a little bit more concrete starting with what exactly is an active service. I'm not an engineer, so engineers may correct me. But my definition is a service that is both transmitting and receiving information. This conference uses the example of sharing between cellular and radar. And I thought that tied nicely to a couple of complicated shared bands that have been in the news in recent months and years.

The 100 megahertz starting at 3.4 gigahertz where the FCC is currently seeking comment on sharing and the adjacent 150 megahertz in the citizens' band radio service or CBRS, which we all got noted earlier, as an example of a new framework for tiered sharing. While we probably won't go into great detail on either of those bands during our panels, and there are certainly many others, it might be helpful to keep in mind how our discussion applied to either or both of those bands in hindsight or moving forward. Now, going back to our previous panel, we already heard a great discussion of evidence-based policy making. And this program generally defined evidence-based policy making as the process of using the best available research to make decisions at all stages of the policy process.

I also really like Thyaga's framing earlier of marrying data to decision making. Now, that all sounds great in theory. But what does that really mean in practice? And David kicked off the very first panel with a very similar question, but I think it's a really important one. So, I'll ask each of our panelists to respond from their perspective. We have the benefit of having an economist, a couple of engineers, and an attorney, so it will be interesting to hear how their views might differ. So, starting, Julie, with what, what does evidence mean to you as related to spectrum sharing among active services, and to what extent do you think we are or are not already using evidence-based policy making?

[01:57:14]

Giulia: Hi, Renee. And thanks for having me and thanks for giving a shout out to Paul Milgrom. It really is a huge accomplishment and very exciting for the FCC, so we've been all kind of on cloud nine for him for the last 24 hours. So, that's exciting. But turning to evidence-based spectrum policy making... So, as you mentioned, the office of economics and analytics was stood up just about a year and a half ago, a little over that actually. And we've been spending a lot of our time doing cost benefit analysis and really elevating that economic analysis and essentially evidence-based analysis at the FCC. And so with respect to spectrum, I think most of the time what we are thinking about is really that [Inaudible 02:02:21] evidence that we talked a lot about in the first panel,

which is... And unfortunately a lot of it comes in from the outside, although I think OEA does an extraordinary job of developing evidence and looking at that. Looking at the evidence there and developing our own conclusions.

But really we are thinking about it in terms of... OEA is thinking about it in terms of a cost benefit analysis. So, looking at the evidence brought in from both sides, evaluating that, and determining what that means for the policy cuts that we're making. But I will also say that I think most of spectrum-based evidence these days is [Inaudible 02:03:02], and it's [Inaudible 02:03:03] in a world as the first panel made so clear...in a world where every band is unique. Every repurposing situation is unique, so it is sort of combining what evidence we can find and glean that we think what we think is appropriate and applicable with a whole lot of sort of theoretical understanding of what we think will happen in the future for this band. So, I think most of what we're looking at is economic and engineering filings. What we think has happened in previous bands... But again, we're not talking as much yet about the type of real time evidence about how spectrum sharing is occurring. And sort of taking the evidence in real time to make the right policy decisions for that band. I'll stop there.

[02:03:52]

Renee: Thanks, Giulia. Thanks. Paul, I'll turn it over to you. You're an engineer. How do you think about evidence, and are we doing it today? You're on mute.

[02:04:08]

Paul: That should be better. I think you're doing that already today in the sense of taking evidence into play. I think evidence comes in three pieces. One of them is in data. One of them could be in theory. And the other one could be in modeling, which kind of combines a little bit of each of these. And a lot of it is brought in today in a variety of different methodologies. The problem that associates when we get together with data driven or what is data driven is the need for metrics to actually tie the data to something else. Data is empty until you actually put things into consideration as to what it means. And so that's I think where some of the gaps actually rise or actually where most of us make a lot of our living in the sense of having the arguments associated with...

Yeah, that data means this because it helps my client or me in that way, or this data means that because it hurts me, and I don't want to be used. And so a lot of the actual arguments come down not in the sense of the evidence-based process, but it's actually in how that evidence is actually applied. And I associated that as an engineer and a lot of things that we do, a lot of work in developing systems is developing the right metrics. And evidence based has to actually tie the data to the metrics. And that is where the tough time is for policy makers to do because policy makers generally don't like to have strict metrics. They tend to like to have a little bit of give and take, so it gives them the opportunity to kind of do what they want.

[02:05:44]

Renee: Thanks, Paul. And Patrick, we'll turn to you in a moment. But first I want to go briefly back to Giulia. We have a request, if you could briefly describe what you mean by [Inaudible 02:05:58], for those in the audience who might not be as familiar with that term.

[02:06:02]

Giulia: Of course. I did see that from Pierre. So, [Inaudible 00:02:06:02] is where we're really looking before we make the policy decision. We are making as part of the rule making process, using what evidence we can glean to make the decision as to what the policy will be. And I want to sort of make sure that these... That is a pretty big distinction, I think, for sort of the rule making process at the commission where policy is made, and then you sort of let it go and see what happens. And so most of those decisions we're making...before we in fact make the final decision, we're looking at that evidence. Once the decision is made, it's a question about how much more evidence, or how can we integrate evidence at that point. And I think that's where the challenge is.

And since I have the mic, I'm going to use it for a second to say something to Paul, which is I don't know so much that policy makers don't like metrics. I think the challenge for policy makers is to define metrics, and then define metrics that we can collect over time. So, as Scott Wallsten was saying, we're still stuck in the counting lines. But it's because we've been collecting that information for a long time. We know what it means, and we can measure it and compare it over time. If you start to talk about metrics, you need to be able to compare the current metrics to past metrics. And that's where it's a real challenge for policy to...between policy and politics, and innovation, keeping those metrics and ensuring that they continue to be reliable and appropriate to look for...to make decisions on is a real challenge for policy makers.

[02:07:12]

Renee: I love it. We're having a debate already, and we haven't even made it through opening statements. Paul, I'll give you a chance to respond briefly if you prefer. If not, we'll go over to Patrick, who has been patiently waiting. Take it away, Patrick.

[02:08:03]

Patrick: So, I think the way that we think of evidence-based policy making for spectrum ties very closely to what Giulia said but also with what Paul said. In terms of Giulia's framing of it, we look at it as cost benefit analysis in terms of allocation and assignments. And a lot of times, allocation decisions are made when we're repurposing spectrum from a specific use such a say government radar systems or [Inaudible 02:08:38] operations to general purpose commercial applications like mobile broadband. And a lot of times, the cost benefits aren't even distributed. The incumbent systems see this repurposing as merely a cost. There's no upside. There's no benefit. Whereas the commercial industry is very excited about the benefits, but they're not as attuned to the cost of the particular incumbent systems.

In a private market, economic actors can negotiate those and come to a commercially reasonable outcome. But we see time and time again when we're dealing with federal agencies, for instance, where we can't negotiate. We can't enter into commercial agreements. And the policy leaders that we've relied on in the past such as the commercial [Inaudible 02:09:38] enhancement act, which allows for federal agencies to transition systems off of spectrum that can be used for commercial use and use a portion of those auction revenues to upgrade their systems tends to be or has been narrowly focused on clearing and vacating those bands.

There has been some...an amendment to that law in 2012 with the Middle-Class Tax Relief Act that allows for some of that money to go for spectrum sharing. But we need to really look more at some of those mechanisms simply because we're mixing disparate uses, so we have commercial broadband on one hand and government, military radars on the other. Both are valuable. But we have to try to find a way to distribute those costs and benefits in a way that makes sense for policy makers.

[02:10:39]

Renee: Thanks, Patrick. And Russ, I'd love to hear your thoughts on what is evidence, and are we using it today? Or reacting to anything that the three panelists have said so far about it.

[02:10:53]

Russ: Yeah, so before we get into a debate, let me make a couple quick statements. So, first, congratulate the FCC on doing a good job, at least in an engineering perspective and delivering evidence-based decision making. Examples are 6 gigahertz spectrum as well as CBRS. I think those are really good ones. The other thing I was thinking about this panel this morning. I went to the FCC's website and was looking at their national spectrum management directive. There's 21 key points. That's quite a few. I just want to read number two from that list because I think it's really relative to this discussion. It's promoting transparent fair economically efficient and affective spectrum management policies by regulating the efficient and adequate use of the spectrum, taking into due account the need to avoid harmful interference and the possibility of imposing technical restrictions in order to safeguard the public interest. So, to me that kind of frames up a lot of things we're talking about here today.

We're all looking at how do we get more efficient use of spectrum. And as we talk about evidence-based approaches... This is a data driven approach. Everything we do in life is surrounded by big data. No matter what it is. It's kind of like why aren't we more practice in leveraging some of that data for spectrum management, which is one of the scarcest resources there is. So, 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 maybe today. I think as you look at some of these bands where there's incumbent services, there's a couple rules that come to mind at least in my opinion. One... And I think this is from the first

speaker even. Do no harm to incumbent services. The second one is we really need a simple approach. And I could say things about CBRS.

It's kind of a Cadillac model in a way, or it took a long time to develop. And it's got some economic costs there. Also I'd say one size doesn't fit all. When we look at spectrum management and sharing, incumbent services vary quite a bit in some of these DOD bands for instance. And so just one sharing technique may not work across other bands with different services between radars or other uses. And then I think we really need to focus on maximizing the precious little spectrum that there is, all while making sure we stimulate innovation in those bands. But there's a lot of opportunities here. I think leveraging evidence in more data, we can open up tremendous amounts of additional uses and more efficiencies in spectrum. The challenge will be, I think as Dale pointed out, how do you measure some of these things like harmful interference, the noise, and how do you really get to some type of enforcement. And not a heavy-handed enforcement but maybe more of an industry level enforcement. Sort of like what's happening with multi stakeholder groups in certain bands. But I think this is all open for discussion as we talk about evidence-based approaches.

[02:14:10]

Renee: Thanks, Russ. So, staying on the topic of what exactly is evidence, and how should it inform policy, I'll start again with you, Russ, since you were last on the introductory remarks. Is evidence always scenario specific, or are there general types of evidence that are always needed? You just alluded to every scenario being very different. But I'd love to hear you expand upon that a little bit.

[02:14:40]

Russ: Yeah, I think there's some base lines that are very common in some of the sharing in terms of the evidence that should be utilized or collected towards a decision. But, again, I think there will be some differences in terms of it could be receiver sensitivity or receiver interference. It could be based on power levels. And I think as we move forward with spectrum sharing, we're going to have to look at every aspect in that ecosystem that could potentially be adjusted to allow greater spectrum sharing. So, yes, the evidence... There's a common set of evidence I think that could be utilized, but there is also some differences based on what the services in that band are.

[02:15:26]

Renee: Patrick, what are your thoughts on that topic? How should we be thinking about spectrum evidence? Is it always specific? Is there some common framework that we should always be looking at when we're considering evidence?

[02:15:42]

Patrick: I think the experience that we've had in PCS, AWS, millimeter wave, tends...CBRA...tends to show that it is specific to the band. It's specific to the users and the uses. So, I think every band is going to be a little bit different, and there will have to be different metrics

that have to be developed to understand those. But in terms of general applicability, I think Dale was spot on about the need for enforcement, a robust enforcement mechanism. We can't have a successful spectrum management regime without an affective enforcement regime. And that enforcement regime has to be there to identify harmful interference when it occurs, mitigate it, and then remediate it.

And really good process put in place on the CBRS band where the spectrum access system, which is essentially the databases, that control access to particular frequencies is a closed loop system that in the event there is harmful interference, there is a mechanism to go in and stop it, and prevent it in the future. In other instances such as say the 6 gigahertz band, the FCC had the ability to expand the automated frequency coordinator, which is kind of like a SAS or a spectrum access system to all devices in that band.

They chose to only do it to outdoor devices and decided not to require it for indoor devices. So, time will see whether or not that decision was right. The challenge we have is the decision is made, and there's really no way to close the barndoor once the horse is out. So, kind of thinking holistically about these and making sure that the enforcement mechanism is baked into the framework from the beginning really helps to prevent intractable interference problems in the future. And then when there are some, to be able to recalibrate and to adjust to fix those.

[02:18:03]

Renee:

I really like that point. It's not just about making the policy. It's about enforcing the policy, and monitoring the policy, and seeing what happens. Which brings me to my next question around evidence and it not necessarily always being neutral. We see facts, and figures, and charts, and graphs on paper. And it seems pretty definitive. But it's never truly neutral. It's not neutral in the law. It's not probably neutral when it comes to spectrum. So, how should people, whether they're in government or in industry, recognize and grapple with potential biases in the presentation of evidence? Is there any way that we can reduce bias through neutral parties or otherwise? And Paul, I will start with you for this one. You work for both industry as well as for the government and may have some particular thoughts on this.

[02:19:00]

Paul:

I live both sides. Unfortunately even with science, we have noticed that there are biases. When people are trying to make hypothesis work in their favor. Not in their favor in the sense that they're trying to do something nefarious but more of that they have a strong belief, and they want to actually show only the evidence that is associated with that strong belief tends to bias the result. Now, is it needing to have neutral parties? So, the question is how do you actually get the right neutral parties, and how do you fund those neutral parties to actually spend the time and effort that you need. The FCC has some challenges on that and getting the engineering talent, as well as the NTIA and the like.

So, it's difficult to find those unbiased or neutral parties. I tend to look at it as a possibility of arguing the same point. Meaning when you do a peer review paper, you're arguing about a particular hypothesis that is put out there. It isn't that you change the argument and try to say, "I think this is good because of this." It should be, "Here is the major points. Now let's walk through each of those major points and have the argument about each of those points." And look at the numerics, and look at the models, and look at that. What I've noticed in a lot of even the spectrum world, the argument tends to change. It's that people never argue about the same thing.

They argue about slightly different things to try to make their point. [Inaudible 02:20:35] hopefully that somebody could figure out and kind of wade through it. I've been on multiple occasions on both sides of the table of watching the argument just change in front of my eyes. And I'm saying, "Wasn't the real question interference? Wasn't it actually caused by these pieces of equipment? Aren't we talking about that?" And all of a sudden, "No, no, no. I'm going to lose that argument. Let's start a new argument." It should be very in some sense like a peer review general, try to figure out... Of course those are going to the wayside in some respects nowadays also. But the idea how to make the same argument and follow that process through to complete an argument before moving on to the next one. That's where I think we have some of our major problems.

[02:21:14]

Renee:

Giulia, I'd be interested in your thoughts as a policy maker who is weighing evidence from different parties – recognizing that it's highly unlikely that anyone is going to present evidence that's not in their favor but also keeping in mind that the commission also has an agenda as we heard earlier and has every right to have a policy agenda. How are you thinking about bias? Is it a problem? Is it addressed? Should it be addressed in different ways than perhaps it is today?

[02:21:45]

Giulia:

So, certainly I think bias is always a problem. It's something that you have to look for in all research. And sort of whenever humans are involved. And so I think for us at the FCC, I think when we're evaluating... And I will also say that the funding constraints are real. OET nor OEA can spend their life going out and collecting data ourselves on all of these problems. It wouldn't be efficient. It wouldn't be affective. And in many cases, you can do the cost benefit analysis on collecting that data, and it's not there. And so in many cases, we really have to rely on the evidence coming in from both sides. And there are some things that we look for in terms of trying to sort of tease out where the truth is. Number one is in my mind showing your work is essential. So, if you're going to be looking for...when we're looking at analysis, we want to see transparency.

We try to provide transparency in our own analysis, and we want to see it in the analysis that are brought to us. I think there is obviously understanding biases, motives, incentives that is inherent in sort of thinking about how much do we weigh each of

these positions, and how accurate do we think this is, and is this realistic. But really we are looking at those biases. And credibility certainly is important. I think we all have people we think are more or less credible in terms of the work they do, and I think particularly in telecom, economics and the engineering, it's a recursive game. It's the same people on either side of the table over and over again, and so I think developing that credibility and sticking with that, and more people doing research... Knowing the lines they're not willing to cross and making that clear that... We all at times in our lives have been paid to argue for things.

The question is how far are we willing to take that. And then I think for the FCC, it is taking all of this information in and then performing our own analysis to ensure that we are comfortable with whatever the answer is. And yes to the question does bias exist in the commission. Of course it does. Politics is sort of inherently that. What I think what we're trying to do and when I think we're doing our job right at least at OEA and I'm guessing the same thing is true of OET 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. And that may not... that's not necessarily the approach that the commission takes, but we do the commission a better service if we try to be as objective as possible internally and have a legitimate discussion about it. But of course there are challenges always in that. But that's, I think... Biases exist, and really it's more a matter of how do you address it and deal with it.

[02:25:12]

Renee: Thanks. And looking at the time, I will pause on my questions for now to make sure we have a chance to answer some questions from the audience and others. That is Keith noted up top following the Weiser rule and in the grand Silicon Flatirons tradition, our first question will come from a student. So, I'm very pleased to welcome Lily Wasser, who will have our first question.

[02:25:37]

Lily: Hi. Thank you for having me. I'm just... You started addressing a little bit how you determine credibility. But if you could address that a little bit further. Also when you're looking at economic concerns, how do you really address what's credible economic evidence when you're looking at these policy issues and how they're going to affect us on an economic basis?

[02:26:03]

Renee: Giulia, I think that's to you.

[02:26:04]

Giulia: Yeah, probably. I'll start. So, let me take the piece that I'm... When we're looking... So, from a cost benefit analysis standpoint, when we're looking at the economics, I think we are looking at really the whole welfare game, which is sort of what are the costs and

benefits, what are the sort of more social welfare impacts that those could have. And we are admittedly.. So, economics inherently are less concerned with transfers than we are of costs and losses holistically. So, that creates some funny things, but we do... When we're looking at cost benefit analysis, we're trying to do that sort of more inherent economic costs, and losses, and benefits. But then we're also looking at the whole picture and trying to factor in all of the other potential losses and the different sides of the equation. And then in terms of... And I'm sorry. What was your first question again?

[02:27:13]

Lily: I was just asking how you're kind of addressing the credibility of it. Because obviously you're getting a lot of different data from all different sources.

[02:27:24]

Giulia: Yeah, and I think that's where... We get data from all sources. We want data from all sources. We ask for data from all sources. And then it really comes down to us evaluating do we think the analysis is sound on their own. And that's why we have... So, the FCC has a team of over 60 economists who are looking at just that question – are these analysis sound based on our own evaluation of them. We're then... Again, we're looking for have people shown to the work. To the extent analysis basically has that backup of this is where the data comes from. Then we can dig into that ourselves, and then start to say, "Do we think these assumptions are realistic? If we change the assumptions that we think are more realistic, what happens here?"

And so the extent to which economists are coming in and showing their work to us, it's hugely helpful. We are sort of inherently also always looking at the biases. Everybody has a point of view. Everybody has an incentive. And to the extent you're filing in an interested party in a proceeding, you clearly have an interest. And so we're taking that into account. So, at the end of the day, it's as much art at science. And that's sort of a big part of what we're doing every day is weighing these different sides and looking where we think the policy should be coming out. Also factoring in of course what the... The chairman is the one at the FCC who is actually appointed, so certainly their feeling on policy will at the end of the day matter when it comes to when the ultimate policy decision gets made. We just provide the evidence and evaluate it the best we can.

[02:29:11]

Lily: Thank you.

[02:29:12]

Renee: Thanks, Lily, for that great question. And I'll also ask the other panelists to comment if you would like. That question around credibility is such an important one, and particularly for the students who may be in the audience thinking about becoming practitioners. Paul, I'll hit you first. How do you think about credibility when you know you're going to be in front of the commission on multiple issues over multiple years

where you might be in a defensive posture versus an offensive posture? What are some rules of the road, some advice that you would offer to people?

[02:29:12]

Paul:

I don't know how this works [Inaudible 02:29:50] people, but I tend to try to be extremely forthright to the limit of actually being somewhat combative when I'm with my own clients in the sense that I will not move from being truthful. Engineering is a very truthful statement, and your word is your bond in some respects. And so I think exactly what Giulia was saying is what happens in even the engineering groups. Where you get a reputation while working with people to listening to what the question is, trying to understand where the commission is coming from, trying to educate them in a lot of different ways, and trying to have them understand why you're looking at it from this perspective, why it's important.

But also to be so truthful that they know that you will not go off and say something to them that is wrong. You may not have all of the evidence. We're going to say... Let's take it from a non-nefarious point of view. You don't have all the evidence. You don't know everything. No one knows all the different pieces. So, as long as you represent yourself as best you can, truthfully, usually you build up that reputation where they can give you a call. And I've actually been contacted, saying, "What do you think about this? We have a question. Would you be willing to answer that question?" To have that kind of interaction allows you to be able to understand and try to help really... You're trying to help your client, but you're actually trying to help the United States. We are all in this country to do policy correctly.

[02:31:17]

Renee:

Thanks, Paul. Russ or Patrick, do you have anything to add?

[02:31:23]

Russ:

I can add a couple comments. I'll just be short. Yeah, I go back to that number two statement, promoting transparency for economical efficient and affective spectrum management policies. I think it really comes down to both credibility and the economics. The FCC is being hit from all sides of, " Hey, I want dedicated spectrum. I want shared spectrum. I want licensed spectrum." And so you have to understand their point of view. They're trying to make the most economic use of spectrum. And for instance, licensed spectrum, you guarantee a certain level of investment from operators. Unlicensed, I think there is... It's well known there's a great track record in terms of the value. Although it's very difficult to quantify some of these things, and I think that's where the FCC staff really needs help. We look at that from the FCC tact. We work on a number of these challenges. But realistically, too, it's how do we get more efficient use out of that spectrum. So, from the credibility standpoint, we try to bring in the facts, the evidence and present those to help drive policy.

[02:32:31]

Renee: Thanks, Russ. Patrick, any quick thoughts? If not, we'll move on to the last question.

[02:32:31]

Patrick: We can go on.

[02:32:38]

Renee: Great. So, we do have a question from the audience. And it goes to harmful interference, which Dale spent quite a bit of time talking about today, among others. So, it says...according to the questioner, this is more used in proceedings before the FCC to enable legal wiggle room for a given spectrum issue digore than anything else. My question – in this age of big data, the CBRS, SAS operations... And SAS is a spectrum access system. And there's a data mining opportunity. How can we begin to push in the direction of quantifying and defining harmful interference? And I will use my moderator post to say and should we, an open question. And then the second half of the question is and is a quantitative measure or system of measurement for harmful interference even possible, given the US regulatory context. And we have two minutes. So, brief answers please but a really interesting question that we could probably spend the next two hours on. Any volunteers to go first?

[02:33:44]

Russ: I'll try to take 15 seconds.

[02:33:48]

Renee: Great. And then over to you, Patrick.

[02:33:49]

Russ: Yeah, so I think this is a really critical issue. We're seeing the cost of creating harmful interference. You can buy eight-dollar component to create interference on GPS that are actually car cigarette pluggable. \$200 for a great spectrum interference capability. But I think this is something, yes, it can be quantified. We need to quantify it, per Dale's sort of outline. It's something where we have to really start to take a deeper look at.

[02:34:20]

Renee: Patrick?

[02:34:21]

Patrick: So, the definition of harmful interference will depend on the different systems. So, in a lot of ways, it reminds me of Justice Stewart's quip about obscenity. I know it when I see it. Harmful interference is sort of like that in a lot of ways. And I think Dale touched on a way to kind of get out of that indeterminate outcome by focusing not necessarily on harmful interference but on interference limits. So, that could be an objective criteria. And we've seen a little bit of movement in that direction in particular in the C band proceeding and having 5G operators protect incumbent adjacent channel earth station receivers. Rather than defining those and protecting them from harmful interference,

the commission chose a power flex density value, which is objective, which can be measured. And that's the dividing line between what is accept and what's not. So, I think it's a real opportunity to kind of build off of that and some of the innovations that Dale had talked about.

[02:35:34]

Renee: Great. Paul, it sounds like you had some thoughts as well.

[02:35:38]

Paul: Yeah, 20 seconds. Very few thoughts. Right to the point, harmful interference, not only does it matter in the services you provide, but it also depends upon where you are. I like using the example – the amount of noise that you listen to in New York City... Maybe not today but in a normal New York City versus what you would hear out in the middle of a cornfield in Wyoming or Kansas, whatever... The threshold is very different. And so the interesting part about it is to understand that it's also very much in a sense circumstance related, and where you're located, and what time you're located. So, it's a very interesting process. And it should be really investigated in a much more dramatic way only because it'll make a very major impact on how much spectrum we can put into real use.

[02:36:23]

Renee: Great. Giulia? Any thoughts on this, or will you take a pass?

[02:36:27]

Giulia: All I'm going to say is I think that question, how does this fit into the regulatory context, is hugely important and one that we have to start really thinking about. We can collect this data. And like all data, it's costly to collect. So, we better be doing something with it if we're going to collect it. And I think sort of determining what that is and first implementing that in the regulatory context is going to be really huge. And my guess is it's going to happen in baby steps.

[02:36:59]

Renee: Thank you.

[02:36:59]

Giulia: But I think it's possible.

[02:37:02]

Renee: And with that, thank you again to all of the panelists for this good discussion. And put in a plug for the Air Meet to follow. I'll be there, so I hope to see many of you there as well. And on behalf of the entire panel, again, thank you to the folks at Silicon Flatirons for putting this together. Excited to finish off the end of one good day and be back on Thursday for another great session, I'm sure.

[02:37:35]

Russ: Thank you.

[02:37:35]

Patrick: Thank you.

[02:37:36]

Keith: Thank you, Renee, and thank you again to all the panelists. That was a really interesting discussion. I certainly learned a lot. Okay, so that's it for today. And we pick up again tomorrow at 10 o'clock Mountain Time, 12 o'clock Eastern. But in the meantime, it's time to head out to our virtual breakout rooms, so we can get some networking in with the speakers. So, this is an important part of every Silicon Flatirons conference. We're doing our best to make the virtual experience as much like the hallway experience as we could.

I think everybody received a link to Air Meet and the link was also put in the chat window. Air Meet is the browser-based event platform that we're using for the breakouts. Now, it's very critical that you need to log out of Zoom and then connect via Air Meet. If you've got them both on, there's some problems. So, log out of Zoom, connect via Air Meet, and each breakout room which will be a table will have the name of a speaker from today. And speakers will join their own tables, and attendees are encouraged to walk the hallway and join any table, and join any conversation that they like. So, thank you very much, everybody, and we'll see you tomorrow.

[02:38:56]

[No dialogue]