THE BROOKINGS INSTITUTION

THE WIRELESS SPECTRUM AND THE FUTURE OF TECHNOLOGY INNOVATION

A HAMILTON PROJECT POLICY FORUM

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ROUNDTABLE: UNLOCKING SPECTRUM VALUE THROUGH IMPROVED ALLOCATION AND ADJUDICATION:

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P R O C E E D I N G S

MR. ALTMAN: Good afternoon, everyone. Thank you very much for being here today. I'm Roger Altman, and on behalf of the Hamilton Project, let me welcome you all. I'd like to say a word about the Hamilton Project and then a word about our program today. The Hamilton Project was founded nine years ago with the goal of identifying and researching and promulgating policies to achieve better economic growth and more inclusive economic growth in this country. In other words, growth that is more sustained and which benefits all Americans.

The organization was named for Alexander Hamilton, our first Treasury Secretary, because he argued at a time, when very few did, for an activist government to promote broad wellbeing. Now the Hamilton Project operates as a rather different type of think tank than most, a nearly virtual think tank in the sense that we employ a small, albeit extraordinarily talented, permanent staff lead by Melissa Kearney, our policy director and Karen

Andersen.

And periodically that staff produces strategy papers, which throughout the history of the Hamilton Project have been important, but most of our work, including today's is commissioned from the very best academicians and other experts in the country on the subject matter at hand. Today is a good example. And any of you who have read our many previous policy papers know that Hamilton has distinguished itself by producing exceptionally good and consistently exceptional work. We have methodically covered over these nine years many topics which impact growth, and we define that quite broadly. Not just tax and budget policies or monetary policy, but education, poverty, incarceration, and numerous other broader topics like today's questions on spectrum policy and the use of spectrum, which we believe impact overall economic conditions in this country.

I might say that Hamilton has been blessed with strong leadership from the beginning, other than me, with Robert Rubin chairing the Hamilton Project --

and he would be here today, but he's attending Bob Strauss's funeral service in Dallas -- with a strong advisory council divided with policy experts on one hand and leaders in business and finance on the other, and our five executive directors. Quite a remarkable list. I've included initially Peter Orszag, then Jason Furman, then Doug Elmendorf, then Michael Greenstone, and now we've ascended to the pinnacle because Melissa Kearney is the director. And you'll hear from Melissa in just one minute.

Turning to today, we are addressing federal policies towards wireless spectrum and potentially more efficient allocation and usage of such spectrum. And let me just say a word about the importance of the subject. The competitiveness of the country as a whole economically speaking, the universality of broadband access; the quality of our public education, especially in economically-pressured parts of the country; the ability of our infrastructure to keep up with demand for mobile data, these factors and others I could list are tied into this topic today. How well

are we deploying our spectrum, making it as widely available as possible, and using it to maximize both the consumer experience and the competitiveness of the country, as well as I might say certain national security contexts?

And this is what we're going to talk about today. I think you're going to like the panel discussion. It's going to be followed by an address by Tom Wheeler, the Chairman of the Federal Communications Commission, which is at the center of all of this, so I think it's going to be a lively and productive afternoon. And on that note I'm going to hand this to Melissa. (Applause)

MS. KEARNEY: As you all well know, wireless spectrum is a phenomenal economic resource that holds great promise. The efficient use of this resource is critical to our modern information economy, as well as to national security, defense, and first responders. Some of our most common wireless technologies today, our iPhones and our iPads, were not even conceived yet when the backbone of our spectrum policy was put into

place in the 1920s. And of course some of the untapped promise of the wireless spectrum lies with systems beyond our current imagination.

But what we do know today is that the economic promise of wireless spectrum is massive and we need a system of allocation, assignment, and regulatory oversight that is aimed toward achieving that maximum value, that is why the Hamilton Project has identified spectrum policy as an issue of primary importance. Our country is rich with innovative individuals and companies, including many of you in this room, who are working to meet the demand for wireless systems; but that success relies on access to wireless spectrum. Regulatory barriers to that access stifle innovation and curtail the speed of economic growth.

When thinking about spectrum policy, we are confronted with the classic economics problem of how to efficiently allocate a scarce good, which in this case refers to the rights to operate systems that use wireless technologies. An important goal of policy

design should be to facilitate the allocation and the reallocation of wireless spectrum to realize its massive economic value. Economists have long argued for a market-based approach. In the spirit of the argument made by Nobel Laureate Ronald Coase in his seminal papers, over recent decades the FCC has gradually allocated more spectrum rights for flexible use. And since 1993 it has been using auctions to award most new spectrum licenses. Still there's much room for continued improvement.

This policy issue is a very complicated one, at least to many of us, because of the detailed technological and legal issues at play. In our work at Hamilton over the past few months to understand the broader issues involved, we have learned that there are four particular sets of challenges. First, under the status quo, vast portions of the wireless spectrum are licensed to entities that allow it to sit unused or underutilized. Spectrum could be wasted in a variety of ways. Current license users might not use all of the frequencies over which they are entitled to

transmit, or they may have the rights to operate over a wide geographic area, but only operate in part of it. In addition, the licensed user might only make use of those rights intermittently.

Second, there's widespread under investment in high-quality signal transmission and reception technology. One spectrum operator's signal is another operator's interference. Poor receivers impose a negative externality on those operating in a neighboring band because they force neighbors to operate at lower power. High quality receivers can compensate for strong signals in an adjacent band; however, the current system of spectrum regulation does not incentivize users or device manufacturers to invest in high quality receivers, leading to less intensive utilization of wireless resources.

A third challenge is how to realize the private economic value of wireless operation without compromising key government priorities. Many government agencies do not make full use of their spectrum rights allocation; however, recent

technological developments have made possible dynamic sharing, which enables commercial users to make use of otherwise idle spectrum rights without jeopardizing government needs.

Fourth is the challenge of figuring out how to most effectively move beyond the command-and-control paradigm and establish the appropriate mix of licensed versus unlicensed spectrum use. A licensing regime grants license holders the right to exclude others from operating in a frequency band. Unlicensed spectrum implies a commons model of property where access to a frequency band is not excludable and anyone can operate in that band so long as the equipment they use meets FCC standards. Determining how much spectrum to allocate to unlicensed versus licensed property regimes will likely be an enduring policy debate.

These challenges require fresh new thinking on spectrum policy in order to foster innovation and support greater growth for our technologically-dependant economy. With demand for

wireless applications showing no signs of slowing, unlocking the full value of the wireless spectrum has never been a more pressing economic challenge. And for that reason the Hamilton Project is proud to host this forum today. We thank you for enjoining us for this important conversation. And now we turn our attention to our VIP panel discussion featuring the new policy proposal by Pierre de Vries and Phil Weiser.

MR. LEVIN: Okay. Just to keep us on track, I'll start. I'm Blair Levin, and I'll be the facilitator for the discussion. I want to start by introducing the panelists and add a brief moment of context -- oh, now the mics are on -- and then ask Pierre to present the paper. On my immediate left, Preston Marshall, who since he works at Google doesn't actually have a title, but we can think of him as the principal wireless architect for wireless networking at Google. And then we have Dean Brenner, who is the Senior Vice President of Government Affairs at Qualcomm.

I should note I could give long intros to all of these folks, hopefully you have them. There's an enormous amount of experience on this panel both inside government, but also with the private sector. Next is Joan Marsh, who is the Vice President in Federal Regulatory Affairs focusing on wireless issues for AT&T. And we have Phil Weiser, Dean and Thomson Professor, the University of Colorado Law School, the Executive Director and Founder of the Silicon Flatirons Center and notably worked in the National Economic Council from 2010 --

MR. WEISER: Ten.

MR. LEVIN: -- to 2011.

MR. WEISER: Eleven.

MR. LEVIN: Yeah. And actually worked on a number of these issues, as well.

MR. WEISER: And actually was hired by Jason Furman after writing the policy paper for him. So --

MR. LEVIN: Right, which I will mention in a second. And then Pierre de Vries, Senior Fellow and Co-Director of the Spectrum Policy Initiative at

Silicon Flatirons Center.

One theme today is taking ideas and turning them into actions, reality. And I might do one other very quick introduction of Jon Leibowitz, who is somewhere in the audience right here. Jon is Deputy At the Wireless Bureau at the FCC and was the principal author of Chapter 5 of the National Broadband Plan, which laid out a lot of very significant changes in spectrum. And he's been in the trenches actually effectuating those changes, but one of the things he did that probably has the most prominence, but it was based on a paper that Phil and Pierre I think also -- no -- just Phil wrote, but I think he had a coauthor, I can't remember who it was, in about 2008, which suggested a notion of what became incentive auctions.

And when it was one of the few bipartisan pieces of legislation in communications policy that has passed in the past few years. That auction, which I think will occur probably in 2015, will be a major event in a lot of ways, but I think it is an example

of how the Hamilton Project serves a very valuable role of being able to air ideas that, perhaps not on Google time, but nonetheless pretty fast for government, is able to become a reality in the world. And so today we have an opportunity to exam a set of new issues. Because as all of us know in policy, you don't ever solve every problem, you just keep, you move from solving one problem and then you move onto the next problem.

So I'm going to ask Pierre to get up and summarize the paper that I think you all have a lot of access to that focuses on three ways on which we can improve how we use spectrum. Pierre.

MR. DE VRIES: Thank you very much, Blair.

Well, wireless is wonderful. It's a wonderful thing. We all love our smart phones. We love 4G. We love the WI-FI, Bluetooth headsets. First responders use it. It's used for national defense. All kind of communications, but wireless is also used for other things like broadcasting of all kinds. Navigation from GPS to radar to air traffic

control. Machine-to-machine telemetry, satellites monitoring the environment from space. So clearly society benefits hugely from wireless services.

And as always, therefore, we want more, we want better, we want it cheaper, and we want it faster. There's always a challenge in doing that given whatever the current regulatory regime is. And Phil and I have developed three interlocking proposals to help move things forward. And they are harm claim thresholds, also known as interference limits; band agents to address the problem of fragmentation of spectrum bands; and more effective adjudication of interference disputes.

But before I get into that, let me just say what a huge honor it is to be here, what a privilege it is to be with the Hamilton Project here at Brookings. I'd like to thank all of you for being here today investing hours of your valuable time to be with us online as well as in the room. I'd in particular like to thank the Hamilton Project team who have done an enormous amount of work to make this work

accessible, to spread the word through this event and also through the publication you have. And last, but not least, I'd like to thank everybody who's helped us to develop these ideas whether they agree with them or not. There's a list of acknowledgments in the paper. I commend that to you. It's surely an incomplete list, but it's a start.

So do we actually have a problem? Well, we wouldn't be here if we didn't have a problem, but I don't have the time to go through the long litany of all the case studies. I'll just briefly mention two of them, and we can talk about them more, I suspect. The first is the dispute between GPS and LightSquared over the last few years. And that revealed all three frailties of current regulation that I'm going to be talking about in a few moments. And the other was the conflict between SiriusXM and the WCS operators and the resolution, that I think Joan is going to be saying a few words about, the resolution of that problem illustrates both the problems that we have and what the opportunities are going forward.

So how would I characterize the problems that we have? I'll do it under three headings to map to the three proposals. The first is that I think there's unproductive uncertainty about spectrum entitlements. And by that I particularly mean the rights and responsibilities to protect others from harmful interference, but also the responsibility to protect one's self against reasonable interference from other people. That means that parties, because of this uncertainty, often hold wildly incompatible views which makes it very hard to bridge the gap and negotiate a win-win solution.

The second problem is collective action issues. Most bands are fragmented among many services and many licensees, many different kinds of things going on, there are too many players holding blocking rights that have stopped negotiations from succeeding. And the third thing is that there's a shortage of efficient and trusted adjudication that slows up dispute resolution, and it surely also detours contracting between parties. So often disputes over

interference seem to end up on the eighth floor at the FCC as a rulemaking often with Congress in the loop as well.

So as folks say on the West Coast, this doesn't scale. Even if things were working now, and we can debate that, how well it's working, it's not going to work in the future as demand keeps growing and as we have to pack more services more tightly together. So we believe that FCC, the administration NTIA, and Congress need to delegate some more powers and facilitate the decentralization of negotiations. That means I think that there are three key tasks that we try to address in our proposals.

The first task is to reduce this ambiguity over responsibilities for interference harm. Current spectrum policy focuses on transmitters as interferers. And it fails or has failed to address the important role of receivers, we saw that as part of the LightSquared saga, but rather than have the FCC mandate receiver performance standards, we support the use of harm claim thresholds that state the

interference levels that receivers need to tolerate inside their bands and outside their bands that leaves it up to them to figure out how to deal with interference below that threshold.

Now harm claim thresholds are not one size fits all. There will be different thresholds in different bands depending on the kinds of services that need to be protected and needs of the incumbents, plans for future use, and so on. The second task, the second problem is to overcome the drawbacks of excessive fragmentation. Now we're not going to get to every band has just exclusive licensees, we're not going to get there overnight. We may not get there ever for many bands. So as an interim step, we recommend the introduction of what we call band agents, these are entities that could represent large groups of licensees and that facilitates negotiations of changes in operating rights with their neighbors, particularly neighbors in adjacent bands.

You can look in the paper, we discuss various options for implementing this, by the common

set theme there is that the FCC and the NTIA should allow and facilitate band agents rather than mandating them. And thirdly, last but not least, the task is to improve the reliability and efficacy of dispute resolution, which we think means a move to a more fact-based adjudication process that uses judges with expertise in spectrum policy. And also to allow parties to take action against each other directly and not have to go through the FCC as an intermediary.

There are two complementary paths to this. The one is that the if FCC would actually use its administrative law judges to resolve disputes rather than solving problems by rulemaking and also for Congress to establish a court of spectrum claims to resolve federal, nonfederal disputes, and also to keep the FCC honest.

So to sum up, I'll paraphrase Milton Friedman in the spectrum context in saying that maybe we're all Cosians now, another British economist. (Laughter) But ironically Ronald Coase's prescription that we should reach efficient outcomes by allowing

the parties the flexibility to negotiate amongst themselves has scarcely been implemented. Command and control is still with us. Most spectrum is still under command and control.

We believe that these three changes will make it easier for parties to figure out amongst themselves how to reach mutually beneficial outcomes that are also beneficial for society at large, and this way we can unlock the value and all the potential of wireless for producers, for consumers, and for government.

MR. LEVIN: Great. Thank you so much.

And I know for the folks who haven't read the paper, that's a great summary of it. I want to start the questions with Preston. In all spectrum discussions, there's generally a view that people kind of articulate, we're in favor of more investment and more innovation, but in the real world, there's a little bit of a tension between these things as investment, briefly we have very high initial cap X, often benefits from an environment that's somewhat

stable, whereas innovation requires an environment that enables disruption and is fundamentally unstable.

You've seen how this tension plays out on many different sides, but you've generally been on the side of the disruptors. What do you think would be the impact of these proposals on those who really want to bring new innovations and be more disruptive?

MR. MARSHALL: So I think we have to look at the three different recommendations severed initially, although I realize they have some value in benefit. First of all, I'd like to thank the Hamilton Project for inviting me here and the authors for a really interesting piece of work. There's no doubt that the harm claim thresholds that are understood by everybody will greatly enable innovation. I mean, we saw at the end of LightSquared billions of dollars flushed because of that ambiguity, and it's probably poisoned the well. So there's no doubt that transparent thresholds for those are clearly really going to become a prerequisite if we're going to dense up to spectrum.

I think in spectrum policy task force we've put out a premise that we can make spectrum use flexible and that was dessert, but the vegetables were we had to understand how we coexist, and we never got to the vegetable part of that. I would put out a plug here for PCAST, which actually went one distance more and said that different users could assert different harm claim thresholds and that when they went into auction, if you asserted a deeper more strenuous harm claim threshold, you would end up paying more. So you had an incentive to make the minimum claim for harm threshold, and the market would essentially balance between the available technology and the rights that you wanted to obtain.

And I think that still should be the next step to thinking about these as being dynamics or they move with technology.

MR. LEVIN: I'm going to interrupt for just a second, people use typical Washington phrases like PCAST, I may interrupt to try to describe what they are. And I know it was the Presidential Commission of

the Advisory Science Council.

MR. MARSHALL: President's Council -- pretty bad English.

MR. LEVIN: Yeah. (Laughter)

MR. MARSHALL: President's Council of Advisors on Science and Technology.

MR. LEVIN: Yeah, which is a very important report, it talked a lot about spectrum sharing. Chairman Wheeler may be chatting about it a lit bit more later on today. So it's an important thing to keep, that people know what it is. Go ahead. Sorry for interrupting.

MR. MARSHALL: So okay. I want my time back.

MR. LEVIN: You've got it.

MR. MARSHALL: Next step, the second recommendation, where I feel that there's some concern is when we start to take a look at band management and the power of incumbents. So during the introduction, a comment was made that a license implies a right to exclude other users. I think one of the fundamental

premises, I'll use PCAST again, of PCAST was that we can separate exclusivity from protection, that we can protect people without necessarily giving them exclusive rights. Exclusive rights came around after the Titanic sunk. Our technology is a little different. We didn't have a big cloud. We couldn't do computing.

So I think one of the frameworks we have to look at is how do we manage incumbents and give them the minimum rights to exist, which is the right to be protected and not necessarily give them the right to exclude. So I think that is one of the fundamental steps. When I think about a band manager, I really think about incumbents. So we've seen how incumbents behave. They are conservative. They have an investment.

If anyone in this room thinks that spectrum filings have anything to do with electrical engineering and interference, you would be sadly mistaken. If you look at them, many of them are there to protect the business interest of the incumbents.

You can't separate the disruptive economics of new entrant from the spectrum filings. So if we empower incumbents to judge new entrants, we can predict the outcome. So I think in reading the document, it's good that that be mandatory -- or good that this not be mandatory.

I think should we facilitate engineerings getting together and working out how to trade spectrum, yes. Should the FCC have a way to implement those in the regulations -- excuse me -- absolutely. But we have to be careful not to give incumbents the right to make public policy. And I think we see this time and time again that the things that are going to get us to a thousand times more bandwidth in 10 years, Qualcomm's number, are not going to be things that lock out one, two, three, four, and five. They are going to be things that go one, two, four, eight, and sixteen. And those are probably the innovations we don't know about. And there's no reason to believe those necessarily come from the same people who are in it the spectrum now.

So I think we have to look at this, in particular, it's, if you look at the chart on the cover of the handout, there's not a lot of white spectrum in there. There's no new spectrum going to appear. Whether you're a carrier in Europe and you're looking at ASA or you're in the United States looking at PCAST and some of these other sharing concepts; it's very likely that future spectrum access is going to come from sharing. That means sharing with the current incumbents. That means making them uncomfortable. It's going to take a lot of work to do that, and I'm not sure that a vehicle that reflects incumbent interest is the right place for that dialogue. Certainly they have an important input in the process, but we will otherwise essentially stagnate the technology and the incumbency in the spectrum.

And I think that would really be an obstacle to any future innovation.

MR. LEVIN: Great.

Dean, we've been talking about the

importance of facilitating negotiations between incumbent and spectrum users and those who, between incumbent spectrum users and those who wish to gain access to the spectrum. You've had a lot of experience in this game, particularly while Qualcomm wanted to free up some of the broadcast spectrum, you've been in those negotiations with broadcasters. Give us a little color on both your experience, but also how it would inform how to implement the idea in the paper.

MR. BRENNER: Thanks, Blair.

And let me start also by thanking the Hamilton Project and Brookings. And it's very exciting to come over here. And one of my main goals whenever I do come to Brookings is to be invited back, so I will try to achieve that. So just five seconds on Qualcomm, and then I'll get to your question. For anyone who doesn't know, Qualcomm, we're the world 's largest manufacturer of chips for cell phones, tablets, other wireless devices. And we're one of the main inventors of 3G, 4G, and other wireless

technologies. We produced something like seven hundred million chips last year, so we have tremendous scale.

And as Preston alluded to, we're very much concerned about how to deal with this problem. It's a good problem, but it's a problem nonetheless of this explosive growth in wireless data usage. You see it in this room. You see it in any room. And our projection globally is data usage is about doubling every year. So if you extrapolate that ten years out, you're at a thousand times where we are today, and that's, you know, an audacious goal that we've set at Qualcomm. And it isn't going to just be one solution to that. It's going to require more spectrum, it's going to require massive research and development, and it's going to require all kinds of investment and deployment.

So my experience with clearing, with negotiating, I guess what, in the paper, is called mutually agreeable efficiency enhancing agreements through direct negotiation, which was a very

well-termed phrase, was so Qualcomm, we bought channel 55 across the entire United States in an FCC auction and then in one transaction after the auction. And we had an idea for a new technology to allow people to watch video on cell phones. It seems a little bit trite now. It was before the iPhone and this whole explosion.

And so but there were still TV stations on channel 55 and 54 and 56 across the whole country, and so we set out to try and negotiate agreements to get these stations either to move off entirely, because at that time this was before the DTV transition and each television station actually had two channels, one analog and one digital. It's hard to remember those days even. It was back in 2007-2008 timeframe. Or if they weren't willing to move off, we had agreements whereby they would just accept the high level of interference.

And in the paper, they do, the authors do a great job of kind of complaining about lack of clarity and FCC rules. You know, I have a slightly different

experience about that, which is, you know, my experience is that the government protects the vigilant, right? So if you are afraid that there isn't clarity in FCC rules, go ask and go suggest how you think the rule should be read, and they'll tell you whether you're right or not and be a nag and a noodge and you'll get your answer. It won't be as quickly as you would like, but you, the process that I went through, we got an answer.

And at the same time we were negotiating these agreements, and each one of the agreements had to get approved by the commission. And the first time we did that it took a while, and the second time it took a little bit less. And we did, I think, over 60 of those agreements, and by the end we had a pretty good system developed where the difficulty, some of the difficulties that we had, which are, I think, described in the paper, were the fragmentation of the TV band.

Each television station having a very circumscribed service area, much less than the service

area of a nationwide wireless system. And you know, that posed gigantic problems, because in order to use channel 55 in New York City, we had to deal with stations on 54, 55, and 56. And the station in Hagerstown, Maryland, covered some of the New York City cellular area and a station in Scranton, Pennsylvania, and, you know, Upstate New York. So the fragmentation was a problem. And the fact that there wasn't someone on the other side of the table who we could negotiate, you know, or even a couple people that we could negotiate on a binding basis was, posed difficulty.

The biggest difficulty of course is that this is a business negotiation. And unless there's a hammer sitting over the head of the other side, it's hard to get people to budge sometimes, right? And some people just said, thanks, but no thanks, not interested. And you know, finally Congress passed the hard date for the DTV transition, it was originally February of 2009, that spurred a lot of folks to come to the table, and then when it was extended.

So I would say that my experience proves that there are, that, you know, you -- this can be done, but it's very, very hard to scale as Pierre said, and there certainly are challenges. The last point that I wanted to make is just there have been some illusions here to receivers and receiver performance. And I just wanted to say from the point of view of the cellular industry now. So the paper does a very good job of explaining the differences between an industry like the cellular industry where Joan's company both sells the equipment to transmit and the receiver, right, your phone is both a transmitter and a receiver; and so when we design 3G or 4G, when we make our chips, we spend a fortune to make your cell phone that's in your pocket a really, really good receiver, lots of interference cancelation, lots of processing.

Where the difficulty has come in, as the paper points out is, if you have a situation where the party who is doing the transmitting has no connection whatsoever to the companies who are making the

receivers, for example the government runs the GPS system, the government doesn't sell you your Garmin or your Trimble. And you know, that's where the difficulties have come in, and the paper does a nice job of laying out some ideas of how to deal with that. So let me stop there.

MR. LEVIN: Great, thank you.

Joan, like Dean, you've been in the trenches of some of these negotiations. In fact, the paper discusses it in some detail, the negotiations you had with WCS --

MS. MARSH: Uh-huh.

MR. LEVIN: -- and the Sirius folks. Again, how do those experiences, are they similar to Dean's in terms of the implications of how policies should move forward? Do you have different lessons from your own experiences?

MS. MARSH: Yes, thank you, Blair.

And thank you to the Hamilton group and Brookings and the authors for including me in this discussion, which I have found fascinating from the

beginning. A lot of similarities, but I think with some different results. And I'd like to reflect a little bit on my first reaction to the paper. When Phil and Pierre gave it to me, it resonated so much with me because they did capture, I think, very accurately some of the challenges that we faced when we tried to rationalize the WCS band.

So for those of you in the audience who don't talk about spectrum at cocktail parties, because unfortunately we all do -- (Laughter) -- the WCS band is a 2.3 gigahertz range and it was fragmented across many licensees, and between the two WCS bands sat Sirius Satellite Radio with the spectrum they use to serve their customers. This band had been a war zone for about a decade. I see Julian Knapp sitting here. I know he has scars as do a number of people I see sitting here.

And the challenge was that the folks in the WCS band wanted to be able to deploy services, including we were a holder, we wanted to play LTE services; the rules did not permit that as they were

articulated; and the folks in the middle, Sirius Satellite Radio, wanted protection from whatever was going to be deployed. And the challenge to the FCC, which they repeatedly tried to address, was how do we find the balance in the service rules to permit robust deployment in the WCS band while protecting the operations that were in the middle.

When we approached this problem, we approached it with this history and with the understanding that the regulatory process had not yielded a result that was satisfactory. So we decided to go at it from a business-to-business perspective. And the first thing we did was sit down with Sirius to attempt to negotiate a deal. And I'll talk about our experience through the three proposals that Phil and Pierre have proposed here. First, the question of a harm claims threshold, critical to our discussions with Sirius was the definition of harmful interference, it didn't exist. So that was job number one with us to sit down and come to an agreement with Sirius about what would be the definition of harmful

interference.

Now why were we successful? And I agree with Dean, in a lot of situations you wouldn't. In our situation both parties had incentives to come to the table. Sirius felt that it was vulnerable to interference from the WCS operators, and we could not use our spectrum to deploy LTE. Incentives were aligned from a business-to-business perspective for both sides to come together and see if we could reach agreement. And I think that is essential.

In many bands you are not going to have those incentives. I think the incentive structure that Dean dealt with was very different. And I will agree with what Preston said about this, sometimes the incentives of the incumbents is just for status quo. And you do need to align incentives around a change to the regulatory regime. So that was essential to us. And that unlocked really the agreement we were ultimately able to reach.

Now the proposal around a band agent I also find very interesting. Because AT&T effectively acted

as a band agent to resolve this problem. The way we were able to do that is, while we were having the regulatory discussions with Sirius, we also pursued secondary market strategy to acquire the fragmented pieces of the band, thereby aligning incentives behind us of the other licensees. Had we not done that, there would have been enormous dispute that would have continued in this proceeding.

To be very clear about that, I do not think we would have been successful in our effort to, well, we would have maybe reached an agreement with Sirius, I don't know that we would have gotten it through the regulatory process but for the fact that we were able to align interest through our secondary-market activities. So that was essential. That made it clear that if you do have a strong and effective band agent, you can resolve problems, but getting to the band agent will no doubt be a huge challenge. I think that will be one of the most difficult proposals to implement here because incumbents will hang onto their rights, I think, and hold them very close.

The third proposal they make of course is for more efficient adjudication of interference disputes. Without a doubt the regulatory process is very challenging. The FCC has enormous talent, an enormous pool of engineering talent there, but the challenges brought to them, they have to deal with multiple stakeholders, very often bringing multiple visions. For example, with the WCS band, the stakeholders didn't even really agree how they wanted to deploy the spectrum.

When we sat down with Sirius, we were able to be very specific about how we would deploy it and actually even show them a model of what our network, our LTE network might look like. So we were able to give Sirius a very clear vision of what we wanted to do. You don't have that when there's multiple stakeholders. Of course they engage in the regulatory process, that brings politics with it, that brings rhetoric with it.

And I think also another challenge in this area is when that issue ultimately goes up to the

eighth floor, the eighth floor offices don't have their own engineering talent on which to rely. So these issues are really challenging if they go up to the eighth floor and have to be resolved there. So I do think, and I very much appreciated the section on whether we could drive clearer, more efficient, more effective adjudication that's driven by engineering and physics and not by all the other stuff that tends to creep into FCC proceedings.

So ultimately we were successful. We did strike an agreement. The team at the FCC embraced that. We made it through the regulatory process, and it was voted out. And we have every intention of deploying LTE in those bands that were otherwise lying fallow, but I think that our experience is probably more the exception, unfortunately, than the rule. And I think that is what suggests that some of the reforms being proposed and discussed here are very important and very needed in the broader spectrum debate.

MR. LEVIN: Great.

Phil, I'm going to give both you and Pierre

a chance to respond to all of these comments, but first I'd just like you to step away from being the author and reflect back on your experience in government where you were very successful actually in bringing a proposal from the FCC through the Executive Branch to the Congress to reallocate spectrum. In a way we'll see how it works. But if you could describe for the audience some of the difficulties of getting people behind an idea to reallocate spectrum and maybe a little bit about something we haven't talked about, which is reallocating government spectrum and how that informed some of the ideas in the paper as well.

MR. WEISER: So the first thing to note, and Tom Power has said this earlier, which is we've achieved a big accomplishment in this country. And Blair's great work with Jon and those and the broadband plan was a part of it, we've made spectrum a national priority and creating greater access to spectrum. So it's got to start with an awareness that for our innovation economy, the wireless industry is extraordinarily important, and infrastructure is an

important enable er of technological change.

Once you get that premise understood, you are really in an ability to drive policy. The second thing I would say is, it helps when the policy you're driving brings in revenue to the budget. (Laughter) That means what we're talking about today is a lot harder than what I was talking about here six years ago, because six years ago it was about, can you solve the following conundrum; there's all this spectrum in the hands of broadcasters that is worth a lot more money if it can be used by wireless broadband providers. That creates a Cosian opportunity.

And Larry Summers commented on that six years ago. And when I had the chance to work with Larry and Jason and the government, that was something they immediately got. And there was an ability-built consensus around the principle. And one of the things that was very valuable about that process was both in the broadband plan and in the initial discussions, we started with a high level principle, got more rough consensus around it, and then tried to drive into the

details building up momentum.

One challenge with spectrum policy, if you go right to the details, whose ox is being gored, it gets harder to get anything done, because any progress in spectrum, someone is going to say, wait a minute, I'm an incumbent, this affects me adversely, that leads to a desire to gum up the works. So in terms of the challenges, I think a main point is, how do you keep a high level focus on the overarching goal and then drive to the details from there.

One high level of focus I would say now, which is consistent with a 20-year arc, is that freeing up more spectrum for wireless broadband is getting harder. Twenty years ago in 1993, a little over 20 years ago, Congress passed a law saying look to auction spectrum that is underused and create revenues to the Federal Government. We've seen a whole cycle of those auctions happening, that's put a lot of spectrum out into this ecosystem that has had huge positive impact on the economy.

What happened in 2012, the bipartisan law

that Blair referred to, was an agreement we could derive something new, what's now been called an incentive auction, some people call it a reverse auction, but the idea is for the government to play this broker role, which is broadcasters give up spectrum that can be auctioned, other people want to buy it, the government is in the middle, government gets a healthy chunk of that; but the broadcasters are better off and the wireless broadband operators are better off.

That has never been done before anywhere. 2015, this will be a new experiment. If you want to free up more spectrum, where do you go from here? The answer is, you have to go to the type of situation Joan talked about, the WCS case. And I think it's very important to underscore what Joan said, it takes an extraordinary situation, an extraordinary company to pull that off in the current regime. I'd say the same thing about Qualcomm.

The fact that it's so hard to do that means, this is back to Preston's point, that upstarts will

not get it done. Upstarts will get crushed in that process, they won't bother, which means you have to look at some process reforms and you have to create new incentive structures so that -- and I don't know remember if Joan or Dean mentioned this -- things like interference cancelation technologies are encouraged.

The current regime encourages the opposite. It encourages me to say, hey, I've got my spectrum, I want to use it the way I want to use it, and I want to actually ward off others. For those who remember the low power FM saga, this would be familiar to you. By insisting on the most, call it dumb cheap receivers, the broadcasters were able to ward off entry, and at the same time not have to invest in more effective equipment. Now in this case, as I think Dean referred to, it's a little trickier because the broadcasters, themselves, weren't the ones deploying the equipment, it was consumers who bought the cheap radios; but the broadcasters benefited by having more consumers who could buy cheaper equipment.

If the equipment was more expensive, that

hurt the broadcasters, their margins as well. But that was not a good state of affairs for the public at large because lots of entry, lots of innovation was in effect stopped by the legacy system.

MR. LEVIN: Well, great.

Pierre, I want to give you a chance to respond to anything that's been said.

MR. DE VRIES: Yeah.

MR. LEVIN: So go ahead.

MR. DE VRIES: I'll just pick on one of the few things. I'm sure Phil has some comments, further comments, too. I think to this point about incumbents, I think this goes back to a point that Preston made earlier, which was that sharing is uncomfortable. And I think that there is a misconception, that the function of regulation is to avoid harmful interference and is essentially to, not only avoid harmful interference, but to minimize interference. The way, if one reads the statute, at least the way this nonlawyer reads the statute, essentially it says the Federal Communications

Commission can do that if it chooses.

Rather than trying to minimize interference, the goal should be to maximize value. And since there are always going to be oxen that are gored, the way one, the only way you can really maximize value is if there is a win-win, which means you need to get to a way of negotiating. And this actually connects to another point that was made earlier on in the comments, which is that things like harm claim thresholds should be dynamic, they should be able to be changed. I think that's a very important point to understand.

I think we need to try and get to a place where the rules that the FCC might set, that the NTIA might set are a starting point. If parties using that long litany that Dean so eloquently cited that I can't cite, if parties can reach a mutually agreeable solution, which is a win-win for them where the rules change, where, for example, let's say, and let's take a band agents example, let's say we're in the TV white space and right now if one is next to a TV

broadcaster, the maximum power that you can transmit is 40 milliwatts. Let's say Google decides and figures out that, in fact, you know, we can really make a business of it if it's a hundred, not 40, some broadcasters may be affected by that.

If Google, as a band agent running a database, says to broadcasters, on behalf of everybody who uses my database, they'll use a hundred, but I'll collect money from them and give it to you, those parties should be able to change the rules from 40 to a hundred, because that's the mutually beneficial, socially beneficial arrangement.

MR. LEVIN: Great.

Well, we're going to have, I'm going to facilitate a conversation between the panelists for about 25 minutes and then we're going to open it up for questions for about another 10 and then I think Chairman Wheeler will be here to make a presentation.

I want to start by asking, Preston, whether that would work, to enable --

MR. MARSHALL: So --

MR. LEVIN: -- new entrants to come in.

MR. MARSHALL: So I think we have to look at two kinds of new entry cases. There's the tactical one, which is the example of Google entering the market doesn't really affect the broadcasters. And it's a technical and tactical issues to make them well. I think the more interesting and the more complex case is when the burdens are not economic, when they are market share, when they're disruption, when that same interference, with say, with Verizon, then Verizon might look at it as a more existential issue than an economic issue. And I think that's where we want to make sure we haven't transitioned veto.

So when I read the paper, I read something as well, it's like bond holders voting and that's the collection of all interests. If it's, again, work a deal out, guys, but if you can't, it goes to the FCC, then I think that's a very different premise. So I think we have to really view this as two tiers. Guys, you get your first chance, but if it doesn't work,

that's not the end. This is a shot clock on it. You know, we've talked about shot clocks for lots of other parts of communications, because clearly we see interference being used not to make people economically whole in some balancing, economic balancing; but as a fundamental barrier to entry of new products and services. And I think we have to differentiate those two.

MR. LEVIN: Well, Dean, you mentioned, you used the phrase, there has to be a hammer. And what I guess you're suggesting is kind of a two step process where the hammer remains in the hands of the FCC, so that if the parties can't work it out. Is that a fair characterization of what you were saying?

And, Phil, how would that work?

MR. BRENNER: Yeah, the only thing I want to get back to with the harm claim thresholds, I think I have that lingo right, is, again, because in the cellular industry, because Qualcomm makes transceiver chips, transmitters and receivers all in one chip, right, so we don't have this idea of, oh, don't worry

about the receiver, we can have crappy receivers, right? Everyone wants their phone to work just as beautifully whether you're making a call or receiving a call.

Okay. So in the wireless -- you know, when we analyze an interference problem, like today we're looking at the 600 megahertz band plan. And lots of parties and the commission staff were all working, you know, very hard to make sure the band plan is one that's going to facilitate a very successful auction. And so there's an issue about, can you have unlicensed operations in a guard band. So you know, we don't look at that problem and say, that's just a transmitter problem, we don't need to worry about the receiver.

The way we actually analyze the problem is, you know, we assume an unlicensed power level that's in an FCC rule. We look at the, what the filtering performance is. You know, and of course if you put the unlicensed right next to an LTE phone, there isn't much filtering, but we, you know, we talk to filter

vendors. We don't make filters ourselves. And then we look at how good our receivers are able to perform in the face of an interfering signal. I think that is basically similar to what Pierre and Phil have laid out.

And you know, the results of our analysis, it should say, were that if you don't have about eight megahertz separation between the unlicensed transmitter and the licensed LTE receiver, because the licensed receiver has a spec through a voluntary standards group called 3GPP, that there's going to be a big interference problem. But you know, I think, again, this is because the structure of one particular industry is that the transmit side is, A, equally as important as the receive side, and both are under the control of the same equipment vendors and the same operators.

And I know it's a very, you know, the problem that I think, the core problem that I think Pierre and Phil are getting at is this incompatibility of uses and where you have different licensing or

governance models, right? So in the example of LightSquared, you know, the government runs the GPS system, but Trimble and Garmin and Qualcomm and lots of folks do the receive, make the receivers; and so nobody has a property right on that other side. I think that is a big part of the issue.

MR. LEVIN: Go ahead.

MR. DE VRIES: That is an important part of the issue.

I'd like to pick up on something else that you implied as well, Dean, which is that there are industries that, like the cellular industry, with standards bodies 3GPP, the satellite industry does a lot of work developing standards; what we've found, and I think the FCC tack working groups have made a similar observation, is that to date, and this may be the exception is that proves the rule, when standards bodies think about interference, even if they control both the transmitters and receivers in their own band, is they don't think about what's happening in the band outside, the neighboring band.

They just assume that, you know, they will be protected from interference in neighboring bands. And that's particularly the case I think now that we start looking at satellite services that are very weak signals where they don't actually have filters that will reject strong signals in adjacent bands. And I think the kinds of analysis that Dean describes where you say, well, I've got this unlicensed service next door which has these kinds of levels, that's the kind of thing that a harm claim threshold will allow that engineer to do. It will say to the engineer, this is what you have to deal with.

And the reason why this is something we need to attend to now and hasn't really been much of a problem until now is that it's only now that we're really beginning to pack together very closely in space and frequency many, many services and diverse services. And not only that, we know that they're going to keep changing, too. So it may be unlicensed now, in the future it may be another service.

MR. LEVIN: Phil.

MR. WEISER: So one point getting back to Preston's point is, and you talked about this in regulation, is before the fact ex-ante or after the fact ex-post, if you allow incumbents before the fact to stop change based upon hypothesized harm, that is almost guaranteed to be a break in innovation. What we are calling for in the enforcement context is when you make agreements that are win-win agreements, you don't let other people, in the name of interference concerns, but possibly motivated by strategic business interests, to put sand in the gears.

MR. LEVIN: Uh-huh.

MR. WEISER: Instead you put it to them to have to actually show what the impact is. That is a fundamental change in how spectrum policy operates. And you are acknowledging, in fact, you are encouraging some level of interference after the fact and you're putting a fine point on what constitutes harmful interference, which is what the statute is really concerned about. And part of what's happened, in a way, you could say it as getting away from the

statutory core of harmful interference, we've gone to a world where hypothesized possible interference, see, again the low power FM case, can break innovation even if it was never harmful interference.

MR. BRENNER: So the thing we have to do there is restore the certainty that after I deploy I don't get kicked out again. So we come back to, how does someone build a business plan that is spectrum dependant and create uncertainty. Harm claim thresholds, I think, is a great step, but deferring interference resolution until after the fact might be putting some risk back in there.

MR. WEISER: But in our economy that happens all the time.

MR. BRENNER: Well --

MR. WEISER: I mean, anyone --

MR. BRENNER: -- that's why we don't see VC money typically in the licensed bands.

MR. WEISER: Well, we see, but we see --

MR. BRENNER: We see it in the unlicensed because --

MR. WEISER: We see VC --

MR. BRENNER: -- there's certainty.

MR. WEISER: -- money in lots of sectors in the economy where there's some risk that after the fact, you know, they'll be a patten lawsuit or they'll be some other problem.

MR. LEVIN: There's no risk in that.

(Laughter)

Well, actually, Joan, I'd like you to kind of step in here and chat about it. Because one of the things that this question raises is, there really are two models in terms of how people enter the space, one is in the licensed band, very, very specific model, often thought about as cellular; and the second is in the unlicensed band, generally talked about as WI-FI, but not necessarily that, could also be white spaces, et cetera.

Now how do folks at AT&T say it? Because you use, your business model now actually depends on access to both exclusive spectrum, but also a fair amount of WI-FI for offloading. How do you all look

at that?

MS. MARSH: So you're absolutely right, Blair, we very much rely on both licensed and unlicensed for different, to achieve different things. Obviously the bedrock of our service this we provide is in licensed spectrum, and that's where we have over the years made billions of dollars investment in an attempt to roll out the most advanced networks in the world. There's no doubt; however, that we look increasingly to unlicensed spectrum to complement that.

Because in this environment that we're in right now, which is so capacity driven and which we are spectrum constrained -- excuse me, thank you -- you really do have to look to every tool in the toolkit to manage the service and provide that to your customers. And so we look for to increase our spectrum holdings all the time and we're looking to densify our networks all the time and that includes things like hotspots where we do WI-FI deployments or DAS deployments to offload.

We look to WI-FI, specifically hotspots, where we have thousands of WI-FI hotspots, and encourage WI-FI clients in phones to automatically see those hotspots, to offload and get back onto the wired network as quickly as possible a lot of our traffic. And so I think nobody can ignore anymore any opportunity available to them to bring more capacity to bear to meet consumers needs, and increasingly we are looking to unlicensed.

Now our view is we should be looking to unlicensed in some of the bands where the opportunity is the most ripe. The FCC currently is looking at 3.5 gigahertz. We're very supportive of innovative models there to see where we can drive more unlicensed investment. They are also looking at 5 gigahertz, and in those places we're very supportive. We are skeptical of some of the demand for our large unlicensed allocations in the 600 megahertz band.

We have an enormous challenge in that band to make sure that the auction works, that the reverse can meet the forward. There is a specific revenue

requirement in that auction to make it be successful. If enough revenue is not raised to meet all the revenue targets, the auction cannot close. So in that area specifically we don't think that that's a great area to experiment with unlicensed. As Dean said, there is a discussion about potentially putting unlicensed, any of the duplex gap for the guard bands.

Our concern will always be that that unlicensed service not create interference for the adjacent licensed allocations that will affect the fungibility of the blocks at auction and ultimately potentially the revenue raises at auction.

MR. LEVIN: Yeah.

MR. DE VRIES: One of the things which I think Melissa mentioned in her opening remarks was this ongoing debate that we're going to have between licensed and unlicensed, and we've just had a little bit of it here. I want to make a few remarks about that. First is, you know, some licensed is more licensed than others, and one should make the distinction between cellular licenses, which are

exclusively assigned flexible use tradeable licenses and most other licenses, which are -- for example, to take one, broadcasting, when you've got to do broadcasting, you can only do broadcasting in a certain way and so on.

So I think that the important transition that we made in the late '80s, early '90s, was we started to come up with regulatory regimes that went from command and control, you shall use this technology for this service and you're stuck with it to figure it out yourself, be flexible, if you don't like to do it this way, do it that way. And I think these flexible assignments, both exclusively assigned flexible use tradeable licensed and unlicensed, have achieved that. I think because they were created roughly at the same time there's a lot of sibling rivalry between them. (Laughter)

But don't be confused, they're both good. And they've probably argued each other to a standstill about who is better than the other. We need to call that good and transition more of command and control

into that kind of regime.

MR. WEISER: Well, and if I could, Blair's premise is very important for people who don't know the facts of the iPhone, it's fair to say, I'm not sure if AT&T will acknowledge it quite in this form, that WI-FI saved their bacon because they offloaded probably as much as 50 percent of total iPhone usage onto WI-FI networks, thereby shielding their network from a lot of usage that otherwise would have fallen, you know, squarely on them. That event I think was a wonderful occasion to end some of the sibling rivalry and say, wait a minute, we're siblings, we're not rivals, we're siblings, we're in this together.

And the ecosystem depends on both. The spectrum policy task force, which a number of people here were a part of, I see Julie in the front row, that said it pretty clearly, we're in it together, we need both. I think that's getting normalized. We're not all the way there, but I think we're close.

MR. LEVIN: Preston.

MR. MARSHALL: So I think we should go a

step beyond that. So I think we've always viewed licensed and unlicensed as discrete choices and you either license or unlicense, every megahertz has a tag on it. And I think, I'm going to channel the PCAST thing, I think what PCAST argues is that we, in fact, don't even have to do that, that we can allow them to find a dynamic balance. If you're in dense areas, you will pay for protection and you will get a license that protects you, it doesn't exclude other people, but it protects you.

If you're out in the middle of nowhere and you're a wisp and there's not a lot of usage, that same frequency can be used a general, as almost unlicensed. The differences are only significant to lawyers. And so we don't have to make these choices, because we may in some places have unlicensed spectrum that goes fallow. We know we have spectrum that's traditionally licensed, the CMRS spectrum that in lots of the country lies fallow that can be used by other people.

So I think it's not just a discussion of

whether licensed and unlicensed is good or bad and the tension between them, but how do we remove the barrier of applications moving between them. The carriers benefit from the volume that comes from unlicensed equipment, and it could also be volume for LTE. And certainly I think a lot of consumers would benefit from LTE. So I think what PCAST proposed was to use its first 150 megahertz greenfield to say, let's allow it to be both in some cases.

What does the market say is right? If I can offer a service and meet QOS and not pay for spectrum, I'd be crazy to pay for spectrum. If my competitors wanted to have at it. On the other hand, if I'm in New York City and I'm in a really dense apartment block, I can pay for it. So I think yes, we should view them both as good, but I think ultimately we should view them as starting to become more fungible and let the market decide the allocation rather than the FCC.

MR. BRENNER: I have a --

MR. LEVIN: Dean, yes.

MR. BRENNER: Yeah, so I have a slightly different view about that, not totally different, slightly different. So the way I think about spectrum, you know, there's a third way, right? So there's licensed, and that is still going to be the cellular industry's top priority if we can, like the 600 megahertz band, if we can find a way to get the TV stations incentivized through the auction to move off, we get the spectrum cleared, that's going to be, you know, produce the greatest utility for LTE and for cellular. So that approach needs to continue.

And then at the other pole would be unlicensed. And again, our chips, we support licensed and unlicensed it technologies, that's why your phone can go back and forth almost seamlessly. And you know, so we support the commission's initiatives in 5 gigahertz, et cetera. But then there is this third category of spectrum where it's just not going to be cleared for decades, you know. A band with radars that's going to take a very, very long time to be entirely clear, but we know the band isn't used 24/7

on a national basis.

So there are pockets of either geography, time, or frequency where the band is available. And so and the commission, Jon Leibowitz and others, to their credit, recognize that we have this third category and how do we create a system with, you know, a degree of property rights, I would say, to create the right kind of incentives to see the band actually be used. So what I call this, I know Chris Rinney of AT&T likes this phrase, I call it sharing with certainty.

So the idea that we have is that when the spectrum is available, an AT&T or new entrant, whoever, is able to use it and will get off when the government needs it, but it knows that it's not just going to be a free for all.

MR. LEVIN: Great.

MR. BRENNER: So that's how we look at it.

MS. MARSH: And I would --

MR. LEVIN: Joan, go ahead.

MS. MARSH: First, to respond to Phil's,

when the bacon is sizzling and it is often sizzling in this industry, there's no doubt, again, it's not just WI-FI. I mean, WI-FI was a component at it, but WI-FI is not a panacea for wireless capacity problems. It also takes an enormous amount of capital investment in your infrastructure to densify it so you have a robust macronetwork, hopefully complemented by WI-FI offload and again, all the other tools available. And I agree with Dean completely. When we think about sharing, I do, too, think about completely different models of sharing.

There is the unlicensed kind of sharing, and I do think that that regime will take off on a number of bands; but equally as important is I think what's emerging as the AWS3 model of sharing where we anticipate we'll go to auction later this year and buy spectrum. And we know there's going to be channels that we're not going to be able to use or at least not going to be able to use for some period of time because the government is going to continue to occupy that.

What we will need is clear definition about where those exclusion zones are, where we will not be able be permitted to operate, and how long those exclusion zones will exist. If the government can define them with clarity, we can value them at auction, and then we can unlock the value of the AWS3 spectrum even before the government has completely relocated.

MR. LEVIN: Great.

I want to open it up to questions. We have people with microphones.

While people are raising their hands, Pierre, one quick question to you, Joan earlier, we haven't in this discussion talked much about the band agents --

MR. DE VRIES: Uh-huh.

MR. LEVIN: -- she mentioned that theoretically it might be a good idea, but actually effectuating that is really hard because you have so many different interests and people unwilling to give up their own sense of priorities and give the power to

somebody else. Do you want to quickly respond to that? And then we'll hit audience questions.

MR. DE VRIES: Yes. Well, the, in a way all I need to say is, that's a very good question. (Laughter) It is a very good question. We have some thoughts about how one might do that. Really what you're trying to do is to consolidate interests. The first thing we need to do is to make sure that if parties want to band together, that they can. We've actually seen a precedent in FCC rules to create frequency coordinators where there are parties, now companies, that were allowed to exist to actually help folks in public safety and microwave services and land mobile radio to make sure that they didn't interfere with each other. Not mandated, but they've actually grown up because they were allowed.

I think a second thing that can be done is to provide more power to particular players that are already able to be band agents. So there are band managers like the DOD, for example, like the FAA, there are agencies that one might, in fact, say to

them, look, they just do de jure what you already do de facto. You're a band agent.

MR. LEVIN: Great.

Well, I'm going to go to the audience for questions. We have a number of them, so we're going to both keep the questions brief, and we'll try to keep the answers brief as well.

Go ahead.

QUESTIONER: Jim Schneider. The question concerns the framing of this debate, which is a win-win framing where you have private actors negotiating with no acknowledgement that the public has tremendous residual rights in those bands. In many cases those residual rights are far more valuable than the rights that the incumbents have. This is not an industry-friendly formulation, because industry would like to sort of form this cartel and negotiate behind the scenes. And the hidden lubricant in many of these deals, which was not at all discussed, is, oh, well, we're going get a whole bunch of these public rights because the FCC couldn't care less, the

public is not involved in these debates, they don't understand them; so we'll come up with the deal, and it'll be at the expense of public. And that's the lubricant.

MR. LEVIN: And the question is?

QUESTIONER: So would anybody up there care to agree that the public, when you're coming up with these band agents, actually have very substantial residual rights? Like LightSquared, what wasn't mentioned in the debate between GPS is that LightSquared hired a bunch of lobbyists and they got rights for terrestrial broadcasting when they didn't have those rights. That was really what made that workable. And you can do that with the incentive auctions. What's really going on there is the public is going to give away billions and billions of dollars to the broadcast as a lubricant for this apparent win-win. So --

MR. LEVIN: Anybody on the panel want to --

QUESTIONER: -- we -- would anybody like to comment?

MR. LEVIN: Phil, why don't you go ahead, please.

QUESTIONER: It's not just mutually beneficial as Pierre said or mutually beneficial, equal socially beneficial, but there's a social element here that hasn't been addressed, huge billions and billions of dollars of giveaways to lubricate these deals that --

MR. LEVIN: Can we have Phil? Let Phil answer the question.

MR. WEISER: So the alternative world is the world we live in today where the incumbents may be vested with some public idea of what they're doing is in the public interest, holds on to their current use. The alternative world is that use goes to a higher value purpose. The question I would say is, which of the two are the better worlds. There is an idea that, gosh, couldn't we get the better world and not have some windfall in the system? And the problem is, if we wait for long enough to get to a place where there are no windfalls in spectrum, then we make no

progress, and that's not a better world.

MR. LEVIN: In the back of the room, Jonathan.

QUESTIONER: Yeah, just building off what Pierre said about the third parties doing the adjudications, I agree completely we have to do more adjudications, given the densification, there's going to be more and more interference. An idea to kind of amend to your response is what if you did, had a third party do it, have the FCC explicitly outsource it so that a listed group of parties that were qualified to do it could make a determination, and then send that to an ALJ? Because the FCC will never have the resources to do it all.

MR. WEISER: Jonathan, thank you very much for that. I would say that is a friendly amendment. And the thought had occurred to me that within adjudication, there is different experiments that can happen. And the idea of having alternative modes of adjudication, we talked both of the FCC, we also talked about creating a court of spectrum claims,

which is important because when one of the rights holders is the Federal Government, having the FCC adjudicate that is a fraught situation. The court of federal -- the Federal Court of claims does adjudicate rights against the government already, but yet spectrum rights against the government are not adjudicated. A problem for the sharing environment that has to get addressed.

Your point, Jonathan, is another good one, which is the FCC could do, as it has done in other cases, including, I believe part -- the attachment rules are part -- what's that? No. Part 15 is unlicensed.

MR. LEVIN: Part 68.

MR. WEISER: Part 68?

MR. LEVIN: Yeah.

MR. WEISER: Part 68 rules, what attaches to the network, it has to be, it has to actually be compatible. Whether or not equipment meets that requirement is determined by outsourced third parties today. So it wouldn't even be a novel proposal, and I

do think it's a good idea.

MR. LEVIN: We're going to go to this side of the room, and then we'll go to the back again.

Go ahead.

QUESTIONER: Yeah, my name is Lee Young. First, thanks for your discussion, but I wondered if you could address the issues that impact the consumers and general public? For instance, whether -- let's say about powers grabbing, will they affect general public, whether you will be under pressure of NSA or some other federal enforcement to close consumers account when other disadvantaged areas, the new area, you don't get any advantage. And how do you spend your time and not be ever to influence the election, whether you join LX or you join the Cutt brothers and you are (inaudible) --

MR. LEVIN: I think I'll give --

QUESTIONER: -- to Congress?

MR. LEVIN: With respect, I think that question is a little bit off the, it's a broad general question.

QUESTIONER: Yeah, I know, but all the --

MR. LEVIN: That it's not really the --

QUESTIONER: -- production (inaudible).

MR. LEVIN: -- question that I think this panel is organized to address.

So I'm going to say in the back of the room, Mark, in the purple shirt. No. I'm -- and then we'll get to you, Mark.

QUESTIONER: I love the expression AT&T or whoever. If you're the whoever, you've got a problem in the spectrum space. And I want to raise this, so I want to ask the question, because you're -- the band agents plus the raid court sounds a lot like professional organizations and raid courts in the music space. And the key question here is, what do you do about market power? And I want everybody in the room to read Judge Cote's decision from a couple of days ago in the Pandora versus ASCAP case, because there you see what dominant incumbents will do when they're allowed to form cartels and they think they can get out from under the Antitrust Laws, which

they've said they've taken their rights out. Read that.

It reminds you that the essence of this space, with dominant incumbents, is how they will abuse their market power. We tend to forget that. Your proposal, I would add, I would like you to see address that very carefully, the market power problem with your band agents.

MR. WEISER: So Mark's point --

MR. LEVIN: Yeah, go ahead.

MR. WEISER: -- is a really good one, which I'm not sure we addressed explicitly, but it's worth saying. In theory, if you had only one band agent who represented lots and lots of holders across different bands, you would get a serious market power problem. Unlike ASCAP, we're not viewing this as outside the antitrust regime. ASCAP has a complicated relationship. They're under a consent decree, and thus, I do think that's a fair point. We do say explicitly in this, what you're saying, say it even more explicitly, multiple band agents is a good thing.

You want some competition between band agents.

If you ended up having just one of them across all the bands, that could create some real problems.

MR. DE VRIES: Yeah. The only thing I'd add to that is that, you know, if we focus on the services that we use, you know, cellular communications, communications in general; the world looks one way. If you look more broadly at everything else that's also wireless; satellites, radars, other kinds of communications, the world looks very different. And the problems that we see there are problems of fragmentation, not problems of concentration.

MR. LEVIN: I think there was a question right there. Yeah, you, we'll get you the mic.

QUESTIONER: Thank you. My name is Genja Wey from the Global Policy Group. I would like to know the opinions of yours regarding the need for spectrums to be used in vehicle-to-vehicle communications. And if so, what are your recommendations of policy challenges if there is a

need for one? Thank you.

MR. LEVIN: Let me just restate it slightly to say that what are the key uses that will be emerging over the next 20 years will be actually on the road, but not just kind of the traditional voice communications, but rather machine to machine and vehicle to vehicle. Any comments on that?

MR. BRENNER: Yeah, that's something we're very focused on. So Qualcomm is developing that technology. There's -- in 1999, the FCC actually made a spectrum allocation of 75 megahertz in the 5.9 gigahertz band for something that was called the dedicated short-range communication service, which has morphed into vehicle-to-vehicle and vehicle-to-infrastructure communication. And this is something that we're very focused on at Qualcomm.

And there's a spectrum fight between whether some of that spectrum can be made, can be shared with WI-FI. And we have a proposal about that, which I won't go into, but we're very focused on that.

MS. MARSH: As is AT&T. We're very focused

on interconnected cars. And we have actually have deals right now with major carmakers to put LTE capabilities into the car that would be dynamic. So instead of a static console that would only do certain fixed functionalities right now, it would be LTE infrastructure where you could really drive apps the same way you do on your iPhone and your tablet. So as consumer interest changes and it becomes more dynamic space, that becomes a more dynamic tool for consumers in the car.

MR. BRENNER: And just to bring the punch line, the demands for access to wireless is a lot now. Once you getting more and more machine to machine communication on top of it, we're going to see that go even up further.

MR. LEVIN: Right, sure.

MR. MARSHALL: So the risk here is that there are many, many virtuous uses for spectrum, medical body area networks, vehicle to vehicle. I think everyone in the room has a patent. The problem is to create marketplaces for that spectrum. I think

one of the things that we felt in the PCAST report was that if, rather than breaking into little bands and saying, this is licensed and unlicensed and purpose, allow it to divide. Because maybe the hospital isn't needed in the exact same place as the vehicle to vehicle because I-95 doesn't go through the middle of the hospital.

So we need to be thinking, not about how to carve out 5 megahertz here and there, but how do we manage the sharing amongst uses, be it in a cloud as PCAST proposed or direct device to device, so we get out of making a bad situation even worse. Because I think the virtuous slip is, well, the next guy gets 2.5 megahertz and the next guy gets 1 megahertz. We are running out of spectrum to give every different application its own utility company, let me not forget them.

So I think we have to make a transition to saying, we allocate spectrum access, but we don't allocate spectrum. So --

MR. LEVIN: Well, I think there's a question

from Twitter --

MR. WEISER: He can't let it go.

MR. LEVIN: -- which I think is, which came in a few minutes ago, but before as you said, but as kind of a natural follow up for a lot of the folks in the audience following this, why do we need to rely on regulatory reform to solve this problem? In economics language, why not just rely on price changes to economic spectrum usage? Does anyone want to answer that? In other words, why not just free it all up?

MR. WEISER: So free it all up is a very appealing sounding panacea, but of course the hard work is, what do you mean by that exactly. Do you mean give up any protection against any interference at all? In which case if you go that far, people who are flying planes are going to have a thing or two to say about that and so are other companies who paid money at auction. So I don't think giving up any protection against interference is a good idea.

I think getting more smart, effective, and defined about how we correct interference is a good

idea. Getting smarter and more effective about how we allow fragmented uses to come together to negotiate would be a good idea, and ultimately you've got to have someone who can make these judgments as an adjudicator. So we're trying to free it up a lot more. Why we can't let go entirely is because there are some important public values at stake here and I don't think you want just the Wild West reign here.

MR. DE VRIES: And I --

MR. LEVIN: Oh, go ahead.

MR. DE VRIES: I just want to pick up on that. So free it all up and then that allows me to get back to Preston's point, which is --

MR. LEVIN: Backwards.

MR. DE VRIES: -- backwards, but forwards, so you know, to think about we've just go the this one big band and we don't divide it up into little bands anymore and let's free that all up and let people just figure it out, I'm going to tie it back to the three proposals that we made just point by point. So if you say, we'll just allocate, you know, this service, that

service, they all interact with each other; the key question is, what are you allocating? So in other words, what entitlements are you giving to people?

Entitlements to operate and requirements to accept interference. So we need to be able to state that more clearly. We think harm claim thresholds is part of that. Secondly, you're going to have millions and millions of devices operating. If you need to change what those harm claim thresholds are, for example, you're going to have to find a way to negotiate. Unless you're the New York Stock Exchange, it's really hard to negotiate between millions of people at the same time. Now there may well be market solutions for this, but we think band agents are also part of aggregating those negotiations.

And the third thing is, when you've got this shared band, it's not always going to work perfectly. People are going to bang into each other. There are going to be disagreements about who is entitled to bang into whom. You're going to need adjudication. You're going to need a lot more adjudication than

we're doing right now. And it's only by creating the kinds of structures that we're talking about that you can do that.

MR. LEVIN: There was a question in the back.

QUESTIONER: Yeah, Michael Keller Brees, New America Foundation. I wanted to ask Pierre or Phil to say a little bit more about how the process for setting the harm claim thresholds, you know, such as who decides what inputs, using the example that Dean and Joan raised, which is, you know, what's going on right now, which is a reallocation of the 600 megahertz TV spectrum for auction.

And you know, Dean mentioned for example that on the border between, you know, in terms of using the unlicensed, using the guard bands for unlicensed, that there would, that they found that they would need an 8 megahertz separation. That would be equivalent of a harm claim threshold. But it's interesting, you know, I think that's a great example because when they filed that recently, Qualcomm's

competitor Broadcom filed rebutting that saying, no, no, no, wait, Qualcomm just doesn't want to license.

Actually what they're pointing to a 3GPP, the standards body, is a minimum for filters, but actually the filters we sell and the filters that are out there in the marketplace only require 3 or maybe 4 megahertz as a separation. So can we really trust -- you know, for example standards bodies are dominated by the incumbent interest because they're very expensive to participate and that's what they're there for. So I'm wondering who would actually decide these harm claim thresholds, when this is a great example of two competitors going head to head who want entirely different harm claim thresholds, because one is selling unlicensed chips into this market and the other is not.

MR. LEVIN: Actually both --

MR. DE VRIES: So I'll try and take a shortcut at that. The short answer is that I see harm claim thresholds as part of an entitlement to operate just like transmit power. And in the end the FCC is

going to have to decide that as the starting point, the same way it makes the decisions today. They may change downstream, but it's going to have to pick it. It can use things like multi-stakeholder organizations, but the FCC will have to make the decision. How will it make the decision? Let me just take three examples.

One, if you've got a band you want to allocate, there is already an incumbent service next door, you know what that interference looks like, so you can characterize that, that will give you one way of setting the harm claim threshold. The next one is, let's say you've got a receiver, a receiving service, it's a GPS or a Satellite Earth Station, where you know what those services can tolerate; you'll use that to set the harm claim threshold. Now that's probably not going to be the efficient level. If the commission doesn't think that the market is going to get to an efficient level, it may, in fact, say, the level is going to be low for the next five years and then it's going to ratchet up.

And then last, but not least, it may well be, and this is something that Evan Queral and Jon Williams at the FCC talked about, if the FCC says, it's a quiet band now, it's going to get busy in future, it sets the harm claim threshold to be busy so that people know that they have to deal with it now.

MR. WEISER: Let me say one thing that's implicit in Pierre's answer and hits both what Michael and Mark said earlier and a little bit what Jim said. The FCC and the antitrust laws and the public interest are important to remain as part of this equation, because as you set harm claim thresholds, you can't assume categorically that what a standard setting body group or what a band agent is, is the right thing. You need, as I think Preston or Dean said, you need the hammer to be oversight.

I think what's also important is that the FCC does not have a monopoly on wisdom in this area, and so it needs to look for evidence in the marketplace of what a harm claim threshold can be. In some cases you will get that data and can help craft

it. In other cases it will be harder.

MR. DE VRIES: Uh-huh.

MR. WEISER: It's also important to know when you set the harm claim threshold, that will actually help drive potential future innovation in things like interference cancelation technologies. Where the incentives already exist for those to be done very well, you don't have to worry quite as much about that; but where they don't exist, that's where it's a much harder issue.

MR. LEVIN: For those of you who didn't have an opportunity to have your question asked, I apologize, but our main speaker, the Chairman of the FCC is now here, and I think we all want to hear him speak. So please join me in thanking the panel. (Applause) And now let me turn the program back to Roger. I think Roger is coming up to introduce our speaker.

MR. ALTMAN: Thanks for the assist.

MR. LEVIN: No, thank you.

MR. ALTMAN: Thank you, Phil.

Thank you. Thank you all very much.

We are very fortunate this afternoon to have with us Tom Wheeler, the Chairman of the Federal Communications Commission as our keynote speaker. Tom became Chairman of the FCC about six months ago. I'm sure there have been some days in which, Tom, it seems like six years ago. But if we'd had this forum, this particular forum 10 years ago today or 20 years ago today, some people, maybe not the particular audience, but some people more broadly might have said to themselves, why is the FCC important anyway?

But I don't think anybody, whether in this room today or otherwise among informed people, would say that under current circumstances. And our panel discussion just now I think illustrated why no one has to be concerned about whether the FCC is important. Tom Wheeler came to this position with qualifications that very few, if any, of his 30 predecessors could match. He started a series of companies offering cable, wireless, and video services. He headed, earlier in his career, both the National Cable

Television Association, and then later the Cellular and Internet Association.

And I imagine that those two tours of duty subsequently qualified him for his election, which did happen, to both the Cable Television Hall of Fame and the Wireless Hall of Fame, which is a little bit like being elected to both the Apple Hall of Fame and the Google Hall of Fame, which would only happen if neither side knew about the other election. (Laughter) Tom also served as a trustee of the Kennedy Center for 12 years as well as Chairman of the Foundation For the National Archives.

He's a person of very wide interests, which in my own experience having served with him twice in the U.S. Treasury is really actually an important thing. He's an active pilot. He's published two books set during the Civil War. In fact, Tom, some of the current heated debates over spectrum resemble the battle of the wilderness. And he attended Ohio State, a great school, which is no longer pursuing the National Collegiate Basketball men's title.

(Laughter) It's my pleasure to introduce Tom Wheeler. (Applause)

MR. WHEELER: Thank you, Roger, for that warm, up to a point -- (Laughter) -- introduction.

And thanks to Brookings for hosting this and to those who preceded me with the panel. Now I must share a dirty little secret with you, I was a little late arriving, but as Karen met me out at the front door, she says, don't worry, we've just asked Blair to keep talking until you get here. (Laughter) Not a heavy lift. (Laughter) But giving -- there he is, he's back against the wall getting a cookie, but I also want to commend you for the judgment that you had in scheduling this as you did after lunch, giving an afternoon keynote close to the end of a conference is much less daunting after the audience has already had lunch.

And to Secretary Rubin, for his leadership with the Hamilton Project, which Roger and I were talking about a little bit before we came in, on some of the really interesting topics the Hamilton Project

has addressed including this one today. But I'm not qualified to comment on the earlier projects that were undertaken by the Hamilton Project and how they did it, but I will tell you that the good sense, the common wisdom, the judgment that was exhibited by getting Phil Weiser and Pierre de Vries to write this very interesting paper was, is a great threshold, a great stepping off point for discussion.

And I'm sure you've heard a spirited discussion about that, talking about what we should be doing to update spectrum policy to meet today's realities and to seize tomorrow's opportunities. And I see my job here as closing this forum by previewing some of the things we will be doing to update our spectrum policy. And in particular I'd like to share some thoughts about two next generation spectrum policies, incentive auctions and sharing, because I believe that together they hold the promise to completely revolutionize the way we manage our airwaves, and in so doing to provide the underpinning for significant economic growth.

From my first day at the commission, I've been arguing that the best way to look forward is to begin by looking backward to the lessons of history. Roger referenced a couple of history books that I have written. History is, in fact, the precursor, and we can learn from it. And I believe that one of the things that we learn when we look at the history of how we have been connecting is that we are now in the fourth great network revolution, the wireless connectivity of miniature computing devices.

And in the preceding three revolutions, the Printing Press, which was the original information revolution; the Steam Railroad, which was the original high-speed network; and the Electronic Telegraph, which was the first electronic network, we can view circumstances that are very similar to those that are presenting themselves to us today. A lot of people jump from that to the assumption that today what is happening is as big as what happened in those earlier revolutions. And I would say that we should not delude ourselves, that the impact of our network

revolution is yet as definingly revolutionary as the other three. And as I emphasized in my pronunciation, the key word there is yet.

And getting to yet is not just a matter of technology. It's also a the matter of intellectual and psychological changes. And the interesting thing about being at the FCC is that it is at that agency that the technological, intellectual, and psychological changes all converge. Our role is to harness the power of modern communications, to produce social and economic benefits. And we can accomplish that in two ways. First, by removing obstacles to progress where the obstacles are unnecessary or counterproductive regulations or private arrangements that restrict economic, intellectual, and cultural advancement; and second, by assuring the availability of the economic inputs we manage, which are essential to modern networks and the most important of which is spectrum.

We are evolving spectrum policy from the age of Marconi's analog wave form to the era of digital on

off pulses that obviate the previous underpinnings of policy, the nature of the wave form and the need to have a big buffer to protect that signal from others. This new technological reality has placed us on the threshold of two fundamentally transformative spectrum policies, incentive auctions and spectrum sharing.

We, at the FCC, will make unprecedented use of market mechanisms in the flexibility of digital technology to arrive greater value from our finite spectrum resource. And so let me start by looking for a moment at the whole concept of incentive auctions. While it's never been tried before, somewhat of a daunting challenge in itself, while it has never been tried before, its success lies, or its power, lies in the way it addresses the root of all issues; and that is economics.

Because if it is possible to marry the economics of demand with the economics of current spectrum holders, it should be possible then to allow market forces to determine the highest and best use of all spectrum. In mid-2015 we will run the first ever

incentive auction. Television broadcasters will have the opportunity to bid in a reverse auction to relinquish some or all of their spectrum rights. And wireless providers will bid in a forward auction on nationwide repacked spectrum suitable for two-way wireless broadband services.

This auction presents a once in a lifetime opportunity for broadcasters. And we are committed to providing them with the information about both our process as well as the financial opportunity the auction represents to enable them to make informed decisions about whether and how to participate. You know, I came to this job after almost a decade as a venture capitalist and even long as an entrepreneur myself. Seldom have I seen such a risk-free opportunity as that which is presented to the broadcasters by the incentive auction, including the opportunity to continue in their current business, to achieve must-carry status, and to be able to share spectrum and turn around and get a check for the spectrum they're vacating.

It's a win-win-win situation. You don't normally get those kinds of opportunities in new and innovative circumstances. Shortly the FCC staff will begin briefing the commissioners and the Congress on the proposed policy decisions necessary for the incentive auction to succeed. These are a tough set of interrelated issues, made even more difficult by the detailed instructions that Congress provided in the Spectrum Act of 2012.

Let me give awe a quick glimpse into some of the issues associated with moving from incentive-auction concept to incentive-auction reality. Since we have no idea how many broadcast license holders intend to show up for the auction, we should probably scale expectations by looking at the patterns of previous auctions. There have been six FCC auctions involving spectrum below 3 gigahertz. All have been regarded as successful. The largest amount of spectrum sold in any auction was 90 megahertz. The average amount of spectrum sold was 45 megahertz.

These auctions enable the development of a robust and competitive wireless industry, and their lessons help us define success insofar the amount of spectrum repurposed for wireless use. The incentive auction will also increase the amount of spectrum for unlicensed use, but that exact amount will depend on the amount of spectrum available for sale to wireless carriers. We are huge proponents of unlicensed spectrum.

Our instruction from Congress; however, is that spectrum reallocated from broadcast licensees must be available for auction, thus the spectrum available for unlicensed applications is limited to the frequencies that are designated as guard bands and channel 37 and the white spaces. And so the amount of unlicensed spectrum at 600 megahertz; therefore, is driven by engineering and mathematics. The number and the extent of guard bands is a reflection of what, in the words of the statute, is "technically reasonable to prevent harmful interference between licensed services" that will operate on the auction spectrum.

But here's the bottom line to incentive auctions, if we get this right, and I'm sure we will, incentive auctions could revolutionize spectrum policy by applying economic forces to the allocation of spectrum, in this case the reallocation, but to the allocation of spectrum rather than just the assignment of individual licenses. The discussion of unlicensed spectrum offers a natural transition to talk about the other big breakthrough policy, spectrum sharing.

The July 2012 PCAST report, which presented the definitive case for enhanced spectrum sharing is rooted in the lessons of unlicensed policy. Unlicensed spectrum has always been based on sharing, WI-FI, Bluetooth, and all the other unlicensed application must share spectrum with each other while not causing interference to the licensed spectrum users. Both the PCAST and the FCC's technological advisory council recommended that the we target the 3.5 gigahertz band as the innovation band.

And I know it's shocking, considering the fact that I participated in both of those groups, that

we're actually pursuing that as our goal. Very soon I will circulate to my fellow commissioners detailed proposed rules designed to make the PCAST vision a reality. Subject to ongoing discussion with other government parties in interest, this is what I hope to be able to recommend; first, the proposal would contain three tiers of prioritization, federal and nonfederal incumbents, priority access licensees, and general authorized use.

The three tiered construct was a key aspect of the PCAST report, and we believe is necessary to realizing the full potential of spectrum sharing. Second, you would include a single highly flexible band plan avoiding the analog trap of bulkenizing spectrum into sub-bands each with its own set of rules. And third, the proposal would anticipate a wide range of flexible uses. Small cells will undoubtedly be a core use case, but we should not limit the band to such use.

Finally, the proposal would reflect economic incentives. Even with the most efficient technology,

there will always be places and times where there is rivalry for spectrum access. To that end, the proposal would set up a flexible auction and licensing scheme that leverages the technical capabilities of the spectrum access system database. In addition to the 3.5 gigahertz band, it provides a real-life opportunity to provide some bold thinking about receiver performance.

And parallel to our formal rulemaking, I inspect that a multi-stakeholder group will be convened to explore the ways to drive, not only efficient transmission, but also efficient reception. In less than two years the PCAST's report is on the verge of reality. It has come a long way. And those who lead that effort, including Mark Gorenberg who headed it up, deserve an ample amount of credit for their vision and for driving it through.

So a few moments ago I mentioned the role intellectual and psychological issues play in determining the outcome of technological innovation. The same holds true for spectrum policy and especially

for incentive auctions and spectrum sharing. There are two controlling forces in spectrum policy. The laws of physics, and the laws of human nature. Of the two, physics is the easy lift; human nature, however, is another challenge. There is something in our human nature that draws us inexorably to worst-case assumptions.

Both the incentive auction and the sharing proposal provide additional, if unneeded, examples of this reality. They both involve significant changes in traditional ways of doing business. And predictably that novelty has produced anxiety. I hope I'm clear on this point, I understand that legitimate, there are legitimate equities of those who we are asking to confront change, both broadcasters and other incumbent spectrum holders. And I understand that inevitably with change comes the perception of risk, but if we proceed responsibly, as I'm confident that we are, the rewards of vastly improved spectrum policy will make our collective endeavor entirely worthwhile for everyone involved.

Now mind you, I'm not complaining, at least much, about our human proclivities. And the people in this room have dealt with this reality of change in multiple contexts. It's been around for as long as our government has existed. But I believe people of goodwill can resolve these kinds of issues. And in that regard, I want to especially call out the efforts of the Defense Department and NTIA at the direction of the President that has brought us so far on the topic of putting spectrum to use for economic growth.

After all, it was NTIA that put their 3.5 gigahertz and other bands on the table with the publication of their fast track proposal in 2010. Now what I'm talking about when I talk about the nontechnical challenge is just pointing out that achieving the goals that we all recognize, including the recommendations of Phil and Pierre requires a psychological about face to reorient from what was to what can be.

And when the speaker's cell phone goes off -- (Laughter) -- when you're in my job, this is a

good sign. This is a spectrum-driven item here. (Laughter) And so just consider this, you know, one more example of why we need more spectrum. (Laughter) But I believe that together the incentive auction and spectrum sharing mark watershed moments in the evolution of spectrum management. Today they're but concepts. Eighteen months from now, eighteen months from now, they'll be reality.

To be clear, while incentive auctions and spectrum sharing are really big deals and really big pieced of the FCC's mobile agenda going forward, they're not our entire spectrum agenda. We will still use traditional tools to unleash spectrum and spur innovation in the mobile sector, notably my favorite tool of all, competition, competition, competition. If you're in this room, the chances are high that you've already heard me extol the virtues of competition as a driver of innovation and investment, so I'll spare you another exposition; but it is worth repeating that as long as I am Chairman, competition will be at the center of our spectrum agenda.

So I started my remarks look backward to the past, let's close with a look to the future. While mobile connectivity has already revolutionized our world in multiple ways, the fact of the matter is, we're just getting warmed up. Think about the iPhone and the Android phones, which have given more than 60 percent of Americans more computing power than was on the Lunar Lander. And they didn't even exist when Barrack Obama became President.

In barely six years those platforms have given rise to the apps economy, which has already created 750,000 jobs in this country, for a spectrum-based capability that didn't exist six years ago. Think about what happens in the next six years or 16 or 60, but it all requires spectrum, and it's why this discussion is so important. Think about our education system and what it would mean if every student had an interactive digital textbook that tailored lessons to his or her strengths and weaknesses.

Think about our healthcare system and how

many lives could be saved by remote monitoring that could diagnose health risks before they become emergencies. Think about people with disabilities. I saw a story last week about wireless technology that will put GPS navigation in shoes to help the sight-impaired find their direction and give them new freedom. And last week a dance instructor who lost her leg during the Boston Marathon bombing was gliding across the stage at the TED conference in Vancouver with a bionic leg specifically engineered for dancing.

And the MIT engineer who designed it said that wireless technology will enable more advanced neural-controlled limbs in the not too distant future. To seize upon these opportunities for job creation, healthcare, education, energy, and helping people deal with their challenges; entrepreneurs will have to update the way in which they do business, and the FCC is going to have to update the way in which we manage and allocate spectrum.

The challenges before us are great, but if we work together to tackle these challenges and seize

the opportunities, we can achieve great things to advance this next network revolution. Thank you very much. (Applause)

MS. KEARNEY: Thank you all for being with us today and thanks for all the work you do to unlock the economic progress of spectrum. Enjoy the rest of your day.

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I, Carleton J. Anderson, III do hereby certify that the forgoing electronic file when originally transmitted was reduced to text at my direction; that said transcript is a true record of the proceedings therein referenced; that I am neither counsel for, related to, nor employed by any of the parties to the action in which these proceedings were taken; and, furthermore, that I am neither a relative or employee of any attorney or counsel employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

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