REPORTER'S TRANSCRIPT of COMMERCE SPECTRUM MANAGEMENT ADVISORY COMMITTEE (CSMAC) MEETING at the NATIONAL INSTITUTE OF STANDARDS and TECHNOLOGY, BOULDER CAMPUS 325 BROADWAY STREET, BOULDER, COLORADO, 80305

Monday, August 1, 2016, beginning at 1:00 p.m. MDT

NOTE: The primary cause for the use of "(indiscernible)" statements in this transcript is due to participants not staying in close proximity to the microphone or poor recording conditions.

UNIDENTIFIED MALE: All right. I think we'll get going if everyone is ready. Welcome to this edition of the CSMAC. I'm going to just turn it over right to Glenn welcome us.

GLENN REYNOLDS: So I'll start off by welcoming everybody to the Boulder labs. I think for those of you who haven't been here before, hopefully, you've had an opportunity to look around.

Obviously, this is a facility that is jointly used by NIST, NOAA, and our ITS labs down at the bottom of the hill in the parts that don't look nearly this nice. And we'll just leave it at that.

Once again, I get the privilege of kind of representing the assistant secretary at this meeting. Larry had fully intended to be here today, both to kick off this CSMAC meeting.

UNIDENTIFIED MALE ON TELEPHONE: Hello? Hello?

UNIDENTIFIED FEMALE ON TELEPHONE: Hi, there.

GLENN REYNOLDS: Folks, for those of you who are on the line, can you please --

UNIDENTIFIED MALE ON TELEPHONE: Is this the CSMAC meeting?

UNIDENTIFIED FEMALE ON TELEPHONE: This is

the CSMAC meeting, at least I think so.

GLENN REYNOLDS: This is the CSMAC meeting and can everybody mute their phones, please.

UNIDENTIFIED MALE ON TELEPHONE: Because it's started, but I don't hear it through the phone.

UNIDENTIFIED FEMALE ON TELEPHONE: Huh.

UNIDENTIFIED MALE ON TELEPHONE: I'm hearing it online.

LARRY ALDER: Can you guys hear us? This is the conference room.

UNIDENTIFIED FEMALE ON TELEPHONE: Uh, let's see (indiscernible) --

(Background conversations from telephone participants)

UNIDENTIFIED MALE: Okay. We'll see if we can figure out the folks on the phone. Again, I don't know if you -- I assume you can't hear us.

UNIDENTIFIED MALE ON TELEPHONE: There's about -- there's a two-minute delay between the video and the phone, and we cannot hear the meeting through the phone.

UNIDENTIFIED MALE: We can hear you, David.

GLENN REYNOLDS: Yeah, that's why I'm a lawyer. Guys, all I can say is we're going to try to fix it on the phone as quickly as we can, but please

bear with us.

As I was about to say, Larry had fully intended to be here with us to kick this off, kick off this last meeting of the CSMAC, as well as to give opening remarks tomorrow morning at the ISART meeting down the road.

But, Larry is, as you all know, kind of coming to the end of the administration. And Larry has been trying to figure out what he wants to do next with his life. And so he's decided to follow his real dream and try to pitch for the White Sox.

And, as a result, the first step in that is he had to get shoulder surgery last week. He says it's a rotator cuff, but we're all kind of skeptical. I think they're putting new muscle in there or something. But anyway he, unfortunately, is on restricted travel for three weeks. So he could not get out here.

So he sends his regards and he sends me here not just with his welcoming, but with his appreciation for all the hard work of this iteration of the CSMAC. Looking back at this CSMAC -- we're still having some issues I hear.

This CSMAC, when you look back at it, has spanned a remarkably transformative period in this industry, if you go back and look, starting with last

January with the record-breaking AWS-3 auction, which closed and set all sorts of records for money for the treasury and other things, but which also included rules for proactive sharing that were developed through the CSMAC process.

Then last April the FCC adopted truly innovative tiered sharing arrangements for the 3.5 gigahertz band, placing new sharing technologies truly in the mainstream of spectrum management. Ow, that hurt. I don't know if that was me.

Then this year we're witnessing the first of its kind incentive auction, an out-of-the-box effort to create a win-win opportunity to repurpose spectrum for brand new services.

But perhaps the most remarkable sort of transition that we've seen over this CSMAC's lifetime is watching the idea of 5G wireless go from something of a vague concept to something really real, underscored by the FCC's recent Spectrum Frontiers order, which gives the U.S. a tremendous competitive advantage in the next technology cycle by putting to use millimeter wave spectrum for advanced wireless broadband, spectrum that was barely on any of our radar screens when this CSMAC convened.

So this last meeting of the current CSMAC is

a bit of a transitional milestone itself in that we're looking both backwards and forwards. On the one hand, we can take a brief moment to appreciate all of the hard work that all of you have put into this, the committed, forward-looking work that is reflected in the final recommendations of the working groups that we heard at the meeting two months ago, and then the work that's reflected in the reports, in the papers that we're going to be talking about today.

The work of the CSMAC has already made important contributions to spectrum policy and will continue to do so as we take on the next spectrum management challenges. But after we take that breath to appreciate the hard work of this group, we'll be right back to the blank white board as we look forward and finish this meeting up with the discussion, trying to identify what issues we should be looking at next. As the saying goes, no good deed goes unpunished.

In closing, I just wanted to first recognize two special guests we have here today or at least one that's here and one that hopefully will be here momentarily. Julie Knapp is here from the FCC.

UNIDENTIFIED MALE: Got his own table and everything.

GLENN REYNOLDS: Exactly. We had to stick

him in his own location. And then, hopefully, momentarily we will be joined by Keith Gremban who is -- oh, Keith is here. Okay. Keith made it from our staff meeting.

UNIDENTIFIED MALE: He doesn't even get a table.

GLENN REYNOLDS: I know. Keith, you should join Julie. Keith who is the head, has been the head now for a little over a year of our Institute for Telecommunication Sciences based here in Boulder.

So I just wanted to welcome everybody again, express our tremendous appreciation for all of the hard work, all the commitment, all the resources, and all of the brain power that all of you guys have dedicated to this effort.

I can assure you that we at NTIA appreciate and recognize that you all have lots of demands on your time, and it is our intent and our obligation, to make sure that we try to make this effort both in this meeting --

UNIDENTIFIED FEMALE ON TELEPHONE: Hey, can you help me with this thing?

GLENN REYNOLDS: -- and all the efforts going forward a valuable use of your time for all parts of this wireless echo system. So with that, I'm going

to pass it back to Mark and Larry --

UNIDENTIFIED MALE ON TELEPHONE: Hi, Janice. This is (indiscernible). I have the exact same problem.

MARK CROSBY (telephonically): This is Mark Crosby, same thing.

LARRY ALDER: Okay. I think we're going to just try to work through it. David, you're working the -- okay. So I apologize to the folks on the phone, but we're going to just keep plowing forward.

So, again, this is the final meeting for this version of the CSMAC and I think Mark and myself would like to echo Glenn and Larry Strickling's in-proxy comments through Glenn to thank everyone for the tremendous work that's been put together in these five subcommittees.

There's really been some great work. I know I've learned a lot from the reports. And I think these are really outstanding work, and I appreciate all the time. And I know Mark does as well. Mark worked harder than anyone else, so great.

So for today, we've got kind of an interesting agenda. We're going to hear from our guests. So there'll be kind of the first hour we'll get to do a lot of listening to our esteemed guests. And then we're going to walk through the reports.

A lot of it was voted on and approved last time. There's a few clean-up things that we want to present, specifically around the 5G report and recommendations. And then we're going to move into an interesting and uncharted water for this group.

We're going to have a little brainstorming session around future topics. So this is your chance to, you know, open the doors pretty widely at a high level, and we'll discuss potential future topics, you know, real-time brainstorming, which will be input for Paige and her process informing topics for next group.

So that's kind of what we have on the agenda for today. So I thought what we'd do then is start with our traditional roll call. So why don't we start down there with Bob.

ROBERT PEPPER: Robert Pepper, The Aspen Institute.

RICK REASER: Rick Reaser, Raytheon.

STEVE SHARKEY: Steve Sharkey, T-Mobile.

DENNIS ROBERSON: Dennis Roberson, Illinois Institute of Technology and Roberson Associates.

PAUL KOLODZY: Paul Kolodzy, Kolodzy Consulting.

AUDREY ALLISON: Audrey Allison, Boeing.

CHARLA RATH: Charla Rath, Verizon.

BRYAN TRAMONT: Bryan Tramont, Wilkinson Barker.

PAIGE ATKINS: Paige Atkins, NTIA.

LARRY ALDER: Larry Alder with Google.

MARK GIBSON: Mark Gibson with Comsearch.

GLEN REYNOLDS: Glen Reynolds, NTIA.

MARIAM SOROND: Mariam Sorond, DISH Network.

ROBERT KUBIK: Robert Kubik, Samsung.

DALE HATFIELD: Dale Hatfield, University of Colorado.

JENNIFER WARREN: Jennifer Warren, Lockheed Martin.

JEFF REED: Jeff Reed, Virginia Tech.

KURT SCHAUBACH: Kurt Schaubach, Federated Wireless.

MICHAEL CALABRESE: Michael Calabrese, Open Technology Institute at New America.

CARL POVELITES: Carl Povelites, AT&T.

LARRY ALDER: And I dare not ask for the phone, David, huh?

(inaudible response)

UNIDENTIFIED MALE: Well, we know Janice is there.

LARRY ALDER: We know that Janice, Mark Crosby, David Donovan, Mike Chartier, and Harold

Furchtgott-Roth, those are the people we know were supposed to be on the phone. I'm going to wait for --

(dialing of phone and automated recording playing)

LARRY ALDER: Okay. Can anyone on the phone hear us? Anyone on the phone want to introduce themselves? We're doing the roll call. I don't think it's working so --

UNIDENTIFIED FEMALE ON TELEPHONE: Hi there. Are we on the with Boulder now or just each other?

LARRY ALDER: This is Boulder.

UNIDENTIFIED FEMALE ON TELEPHONE: Okay. Second time's a charm. Great. Thanks. I can see you, but I couldn't hear -- you know -- we got cut off. Anyway, thanks.

LARRY ALDER: So, Janice, why don't you introduce yourself and then if anyone else is on the call, we'll have you introduce yourself, and after you introduce yourself, let's go ahead and use the mute buttons to keep -- go ahead, Janice.

JANICE OBUCHOWSKI: Okay, it's Janice Obuchowski, (indiscernible).

LARRY ALDER: Any other people on the phone?

JANICE OBUCHOWSKI: All right. It's Janice Obuchowski from Washington, but I think we have a

two-minute delay. You'll hear me in two minutes.

LARRY ALDER: I heard Mark Crosby there.

MARK CROSBY: Yeah, Mark's on.

LARRY ALDER: Hi, Mark. Okay. I think we're good. Let's continue on then with the agenda. So I don't think there's -- Mark, do you have any other introductory remarks? I think we've covered the introductory remarks, and so we'll jump right in with the spectrum update from Paige.

PAIGE ATKINS: Thank you -- a little bit of feedback there. Well, welcome back to Boulder where we are fortunate, again, to hold our CSMAC meeting alongside the ISART conference, and the topic of this year's conference spectrum forensics --

DAVID DONOVAN: Donovan is here.

PAIGE ATKINS: Who was that?

LARRY ALDER: David Donovan just joined.

PAIGE ATKINS: Okay. -- is timely as we look to the next generation --

DAVID DONOVAN: Hello?

MARK CROSBY: David, there's a two-minute delay so --

PAIGE ATKINS: -- of challenges and opportunities associated with spectrum policy --

(indiscernible background conversations from

telephone participants.)

PAIGE ATKINS: -- in particular the necessary technology capabilities and regulatory frameworks that enable sharing while mitigating or avoiding interference.

There is an impressive array of panelists and discussions this week, so I hope all of you, if not, some of you, can participate throughout the week, and it is being sponsored by The Center for Advanced Communications. So it's a great opportunity.

And the ISART agenda notes, paraphrasing Robert Frost, that Spectrum Forensics will help build and maintain good fences to make good neighbors. And the ISART's sharing-centric theme of good fences and good neighbors is very applicable to our discussions here in CSMAC and our continuing discussions for the next cycle.

We continue to live in exciting times in spectrum management. I commend, as everyone has already today, the CSMAC membership for answering the call and in particular for the fast-paced assessments that we've asked you to do the last few months and the expedited timelines that we've put before you.

Since this is part of an extended membership term, we appreciate that this is yeoman's work. These

are challenging issues at the cutting edge of new technology and regulatory environments, and we do appreciate the intellectual capital that you bring to bear for us to answer the tough challenges and formulate the right approach for the future.

As we close out this chapter of the committee's current term, I look forward to your insights and discussion today on what we need to focus on for the future and the priorities. And that will help us formulate the next set of questions for the next membership term.

But for now, I'll turn to some of the exciting things that have occurred since the last CSMAC meeting in June. For a brief two months, a lot has happened. And I will touch on some and others in this room, Julie and Keith, will elaborate on many of these.

So a major step forward, as Glenn already mentioned, was Spectrum Frontiers. This item made available more spectrum for flexible-use wireless broadband than ever before and lays the critical groundwork for 5G services and applications and high frequency, in particular millimeter wave spectrum.

The FCC's actions supported by NTIA and the federal agencies offers exciting opportunities, particularly for spectrum sharing and dual-use

technologies. And in particular, for spectrum sharing, it was focused on the federal, non-federal sharing. It provides some unique opportunities for us that we need to exploit. And I'm sure Julie Knapp will talk about that in much more detail in a few minutes.

Now, the advanced wireless research initiative, if some of you heard the White House press, we really need to put in place the building blocks of research and technology development that will help make Frontiers as well as 5G a reality.

And in July, the administration laid out steps for U.S. leadership by launching a $400,000,000 program to enable advanced wireless research over the next decade. And that really builds on the Frontiers policy framework that the FCC has put in place.

And through this initiative, which is run by The National Science Foundation or NSF, there are more than 20 technology companies and private sector associations in conjunction with NSF that are investing 85 million in four city-scale public/private testing platforms to support fundamental research on advanced wireless technologies.

And the fundamental research supported on these platforms will include the $350,000,000 investment by NSF for academic research over the next seven years

and will allow academics, entrepreneurs and industry to mature advanced wireless technologies concepts, which will translate into future innovations for next generation 5G and other capabilities. So it's an exciting opportunity for many.

Now, in a related announcement, NTIA's ITS, the Institute for Telecommunication Sciences, this fall will sponsor undergraduate and graduate student research that will leverage the testbed it is developing with the University of Colorado Boulder across the federal and university campuses here in Boulder.

And the testbed will support research on campus scale wireless networking, spectrum sharing, and mobile applications and enable collaboration between ITS, University of Colorado Boulder and the city of Boulder. And so it's a very exciting opportunity for all of us.

And you will hear more from our director of ITS today, Dr. Keith Gremban, who will talk about their strategic thrusts and related efforts to better inform spectrum policy decisions and support development of new telecommunications technologies.

Now, I wouldn't do justice to our efforts without mentioning our continued progress on the 500 megahertz goal. Everyone's aware we're almost halfway

there, which we have been for a while now.

And, collectively, we continue to evaluate the feasibility of increased sharing and multiple bands, including with unlicensed devices in 5 gigahertz, and many of you are participating in those efforts.

And since the last CSMAC meeting, the FCC's comment period has closed on its public notice to refresh the record in the proceeding on 5.9 gigahertz. We also continue an intense schedule of analysis and modeling for 5350 to 5470 megahertz and continue to work with the agencies and industry on modeling approaches to ensure we can ascertain whether sharing is technically feasible in these bands.

The 5 gigahertz bands are a vital part of our storyline related to meeting the 500 megahertz goal. And we also continue to make progress on 3 dot 5 gigahertz and the incentive auction which, again, Julie will talk to you in more detail in a few minutes.

And as Assistant Secretary Strickling has mentioned before, we are optimistic that later this year in conjunction with the FCC and the agencies, we will be able to lay out a road map of how we will achieve that 500 megahertz by the year 2020.

Now, meanwhile, the Spectrum Pipeline Act, which the president signed into law last fall as part of

a bipartisan budget act, sets out targets for identifying an additional 130 megahertz for wireless broadband as part of a series of deadlines in the 2022 to 2024 time frame. However, more significantly, the Pipeline Act made important changes to the spectrum relocation fund and the use of the spectrum auction proceeds.

The Spectrum Pipeline Act allows federal agencies to more flexibly apply those funds for advanced spectrum planning and research and development that may lead to more efficient spectrum use and repurposing of spectrum for commercial applications, while ensuring we maintain or enhance our federal critical capabilities.

This is a significant step forward and an important component to creating a sustainable pipeline, and we've moved quickly to implement this act, including reconstituting the technical panel. And some will be familiar with the technical panel's purpose in AWS-3. This is a slightly different purpose and responsibilities. And the agency's proposals are subject to the technical panel review and approval under the statute.

The intent is to help direct this additional SRF funds to invest in high-payoff activities while hopefully enabling sharing and relocation decisions.

And we are already working with several federal agencies on pending proposals that they would like to bring forward through this process. So we're very excited about that.

Now I'm going to take a slightly different turn. It's really amazing to look back 30-plus years and see all the progress that we've made from a spectrum policy perspective.

The effort to provide more spectrum access for broadband wireless services really stands on the shoulders of a federal spectrum policy that goes back to about 1983 when FCC allocated the initial spectrum used to begin the building blocks for the first cellular networks.

And at least as far back as the administration of President Bill Clinton, every administration has acted to make spectrum available to accommodate the need for commercial wireless services.

In 1993, Congress gave the commission auction authority, recognizing it is a way to find the most efficient way to get spectrum access into the most productive hands and into the market. And, at that time, Congress also directed NTIA to identify over 200 megahertz of federal government spectrum to repurpose for the private sector.

And as the commercial wireless industry took off, the U.S. government responded in a thoughtful, strategic, and bipartisan approach to making additional spectrum available while preserving the spectrum access that government agencies and departments continue to need to serve the public, and, in particular, in the areas of homeland security, public safety, and other critical mission areas.

Now, since 1994, the FCC has conducted nearly a hundred spectrum auctions that have generated billions of dollars for the U.S. Treasury, supporting important public policy goals.

In 2003, fast forward, the president's spectrum policy initiative under President George W. Bush committed us to developing a comprehensive spectrum policy for the 21st century. And this initiative, in part, resulted in the formation of two key advisory committees -- CSMAC as well as the PPSG, the Policy and Plans Steering Group.

Since that time, we've had a series of policy and legislative actions that have repurposed in auction multiple bands, federal bands for commercial broadband access, established the spectrum relocation fund to help ease the transition of spectrum from government to commercial use while preserving the

agencies' abilities to serve the public.

And we have progressively reformed the SRF to more flexibly apply those funds for sharing advanced planning and R & D. And as we all know, the Obama administration brought continued emphasis on the need to address accelerating growth of broadband services and applications with two presidential memos, that we're all very familiar with, in an effort to ensure that sufficient spectrum will be available for broadband expansion.

Now, July, last month now, was also the four-year anniversary of a ground-breaking report on spectrum sharing released by the President's Council of Advisors on Science and Technology or PCAST. Though not that long ago, much has changed in four years.

And to put a little perspective, the report cited the internet of things as a novel wireless market. And it is now a part of our common technology vernacular. Similarly, 5G was not fully evolved as a concept and didn't merit a mention in the report. So how far we've come in four short years.

When it was released four years ago, the PCAST report was a game changer in terms of articulating a new paradigm based on using sharing to empower access to federal spectrum without compromising important

federal agency missions.

And for this administration, the PCAST report has been a cornerstone to an important policy trifecta, again, starting with the president's 2010 memo, followed in 2013 by the second memo asking us to accelerate our focus on spectrum sharing.

And we have made significant strides in addressing the recommendations in the PCAST report in some form or fashion including leveraging capabilities in spectrum access systems and 3.5 gigahertz to enable the kind of sharing that the PCAST report envisioned.

So, to be clear, as I've often said, we still have a lot of work ahead of us, not only in the technology, but also the policy, the process, the framework within which we need to implement that technology. But we have that foundation to build on and to ensure we can prove out these new sharing techniques and technologies.

So my intent is not to give you a history lesson, because most of you know that history, but to emphasize that it will continue to be a bipartisan priority, regardless of which new administration takes over in a few months, and our spectrum work and momentum must continue.

However, what has worked in the past does

not guarantee success in the future, so the CSMAC is going to remain a critical component, so we can better think of things out of the box, look at things through different lenses and continue to develop innovative policy, regulatory and technology solutions to fully exploit the spectrum opportunities now and in the future.

So I look forward to wrapping up the final recommendations for this membership today, and as Larry and others have alluded to this brainstorming session in terms of next steps, so we can consider those for the next CSMAC cycle.

And we know being on a federal advisory committee is not a very glamorous job, and we are grateful for your time and invaluable insights. It's the personal commitment that each of you make to volunteer your time and expertise to help us do a better job that is so important to us.

We sincerely appreciate your commitment and the collective wisdom and advice that you've provided to NTIA now over the last 30 months with that extension of six months. So thank you very much. And I'm happy to take any questions that folks may have.

MARK GIBSON: Just to make one comment, you didn't mention the propagation tutorial that ITS has

been doing, which I'd like to just say thank you for. I think Eric Nelson has put them together, and a lot of his people have been doing them. And they are between 50 and 75 people on those calls so thank you very much for that. That's awesome work. There's a lot of really good information in that. So all of us that are participating are getting a lot out of it, so thank you.

PAIGE ATKINS: Thanks, Mark.

DENNIS ROBERSON: Dennis Roberson here. You talk very well about the past, and it is fun even for us to hear it, even though we lived it. No, it really is terrific. As we look forward, what is the game plan for CSMAC? I know these are uncertain times as there's an administration change in the (indiscernible) and so on. But what does the next year look like for CSMAC and for NTIA?

PAIGE ATKINS: Well, from my perspective, and, obviously, I can't guarantee anything, but our plan is to move forward as nothing will be changing. You know, from our perspective, it is very important for us to keep that momentum going.

We are in the process of vetting the new membership through our normal activities, and we hope to do that as expeditiously as possible and to get the next round going. So we're very excited to move forward and

tee up that next cycle with important questions for us to answer.

LARRY ALDER: Last call for questions for Paige.

PAIGE ATKINS: Save all the hard ones for Julie.

LARRY ALDER: For our brainstorming. So without further ado then, we've got Julie from the broadcaster's booth over there.

UNIDENTIFIED MALE: How's (indiscernible) treating you over there, Julie?

(audio cut out)

JULIE KNAPP: -- collaboration. So thanks. It's great to be here. Sometimes it feels like the only time I get to go to these meetings is out here in Boulder.

Just three terms initially come to mind. One is that so many of the things that we have been doing involve sharing of spectrum, perhaps more than any time in the past.

Secondly, complexity -- thinking back to those earlier days where it was generally identify a particular band, have a debate over whether it was lightly used or not and reallocate it, which worked fine for the time, but there's a lot more operations in

the spectrum today, and we're trying to pack more and more together. And that has meant that our ways of recovering spectrum and our ways of sharing spectrum have gotten more complex.

And then, thirdly, collaboration. We couldn't have accomplished the things that were done, such as with AWS-3 and many of the other things and all of the challenges that we have in front of us without the collaboration between NTIA and the federal agencies and the industry and I think all of the people in this room.

So I'm confident that we're going to meet these challenges ahead, but it's going to take all of us working together. So I'm just going to mirror a little bit of what Paige said and perhaps add some commentary to it from the broadcast booth.

Well, first of all, at least on our side, we've done a lot of work to make the incentive auction happen and that's in process, and, you know, it goes back to the term complexity, because I don't think there has been anything that we've had to deal with on our side that was as complex as trying to figure out what the chairman described as the Rubik's cube. And it's been a monumental accomplishment just to get to the point where the auction is actually going on.

The Spectrum Frontiers item, or what some call the 5G item, almost 11 gigahertz of spectrum was identified for mobile. The three bands that we talked about generally -- the 28 gigahertz band, the 37 gigahertz band, 39 gigahertz band -- I'll spare you the details. But every one of them had different sets of incumbencies, different sets of challenges.

And I think one of the really interesting things here that lies in the work ahead is in that band at 37 where we identified 600 megahertz of sharing basically for everybody, a portion of it with a priority for the Department of Defense.

But it's not a separate spot for any one service. It's a spot to find ways that we can maximize use of the spectrum by essentially giving all of the parties access to it. So I think that's going to be one of the very challenging things that we have going ahead.

And if that wasn't enough, there's another 18 gigahertz of spectrum that we put in play in the further notice. So for -- I think this is probably the greatest boon for the FCBA and for the spectrum engineers in terms of all the analytical work that lies ahead.

And it's not only for the United States, but what's going on internationally in trying to identify

the spectrum. So it was quite an accomplishment, I think, for all of us to really lead the world in identifying spectrum for the next generation of mobile services and we went to keep up that momentum as we go forward.

And the 3.5 gigahertz, the great news there, first of all, has been all of the collaboration that has gone among the industry and the stakeholders in the WInnForum process. Getting everybody together in the room to solve all of the details of how this is going to work I think was probably one of the best things that we as an agency could have done.

We set a basic framework and then set, you know, all of the technology experts and the stakeholders together in one place to try to figure out all of the details, and there's been a lot of terrific work that has been going on there.

We also had the applicants for the spectrum access systems. And one of the things is as a regulatory agency when you set these things up is you wonder, when you send the invites out to the party, is anybody going to show up. And it's always gratifying. You know, we've had a number of parties that filed both to be spectrum access service providers and environmental sensing system providers.

So we're in the midst of the approval process. It's going to take some time working through all that and trying to figure out exactly how do we ensure that these systems work the way we expected them to work. But there's a lot of benefit out of it. I think we're packing -- there's another example of where we're packing more together in the spectrum in a dynamic way to make the maximum use of it.

I would just also say that one of the things, the way we think about things, it's not so much about taking a particular model and trying to apply it everywhere, but trying to figure out what is the best model to maximize the use of the spectrum given the conditions that there are in that space.

So SAS was the right approach there. It may or may not be in other places, but the whole theme of trying to find ways to make more use of the spectrum, I think, is the challenge we have ahead.

A couple of other examples that Paige mentioned but I'll say a little bit more about them. What we've been talking about is the 5350 piece for unlicensed. So there's two unlicensed bands that are available now, and broadly -- 5150 to 5350 and 5470 to 5850. So you've got these two big chunks of spectrum that are sitting there.

The IEEE 802.11 AC standard is designed to work in those, but we could get more out of it, if we can fill in the missing piece in the middle. So that's why this is so important. But it is tough, because we have got systems in there like earth exploration satellite systems where the signals are really weak and you're trying to figure out, well, I can't hear them, so how do I share them? Do I predict where they are and find periods of time where I turn off in that particular piece of spectrum and I use it elsewhere?

So that piece has been a challenge. And then there are multiple radar systems. We're already sharing with radar systems in other parts of the 5 gigahertz spectrum, but these are different. They include aeronautical systems. They include systems that have extremely short response times.

So we've had a lot of people working very hard trying to figure out how to do this, and I tip my hat to Charles Glass who's really been in the middle of it leading the effort. He's increased the level of work that is going on there.

He's having meetings a couple times a week trying to get everybody together to sort this out. So there's a lot of dedication going into trying to figure out how to gain access to that spectrum and make sharing

work.

And I shudder to talk about which piece is more difficult or easier, but the other piece that we're looking at is this piece that we call 5.9 gigahertz. It's at 5850 to 5925 so it sits at the high end of the unlicensed spectrum. It's been allocated for intelligent transportation systems, what is often referred to as DRSC -- dedicated short range communications.

We issued, as Paige mentioned, a public notice in early June to refresh the record and to solicit prototypes. The good news is just last Friday we received prototypes from Broadcom, KEA Technologies, and CAV Technologies. And we extended the date.

They were all due to come in on the 30th of July, but, as you know, when you're working with prototypes, sometimes you've got to really put them through their paces to make sure they're working before you submit them in for testing.

So Qualcomm is submitting theirs by August 8th and Cisco by August 18th. There are three phases of testing, first at the FCC lab; then DOT, Department of Transportation, will be doing some basic field tests; and then finally real-world testing.

So we've done a lot. We've still got a lot

left to do. These problems are hard. And, you know, there's a lot of energy and, I think, intelligence going into trying to figure out ways to make them work. Thanks.

LARRY ALDER: Thanks, Julie. Do you folks have questions for Julie? Michael.

MICHAEL CALABRESE: Yeah, Michael Calabrese. Julie, you mentioned the 37 to 37.6, which will be, you know, an intention to have that be a shared, a fairly open shared band among many different types of users.

Are there issues that you've already identified, these would be federal, federal use that you -- whether you could -- I don't know. Are you ready now to say that the CSMAC might, it might be productive for the CSMAC to look at them, or just simply what are your challenges when you think about sharing with federal users in that band? Is it all very cut and dried right now, or is it still a work in progress as far as identifying the issues?

JULIE KNAPP: Thanks, Michael. Start with the proposition that this was spectrum that was allocated to the federal government. And so even if there weren't systems deployed, this was spectrum that for them, I think, from their point of view, was potentially a place that they could deploy systems and

grow.

And I think one of the concerns from the federal side was that they would still have the opportunity to grow and use the spectrum in the future. So what we tried to do was take this piece and, by the way, most of the details we asked questions about in the Further Notice of Proposed Rulemaking.

So the idea here was to provide some of it where there was certainty that the federal government would, and Department of Defense in particular, would have access to it, so that we didn't create a model that said we licensed it all nationwide, and now, although you're co-primary, you have to get permission of an incumbent licensee.

So the idea here was to provide some certainty for Department of Defense access while still allowing all of the other uses in the extended part of the band, because we made this interoperable across the entire spectrum so that the equipment would be able to operate everywhere.

Our hope is that longer term this is a win-win for everybody, that there are applications for LTE that are potentially beneficial to the military as well. So that entire market could help drive a system that creates technology improvements that benefit

everybody.

So long answer for file comments, because we opened these questions in the proceeding and whether -- you know, it's really up to NTIA to say whether this is something they want to take a look at. But we have been working with NTIA and Department of Defense through this whole process and that's what led to where we came out.

MICHAEL CALABRESE: I guess a similar question with respect to 5350 that you mentioned. So there is ongoing technical work. Again, is that a very defined technical problem at this point and it's just a question of working through the process, or are there issues in that band that need to be studied further or developed?

Just wondering, again, if you would see the CSMAC as potentially playing any kind of role there, or is it just a question of working through very defined technical issues at this point?

JULIE KNAPP: So we have a group that has been open to anybody who wanted to participate from the industry working together with the Department of Defense and the other agencies. They've been at it for a while.

Whether an additional process on top of that would help -- what I can tell you is they're on a pretty fast timeline trying to get to an answer. They

understand what the technical characteristics are, and a lot of it is the usual kind of analysis about how do you determine, how do you model the deployments of what might go in there and aggregate interference, all of the usual things we'd go through before.

So I think the problem is pretty well understood. The difficulty is trying to figure out, can you come up with solutions that are viable for the equipment and for the industry to deploy.

UNIDENTIFIED MALE: Thanks.

PAIGE ATKINS: So just to follow up quickly. The subcommittee that was focused on the measurement and sensing and in particular 5 gigahertz, the intent really was, are we missing something? Are we missing something that is innovative, that we're so focused on the technical solution in this ongoing work that we've missed something completely.

And I think there's been some good feedback in that subcommittee. And I also think that just in general as we look at, in particular, in the Frontiers bands and reapply or looking at new techniques for a much more dynamic sharing, that we will want to peel back what should CSMAC perhaps be focused on or other groups that may be collaborative in nature, be focused on to come up with those innovative solutions in the

future.

LARRY ALDER: Go ahead, Rick.

RICK REASER: This is Rick Reaser. I was wondering has there been any thought -- you know, most of the sharing scenarios now sort of deal with new people coming in, dealing with incumbents.

Has the commission looked at maybe starting to establish technical rules that would be phased in over time in the future for new systems, so that they were built to share from the get-go, and has there been much thought or work in that area, because you could phase systems like that in over time and then maybe, you know, 20 years from now have a different landscape.

JULIE KNAPP: Can I give this to Paige? No? I think that sort of thinking is working into the processes in different ways. Whether we think about it in terms of -- we've been talking for a long time about receiver characteristics and, you know, are you mindful that it might be quiet next-door now, but it might not be quiet later, and how do we weave that in without jumping immediately to rules.

And I think there has been an increase in awareness on that front, and some of the things that are going on, I think, supported through, for example, the spectrum research reallocation fund, looking at how we

can take incumbent systems longer to term and make them more friendly for sharing. There's an awareness of that and trying to build that in for the future as well.

LARRY ALDER: Other questions? Jennifer.

JENNIFER WARREN: Jennifer Warren. Julie, just to follow up on Rick's question. Was your answer just focused on the government systems, or is that also on commercial? I wasn't quite sure.

JULIE KNAPP: I think it's across the board. You know, as people have been looking -- we have a ways to go yet, but I think people are -- you know, as we've run into surprises along the way, and I'm not referring to any one particular. People immediately think about GPS, but we've struggled with this in other places as well. I think we still have a lot of work to do going forward to be, as people are designing systems to be cognizant of trying to make them robust.

LARRY ALDER: Julie, I'll ask a question.

JULIE KNAPP: I've exceeded my limit here.

LARRY ALDER: Given that I don't know if you'll be able to stick around for our brainstorming, I wanted to see, do you have any thoughts on what are some of the big, I mean you've mentioned a number, but what are some of the issues, use cases that you think are kind of emerging that need to really be looked at?

JULIE KNAPP: Use cases -- the reason I pause at that is I think the technology is moving so fast now, trying to figure out what it's going to look like in the next year or two is a real challenge.

I think we have to be careful not to let the perfect be the enemy of the good, because we often get into discussions about what's the right interference protection level; what are the right assumptions we make going forward.

This came out of our TAC, as well as I'm seeing it work its way into the analysis, too, of the sharing with systems, and that's statistical analysis of -- rather than, you know, historically we've looked at things like worst case.

Well, you also need to evaluate, well, what would happen if worst case occurred? Is it a dropped call, which is not a good thing, obviously, but if that were a rare event and the trade-off here is that we had a multi-billion-dollar new service that was deployed -- I think that's the area where -- it's not very glamorous, but it's an area where we often struggle as to where's the right balance between protecting the incumbents and providing for new services to be deployed. .

LARRY ALDER: I guess we'll do one last

question from Paul. Oh, we've got two last questions. We'll let Julie run over a little, because I know we have some time on the agenda on the back end. Let's go with Bryan and then Paul.

BRYAN TRAMONT: Thanks, Bryan Tramont from Wilkinson. So, Julie -- and you actually caused me to ask my question, so I blame the chair. My quick question is we -- Charla co-chaired with Audrey our committee looking at sharing of nonfederal bands by federal users. And we've looked through some MOUs and we have some different models.

From where you sit, how often does that problem, how often has that problem come to you, that is, a federal user looking to use a nonfederal band. And is there anything -- and this is probably our fault that we haven't interviewed you as part of our process (indiscernible). We can now. Exactly. Under oath.

But is there anything that you would give us as a to-do or as you've looked throughout your experience, anything that you've picked up you think we should be looking at that's a real barrier to that process?

JULIE KNAPP: So I think in the past largely that didn't happen. Largely, the federal systems were designed for their specific bands, and we had this kind

of -- even though, even where we had shared spectrum. I think the technology, first of all, could be used for some of the federal applications that's coming out of the commercial sector opens up new possibilities for sharing.

And that could be all different kinds of sharing. It could be shared systems, but I think going forward, when we talked about sharing, and I shudder to put words in the mouth of the federal side, but I think where on the federal side, they say, well, I'm willing to share, but how about the other direction?

And I think there's a sense that they are able to share nonfederal in places that they would not have an impact on the nonfederal users. And so I think we have more work to do on that front going forward, in part because there are places where even if there are separate kinds of systems, we may able to share more effectively.

BRYAN TRAMONT: And just a quick follow-up. In your experience, when the federal users want access to a non-federal band, are they traditionally approaching the licensee, so they'll go to Carl or Charla, or do they go to you and you help them find -- is there match-making component, or is it that you're not necessarily involved per se at all?

JULIE KNAPP: I think part of it is establishing what the ground rules are. Sometimes there's an issue of consistent (indiscernible) with the allocation table and how do we deal with that. And what are the conditions that apply for the sharing.

I think there is a role for both the NTIA and the FCC to play and make sure that framework for sharing is going to work in a way that if there's problems, we've already put everything in place to help resolve them.

BRYAN TRAMONT: Thank you.

LARRY ALDER: Paul.

PAUL KOLODZY: This is Paul Kolodzy (indiscernible). Hey, Julie. You made a comment, which I think is interesting and I want to know what your opinion is. For other people to do additional studies, when we talk about going into the statistical analysis, if you go to the next step and ask the question, we're now living in a world now that where we're getting more of systems of systems, where it isn't just a single band doing a single job for a single user to provide a single service, but generally a group of bands and a group of systems and a group of technologies that are actually combined together to provide redundancies and the like.

Does that actually play into your thoughts

in the sense of some analysis that needs to be done or to be looked at when you're looking at sharing and how you cross these systems and share across a multitude of systems to systems?

JULIE KNAPP: It's a great point, Paul, because, yes, I do think about it. We've gone from the days where we started with a single system -- and if your system got interference, you're out of luck. It stopped working -- to systems that are much more dynamic in their ability to share.

So if I get interference in one spot, the service doesn't drop, it just adapts. But that said, if you take enough hits, your investment in that service comes into question. And I think we're still trying to find our way on how do you take into account when the protections for a technology or a service that might be operating five, six, seven bands -- I mean, I expect with the new spectrum that we're opening up, it's not going to be one band is 5G. You know, they're going to -- the services are going to evolve, so they're operating across multiple bands. And so how do we take that into account when we're doing our analysis?

LARRY ALDER: All right. I'd like to thank Julie. I know we'd all like to thank Julie. It's always a pleasure working with him and his organization,

and they've accomplished a great deal over the last few years. So thanks, Julie. Let's give him a round of applause.

JULIE KNAPP: Thanks.

LARRY ALDER: All right. We have Keith now.

(Audio cut out)

KEITH GREMBAN: -- broadcasting booth. I'm suddenly concerned that the Broncos started their training camp on Thursday. So Julie, Broncos started their training camp on Thursday. What do you think of their quarterback controversy?

JULIE KNAPP: I take the 5th.

KEITH GREMBAN: Okay. So thank you for having me here. I want to talk to you a little bit about how ITS works and tries to do the research to inform spectrum policy. So I'll start out by giving everybody a quick overview of ITS.

Many of you are familiar with what we do, but there's probably quite a few people who aren't really aware of some of the stuff that ITS does. Sometimes I say we're one of the most capable laboratories that nobody has ever heard of.

So moving on to Slide 2, I guess it's numbered, the ITS history. It's actually interesting that ITS has been around in one form or another for 100

years. It started originally as the National Bureau of Standards Radio Section in 1916, and went through a number of evolutions there.

It had a big growth area during World War II, when it was the Inner Service Radio Propagation Laboratory. And then finally it became just ITS in 1967. And then recently in 2014, we also signed a memorandum of understanding with NIST to form The Center for Advanced Communications.

So over the course of that history, many of the standard propagation models that are used by federal agencies or commercial entities were developed at ITS. And we continue our history of developing and upgrading these models and performing the measurements to validate them and continually improve them.

So next slide. We are the principal telecommunications laboratory for the U.S. government. And our mission is to inform policy, so we specifically stay out of making any policy pronouncements. But our job is to do the science and engineering that's needed to inform the policy makers.

And the other thing we do as part of this, is as we're developing the science and technology, we solve a lot of the problems for other government agencies. So we actually get over 50 percent of our

operating budget from other government agencies, doing things like spectrum measurements, interference studies and so on.

So the way we're running at ITS, we reorganized last year and set up a policy where we defined a number of strategic thrusts that are important to inform policy, to take spectrum policy to the next level. And we actually released an internal RFP to our employees for ideas for research projects that would, first of all, align with those thrusts and produce the tools or understanding to, again, educate spectrum policy.

So, in fact, we just released our RFP three weeks ago. We start our first round of reviews next week. And the senior staff get together and look at all these proposals carefully and try to determine, okay, are the really advancing the state of the art. Are they going to produce the tool that we need to answer questions for other agencies. Are they addressing some of these fundamental problems that have been identified by bodies like yours in spectrum policy.

On to Slide 4. So ITS at a glance, we reorganized last year around four key technology thrusts. So the first is radio propagation theory. And Mike Cotton, who you'll be seeing at -- well, you've

seen all of them at ISART. Mike Cotton is the leader of that group.

And that's the group that's really responsible for advancing the theory, for advancing our understanding and our use of propagation models, aggregate propagation effects and electromagnetic compatibility analysis.

Eric Nelson leads our RF measurement group, and they're working on continually advancing the state of the art in measurement both just to inform our propagation models as well as to do interference detection and mitigation.

We started a software engineering division last year because nowadays, in the end, whatever we do is embodied in a piece of software that either we're going to use internally to apply to a problem or we're making available publicly for other people to make use of. And so as a result, it's critical to have the best quality software we can possibly generate because we can't release buggy code to the community.

And then, building on Paul's question and Julie's answer here, we also identified the issue of systems engineering evaluations being critical in moving forward. And so we have a division that's devoted to doing systems engineering, systems of systems analysis,

and evaluation of system performance, including what is sometimes an overlooked area, what is the end-user experience of the system as we evaluate it.

It's one thing to give a bit error rate or a level of interference. It's another to say, what does this do to the user on the other end? So we have got some very advanced capabilities for solving that.

Flip over to the next slide on ITS assets. We've actually got some very unique assets that a lot of the community is unaware of. One of the most unique assets is our Table Mountain facility which is a flat-top mesa about 10 miles north of us. And it is one of only two radio quiet zones in the United States, federally mandated. The other one being the big radio telescope in West Virginia.

And so this facility allows us to make propagation experiments and emissions experiments in a very controlled environment, because, by statute, we can limit the amount interference we have from other systems around us.

And we've got a number of facilities up there to use including a turntable big enough to put a city bus on. So we can do antenna analysis and rotate it and so on, so it's a very robust facility.

Internally, well, not internally, we've got

a number of vehicles that are outfitted with antennas, spectrum analyzers and computer systems that we periodically just drive to various places around the country to address interference problems or just do propagation measurements. And you'll see one of those vehicles if you attend ISART. It's part of our show that we'll, part of demonstration we'll have out there.

And, of course, we've got laboratory facilities ranging from Faraday cages and waveform generators to actually do this user evaluation experience, we have sound-proof isolated booths, so we can exactly control the sound and the interference that's caused and really determine how the user responds to that.

And then, finally, we run our own over-the-air LTE network to do, again, further experimentation with. So we've got a lot of good facilities to work with. Next line I'm just going to skip over since we've already talked about spectrum demand and Julie nicely set up the discussion of spectrum sharing.

And on the next slide, what I want to do is talk about the way we work. So we'll identify a problem like spectrum sharing. And in this case, I would claim there's three -- depending on how you slice it -- three

technology areas that are critical to being able to move spectrum sharing forward and making it more efficient.

First, is just spectrum monitoring. You need to understand what the spectrum occupancy is like, what's available to share, what's not available to share.

Second, you need to understand the propagation characteristics. This involves propagation measurements in various environments and upgrading and utilizing propagation models, so you can understand how much effect one system is having on another at a distance.

And then, finally, you need to have good quality electromagnetic compatibility analysis, because just because one system is hitting another with a certain power level, is that really interfering with the system performance? We need to understand that.

And so we have major efforts going underway in all three of those. And what I'll do next is walk through some of those projects and show you what we're doing in those domains so you get a feel for the way ITS works.

So section heading, let's move on to some of the project summaries. The first project I'll talk about is spectrum monitoring. This is a joint effort

between ourselves, ITS, and our counterparts in the NIST communications technology laboratory.

It's been a very successful collaboration with most of the measurement sensing being worked on on the ITS side and the software database issues being worked on on the NIST side.

So we are working on developing general technology and using our prototypes to understand the challenges and the requirements and help influence the standards as we move forward.

For example, you flip over to the next slide, we have had four stations, spectrum monitoring stations, running 24 hours a day, seven days a week for a little over a year in several locations along the U.S. coasts. The figure represents the data obtained for one month along the West Coast in the 3.5 gigahertz band.

If you look at the top graph, the days of the week are along the bottom axis and the vertical axis is the particular band. And then the strength of the signal in a particular band is shown by a color chart.

So you can see by looking at the top axis, the top graph, it looks like in this band there's quite a bit of opportunity for sharing. Now you kind of turn a band, look at it sideways, and you can see the lower graph which gives you the maximum, minimum, median, and

mean occupancy of that band over the days selected.

And it gives you a little more insight into the opportunities and the difficulties with sharing. So it looks like, if you just looked at the mean and average, there is a lot of empty space in that band.

But, in fact, there are spurious signals that pop up -- very, very high power -- that would interfere with sharing uses. So we have to understand this, and we're running these and doing the analysis and developing more analytics to develop more insight on spectrum sharing opportunities.

The next chart we go into a little our propagation modeling and measurement. Again, it's critical to understand the propagation characteristics of the systems that are attempting to share.

Propagation, of course, is a complex phenomenon, and it's very much affected by environmental factors and especially physical factors like terrain, structures, foliage and so on. The figure is an example of one of the products that we provide, which is a propagation modeling website, which allows users to log on, pick a particular model, a particular frequency band and run it across a terrain model.

So it's working well, but we can get better. If you flip to the next slide, this is a case study of

the problem that we have with our current propagation models. They do well in some circumstances, but there are other instances in which the models just do not work very well. And this is an example.

The top left figure is an overhead view of Boulder. Down at the bottom left there's a little kind of curlicue that ends where we place the transmitter, and that's over there on a foothill, a couple miles to the southwest. And the path on the top left shows you the path of our measurement vehicle driving around the city of Boulder. And the graph at the right shows three things.

So, first, in black, is the propagation power expected, the transmission gain expected using a pure, flat free-space model. The red line is propagation transmission gain expected using the irregular terrain model, the Longley-Rice model. And then the blue spots are the actual measured data.

And there's a significant discrepancy between the measured data and the model. This is something we've got to fix. I could pull out other graphs of other urban areas in which the discrepancy is very small. And we have to understand that.

And so we are continually working to do more measurements and use them to upgrade our models so we

can get better and better agreement and develop a process of measure, model, analyze, measure, model and converge to a point where our answers are good for the spectrum sharing community.

The next line is something that Julie brought up, which is the effect of aggregates of transmitters on the spectral environment. And this is a problem as we put in more and more cellular devices and user devices, how are these going to effect some of the systems like weather radars, air traffic control radars and so on.

So to understand that, we've got to get a handle on how these aggregates behave. So we need to be able to model the populations of aggregates, we need to be able to model the way they transmit, and model the aggregate transmission effects on the other end.

The figure at the bottom left here shows a first order model of a population of end-user devices. We obtained a map of cellular base stations from one of the providers and then randomly dropped end-user devices over this terrain and then associated the devices to cell towers by picking, by running a propagation model, and if there were two towers within five DB of each other, we'd pick randomly an association.

And those associations are shown on the

figure -- you see these hub-and-spoke pieces, and those are the end-user devices connected to the base station hub. So that just drops them down. So now how do they respond in terms of transmission and power?

Over to the next slide. This was a measurement exercise that we did here in Boulder. We took one of our measurement systems and put it at the base of a cell tower and intercepted end-user transmission to the tower and plotted the power of the end user device.

And so your first naive thought is, well, it's probably going to be Gaussian distributed, right? The law of large numbers says that everything turns out to be Gaussian in the end. But you look at the histogram under the Gaussian, not too many of those measurements turned out to be very Gaussian.

And a little more thought, that makes sense. If you turn to the next slide, this was our simulation of that. And what we did for the simulation was, again, we've associated each of the end users with a base station, and based on the distance from the base station, that determined the power needed to reach the base station.

And so if you step back and think about it, is you have these increasing concentric circles of area

of transmitters. The farther out they are, the more area those concentric circles cover, the more end-user devices are in that area, so the more devices there are farther away transmitting at high power.

So the graph, the simulation matches kind of our intuition. It doesn't quite match yet the distribution we're getting from the cell towers. So we're doing a lot more work to try to equalize that and get the right distribution for transmitters. So then we can start computing the propagation effects at distances from aggregates of devices.

Next slide is our introduction to what we're doing in electromagnetic compatibility analysis. You need to understand, again, we've got multiple systems of systems interacting with each other. When do these interaction become harmful?

The figure on the right shows the way these studies are typically done, in particular, with the radar. You have an operator sitting at the radar and you apply more and more noise to the signal and ask the operator questions.

How many targets can you find? How many false targets are there and so on, to get an idea of what this is doing to the operator. And that is incredibly time-consuming. To get 200 data points from

an operator takes two days of effort, and you can't get a good -- you can't get a good distribution that way.

So you turn over to the next slide. The graph at left actually results from one of those operator experiments. So the green is just the baseline performance of the operator. There are two Gaussian noise conditions, which are shown in kind of purple and blue dots. You can see that as you raise the noise, the operator's performance goes down.

I left in the continuous wave interference, which looks like it performs really well, but that's actually because we put the continuous wave in the wrong spot. And that, again, highlights one of the problems with using these human experiments.

You know, you set up something, and you get to the end after spending two days with an operator, and your results aren't even valid because you haven't done the right thing. You need more control over your experimentation.

So we've been putting a lot of effort, jointly funded by Paige's office, on building a simulation to be able to do this interference analysis. And those are the results shown at the right. And in the time it takes to do 200 trials with a human subject, we can run 100,000 trials in the simulator.

And with the simulator, we've, in fact, tracked down some of the difficulties and mistakes with human trials, so that's maturing rapidly now, and we think we're going to be able to make a lot of use of that.

So that's kind of all I wanted to cover you in the brief amount of time I had here. Let me just leave you with a couple of thoughts. Just remember that we've organized ITS around these four core technical capabilities that we believe are the essential pieces to move forward in advance spectrum policy. And that is, propagation theory, propagation measurement, the software engineering and the systems engineering evaluation.

Our research portfolio, again, is reviewed and updated annually. We have multi-year projects, but every year they are reviewed. And if they're not making progress or there is a higher priority, we drop that project and move on to something else. We have to do that. The state of the art is advancing so rapidly, we can't keep doing the same old thing. We have to adapt to things as we move out.

We're targeting challenges, obviously, things that we have to have immediately to support the current work that the FCC and OSM is doing, as well as

challenging the engineers to think 5 and 10 years out. What are the things that we have to be working on now so that we'll have the tools in place in five years.

And then we're focusing as much as we can on foundational research and the development of these tools that we can make use of in the future. So that's all I wanted to cover. That was a lot. Questions?

LARRY ALDER: Yeah, thanks, Keith. Questions? Dale.

DALE HATFIELD: Putting that TAC hat on just for a moment -- oh, I'm sorry. One of the issues that we're dealing with is not aggregate interference from intentional sources, but unintentional radiation and incidental radiation and so forth and the proliferation of all these type of devices. I won't mention grow lamps here in Boulder.

UNIDENTIFIED MALE: (indiscernible) more interference, but people don't care.

DALE HATFIELD: ITS historically has done an awful lot of work in the noise area, and the TAC recently did something fairly innovative -- issued its own notice of inquiry. It's not an FCC notice of inquiry, but the TAC is asking for information on these sources of noise.

And I'm just wondering what you're doing in

the sort of issues surrounding noise floor, and is anything -- I'm going -- of course, it gets the aggregate interference issue there, too. We had some recent meetings with interference hunters, people that do this professionally, and some of the things they're turning up is where they have multiple interfering digital devices that aggregate would cause interference. I'm just curious if you're continuing that area of research at ITS.

KEITH GREMBAN: Yes, we're continuing that in a couple of forms. So first of all, that's one of the end-user scenarios or end-user applications that we're looking at in the spectrum monitoring domain, but also in our Boulder testbed that we're working on.

That's going to give us the opportunity to set up a lot of sensors over a significant geographic area running 24 by 7, so we can gather good statistics on noise floor and start running experiments on how do we detect interferers of various types, what's the density of sensors we need and how accurately can we determine that.

DALE HATFIELD: Thank you.

LARRY ALDER: Go ahead, Jennifer.

JENNIFER WARREN: Jennifer Warren. And I'm kind of going to build on what Dale's question was

because it's about interference as well. You, in the beginning -- excuse me while my back's to you because of the microphone (indiscernible) --

KEITH GREMBAN: Sure.

JENNIFER WARREN: You know, you indicated in the beginning that one of the roles of ITS is to do the hard technical work to inform policy making. And aggregate interference is clearly one of those areas there's a dearth, I guess, of technical expertise built up for policy makers to make decisions in this area.

So what is your timing? Because there are a lot of decisions that are being made and/or looking to be made where this has been an issue and some real concrete substance for the policymakers would be really helpful.

KEITH GREMBAN: Wow, that's putting me on the spot there. Yeah.

JENNIFER WARREN: (indiscernible).

KEITH GREMBAN: Obviously, as soon as possible. As always with scientific research, it's a little difficult to put a hard timelime on it. We've been working the aggregate population problem over this past year.

So next year, it's going to be applying that and trying to attack and come up with models of

propagation so we can start answering some of those questions. So, hopefully, over this next year, we'll have the beginning of some answers for you.

LARRY ALDER: Steve and then Eric.

STEVE SHARKEY: So mine's maybe a little bit different. So this is the first time -- I didn't realize you had like the audio and visual user experience evaluation capabilities here. And, you know, you note the increasing demand for band width for things like video.

Have you done any work on looking at how to evaluate the efficiency of systems, where, help manage the efficiency of systems by matching the data transmission to the kind of capabilities of devices? Like, so, for instance, a small device 1080p or as we go to, you know, 4K video doesn't make a difference from a user perspective, but use a lot of data.

So have you looked at evaluating user perception that changes based on the size of the device the impact that has on the amount of data required and the potential, you know, difference that would have on, you know, spectrum demand, demand for more capacity?

KEITH GREMBAN: So, yes, we have. There's a couple of NTIA technical reports from last year and this year addressing that issue of user perception for

different quality of display and size of display.

Additionally, we've got a project going now in conjunction with the NIST PSCR laboratory on looking at ways of evaluating the video, the raw video, and determining how well it can be compressed to meet certain user requirements.

LARRY ALDER: Mariam.

MARIAM SOROND: Thank you. This is Mariam from DISH. I know that you do a lot of good work in the propagation and all these areas, and one particular area that we see is the standards work.

So I was wondering -- and from what I can see right now in the standards (indiscernible) is mostly related to public safety requirements. Did you have any plans of increasing or expanding this into other topics or other subjects besides just public safety?

KEITH GREMBAN: Thank you. So we have a significant standards operation in public safety, but we also have support, do a lot of work with the ITU on standards with for RF propagation models, as well as, I think this morning we're hosting an I triple E standards meeting.

I'm sorry. I'm used to standing at the front the and talking out. We are also hosting a meeting of I triple E, what is it, 802, dot, 22, dot 3,

which is standards for spectrum monitoring.

MARIAM SOROND: Oh, sorry. Maybe I should -- I was particularly talking about 3GPP. I should have clarified that. I know you do a lot of good work (indiscernible) --

UNIDENTIFIED MALE: Oh, (indiscernible.)

MARIAM SOROND: Well, because, you know, as it relates to sharing and everything, there's perhaps maybe opportunity there to comment (indiscernible) for enabling technology sharing concepts (indiscernible) a lot of things that you're working on.

So the 3GPP, I think, is mostly focused on public safety and I was wondering if your were planning on expanding that one.

KEITH GREMBAN: So we are expanding a little bit, in particular the internet of things is one of the areas that we are getting involved in the 3GPP standards body.

LARRY ALDER: Okay. Let's -- I think we're running out of time, so we'll do Rick. Did you have one? Okay, Dennis and then Paige had one last comment.

RICK REASER: This is Rick Reaser. So this is a parallel to my question to Julie. I notice you had talked about IPC, and that's sort of looking at the interference protection criteria for existing systems.

Have you guys thought about creating standards for future systems?

I know this gets into the receiver standards world, but I just think that that's something that ought to be looked at in terms of what kind of future interference protection criteria ought to be out there as new systems are being developed so that we build systems that are a little more robust to interference and other types of things like sharing. So I wonder if you have thought about that at all.

KEITH GREMBAN: Actually, the issue of determining, this is the standard, that, I would say, is a policy issue and we would stay away from. What we will do is develop the tools and the methods that can be used for people to experiment with interference protection criteria and determine the number that the community agrees on.

LARRY ALDER: Dennis Roberson.

DENNIS ROBERSON: This is Dennis Roberson, and I'm going to channel a question from the wizard meeting this morning from Tom Taylor. Tom's concern was that we're really running short of radio engineers and with all of the things that are going on that Paige talked about and that Julie talked about, that this is, there's a significant amount of work to be done out

there.

But, in your instance, from National Academy study we conducted earlier -- well, I'll let you respond. Do you see the issue being lack of skills or lack of money to be able to proceed to address all of the challenges that we've been talking about this afternoon? I said it was a loaded question.

KEITH GREMBAN: I look over to Glenn for --

DENNIS ROBERSON: And I'm going beyond -- I'm trying to get your perspective. I'm not really addressing ITS per se. This is not a lobbying for more for money for ITS, though I'd be happy to do that.

This is, in fact, more looking at the generic issue in the context of what Julie and Paige have talked about with the things that are going on and all that new spectrum that Julie just made available to the world and propagation models that we're still not happy with and all of the things that you just talked about, too.

KEITH GREMBAN: So we are unable to address all the problems we think we should be addressing. We have to prioritize. There just isn't a budget for it. That said, we could do more with more resources, but there is a problem in finding qualified personnel.

We've been putting out a lot of job reqs

this year. And it's not been easy finding good radio engineers, and what's even harder, and I say this as an embarrassed computer scientist, it's very hard to find software people now with the mathematical and physics background to be able to do the work we do. And so there are interacting problems there, and we're having to look very hard to find the right people

LARRY ALDER: All right. Let's everyone thank Keith. I'm going to turn it over to Mark. He's going to walk us through the next section of the agenda.

MARK GIBSON: Okay. So now we're at the fun part where all the subcommittees will do outbriefs, but since we did most of the outbriefs at the last meeting, this is just really going to be checking in to see if there's anything different from before.

So we'll start with bidirectional sharing. I know you guys had a little bit of work you did, so is there anything you wanted to update?

CHARLA RATH: The only update is the paper that we did which was distributed to the full committee a couple of weeks ago. We didn't get any comments back on it. No changes to the recommendations that were approved in June.

The only thing, the only couple of things I wanted to mention was first to thank the subcommittee,

because there was an awful lot of work that was done. And, you know, I always you feel a little bit of risk when they call out particular names starting with my subcommittee co-chair.

But I have to say that Bryan did the initial drafting on the report so really appreciate that and then Jennifer and Mark, Steve and probably Janice and a couple of other people were really involved in getting that paper done. So we do appreciate all the help and everything that people did.

We will -- Janice actually provided the whole group some of her thoughts, many of which came out of this. I assume we'll talk about that later. The other thing that we had talked about as a group was just, you know, one of our recommendations was this workshop.

And clearly, you know, a very obvious next step for this group or some other version of this group to take on would be to truly outline what a workshop would look like. But that's it, and unless there are any questions, I don't want to really take up anymore time. Audrey, I don't know if you have anything.

MARK GIBSON: Okay. Thanks, Charla. Any questions for Charla or Audrey or anyone else on the subcommittee? Okay. Good. Thank you, guys. That was

good work. I monitored as much of it as I could, but very good work.

CHARLA RATH: I should have said thanks, too, to Mark Gibson, because you were on almost all of the calls, and I know you were also on all the rest of the subcommittee calls and I don't --

MARK GIBSON: My life is CSMAC.

CHARLA RATH: Yeah.

UNIDENTIFIED MALE: (indiscernible)

MARK GIBSON: At 3:00 in the morning. Yeah. Sometimes they overlap. Then there's this thing that Julie waved the flag on which was WInnForum. That's kind of been taking some time, too.

So, anyhow, the next one is Agency and Industry Collaboration. Steve, anything on that?

STEVE SHARKEY: I don't think so. I mean, it was considered at the last meeting and approved, so I don't think there's anything more to --

MARK GIBSON: There was a revisit of the recommendation, but I think we tweaked that appropriately, so I think it's pretty much all good and all done, so, yeah.

STEVE SHARKEY: Right.

MARK GIBSON: Good. Measurement and Sensing, Dennis and, um --

UNIDENTIFIED MALE: Paul.

MARK GIBSON: -- Paul. I was looking at Steve and I couldn't remember --

UNIDENTIFIED MALE: It's tough getting old.

MARK GIBSON: It's what happens when you spend all your time at CSMAC. Thanks, George.

DENNIS ROBERSON: Following in line with Charla's lead on this, we'll do kudos do to the team and to my counterpart, my co-chair, Paul, for all of the really good work. I will highlight our liaison as being really an extraordinarily valuable member of the team, so Ed (indiscernible), you know, special kudos to you.

Ed has such a depth of expertise in this area that often we found ourselves debating something and then asking Ed to give us the answer. So it was a very helpful contribution. But significant contributions -- as many of you know, we were able to create a catalog of the uses of the spectrum in the 5 gigahertz range.

And hats off to Rick and one of the members of his team. They did a great job in sorting out some of the items that Julie talked about, some of the uses of that 5 gigahertz spectrum that are so difficult in the lower, the 2B part of the U-NII band. And 5.9 has its not only technical but political challenges as we

all know with the Intelligent Transportation System.

And then finally, the one-size-fits-all commentary that we continue to beat the drums on with the fact that there are many different measurement systems. We often think about this as the measurement system. Well, there isn't a measurement system. There are many different architectures that are appropriate for different environments. And you have to match the measurement system with the thing that you are trying to measure.

So those are some of the key observations, and I'm going to pass it to Paul to talk about the results of the actionable recommendations that we made.

PAUL KOLODZY: (indiscernible). So two things that we did. One, is we actually -- I think Rick actually put together a nice little tutorial -- not a tutorial, but an outline on how to look at recommendations and the prioritization of recommendations. I'm not going to go into detail in the meeting here, but it's in the final report, and I think it actually gives you some of the things to worry about.

We have one issue that I think that we have a recommendation that we discussed last meeting. We didn't get really any feedback until this morning. We had one call.

DENNIS ROBERSON: We had a good call.

PAUL KOLODZY: And so I think I'll leave it up to the chairs as to -- we haven't vetted (microphone feedback). We haven't vetted it -- anyway we haven't vetted it with the committee, so I don't know how you chairs want to actually address that issue. That was with Recommendation No. 5, which is the detection augmentation techniques. So we'll leave it up to the chairs to determine what we should do there.

MARK GIBSON: Well, I'm looking at it right now. I mean, you guys had a -- in realtime -- thank god for cell phones -- I mean have you had any chance to discuss it amongst yourselves? Okay. But you had a call, right?

UNIDENTIFIED MALE: Oh, we talked a month ago. One of us took it to do to write up based on the call.

LARRY ALDER: Wouldn't it be appropriate just to attach a note?

MARK GIBSON: Yeah, I think we're going to do that. I mean, I'm looking at it -- it's not my committee, so I'll let you guys deal with it.

DENNIS ROBERSON: The difficulty is we had an approved recommendation.

MARK GIBSON: I realize that. The question

is does this significantly change it to the point where it would need to be revoted? I'll leave it up to you guys. I haven't had a chance to look at this because I got it while we were in the Wizard meeting. So -- go ahead, Larry.

LARRY ALDER: My read of it is it does not look different. Attach a note -- I think that's the --

MARK GIBSON: Yeah.

UNIDENTIFIED MALE: Okay. Well, we'll figure something out.

MARK GIBSON: We've done that in the past where you attach a note and just refer to it that way. But I want to go back and read it just to study it a little bit.

BRYAN TRAMONT: (indiscernible)

MARK GIBSON: No. No. That's the other thing.

UNIDENTIFIED MALE: It came in during another meeting this morning.

BRYAN TRAMONT: No, I understood, I just didn't (indiscernible) what you were talking about.

LARRY ALDER: And that's the other thing. It was just sent to, yeah, four of us, so --

PAUL KOLODZY: Okay. And then we have some recommendations about moving forward, but I don't know

if you want to do that in the other session --

MARK GIBSON: We'll do that in the next session, yeah. Great, thanks

PAUL KOLODZY: -- (indiscernible) worry about that.

MARK GIBSON: Great. Thanks, guys. Spectrum Access System International Expansion -- I see both Kurt and Jeff.

JEFF REED: Yeah, we wrapped up our report and just made some minor tweaks to the recommendation based upon the feedback that we got at the last meeting. And I want to thank the committee members and my co-chair here for their great work. Kurt, do you have anything to add?

KURT SCHAUBACH: Yeah, I just would echo Jeff's comments. Thanks to all for their contributions and, yeah, I don't think there's anything else to really add to the report. As Jeff said, we just tweaked some of the language associated with the recommendations. The recommendations themselves remained unchanged.

MARK GIBSON: Did that tweaked language go out to the whole committee?

KURT SCHAUBACH: It did, yes.

MARK GIBSON: And so basically it was just clarity?

KURT SCHAUBACH: Yes.

MARK GIBSON: Okay. I remember that from the last meeting. Any questions? Okay. Good. Finally, 5G, Mariam and Rob.

ROBERT KUBIK: Sure. I'll kick it off. As others said, thanks to the committee for working in this group. I think we had a relatively active group, good contributions. I'd like to thank the liaisons, Rangam and Bob. They did a great job of helping out and keeping us on track.

Finally, I would like to thank Mariam. She did a great job of providing a lot of the text and editing and a lot of her input's within this document. Since the last meeting, we had circulated the full report that we had talked about. It's a 33-page report, a lot of background material. I don't think we received any comments or suggestions based on that report.

Also, at the last meeting, I think the key comment that we had back is that we wanted to have some more pointed direct recommendations on actions that we could take to move forward. And I'll turn it over to Mariam to address those changes.

MARIAM SOROND: Okay. Thank you. So we actually, out of the six recommendations, I think there were three of them that were voted yes, and three of

them we said we would revise. What happened is we ended up revising all six of them just to make sure they're more actionable.

And, essentially, a lot of, you know, these discussions when we'd have the brainstorming, sessions we would come back and look at it. But with support again from Rangam and Bob and understanding exactly what is actionable, we -- the recommendations now -- on the first one, if you look at it, it's looking at, you know, defining these three sort of -- well, prior to the recommendations, we called out the 5G unique attributes.

And I know I've said this a couple times, that this is so far what the commonalities that we can find are. Obviously, 5G is evolving and as we move forward, there will be a lot more unique attributes, and if you get into the details and the weeds of things, there will be further more attributes that you can find that are unique.

But at least we know for these ones that we've identified, they're not going to change at least, while everything is changing, as they're defining the waveform and other requirements for 5G. So, so far, these attributes really helped with the recommendations.

And the first three recommendations, which I'm going to group together, are really about just

specifically what the deployment scenarios and the unique things about the technology are.

So the actionable stuff really at this point is, we are recommending that the NTIA actually pursues sort of an industry collaboration, an industry agency collaboration to define these and move forward on it. So I think that's where, you know, these collaborative agreements, as we heard today, will help facilitate these early sort of concepts that might help with sharing.

And not so much, you know, as Julie and everybody else talks about, is that we look at it after it's defined, but really pre-definition, we take these, the NTIA sort of takes these steps to, whether it's through CSMAC or other areas but to create this collaboration to be able to see how this will impact sharing.

Now, we didn't, you know, identify any bands over here, and as part of the next session, we could look at the different bands. We could take the 37 gigahertz band, for example, as one of them or even an already-existing band like 1695 to 1710, you know, also is part of going forward and moving backward, like you said earlier, to double-check if that process with 5G should have any sort of considerations that fall under

these categories. So those are really the first three recommendations.

The fourth recommendation is about exactly this whole, you know, baseline assumptions that we've been talking about, you know, on probability aspects, that again was hit earlier today, on worst-case probability aspects.

You know taking that and defining sort of a new look at the baseline assumptions. Again, that does fall into this multi-stakeholder collaboration process. That is going to be the recurring theme of actionable at this point.

Recommendation 5 is really this upgrades to technology, both on the federal and the industry side. So groups like -- you know, on the commercial side, 3GPP is already defining these standards. So that is a place where this sort of early intervention, so called, would help.

Then on the agency side, there could be also opportunities for these kinds of groups. But this time, you know, in lieu of not being able to pick one particular place, we really picked 3GPP and hence the questions about how does this 3GPP membership work.

We know that the Department of Commerce has a 3GPP membership. They're focused more on public

safety issues, but we're really calling out a collaboration between the NTIA and the FCC for this, to be able to move this forward as to, for example, as of right now 5G waveform is still not defined. So there could be hooks right now place in there that allow for better sharing, a little better sort of technology accommodation of sharing. So that's Recommendation 5.

And, finally, 6, I think, was the one that was the least amount of change, and it was identified as one that could happen. It is about propagation modeling. It's really, you know, propagation modeling of all the bands, and we are actually recommending that immediate resources be allocated to this to move the work forward. Because as we heard today, it takes time to get the propagations. You don't want the train to leave on a lot of these things and the propagation work not being there. That's it. Thank you.

MARK GIBSON: Okay. Thanks, Mariam. Remind me, which of these -- these were all approved last time, though, right?

MARIAM SOROND: Three of them were.

MARK GIBSON: I forgot which ones.

LARRY ALDER: (indiscernible) she said (indiscernible) all of them (indiscernible).

MARK GIBSON: We're just going to do the

whole thing, just do the whole thing again. Is that okay with everybody, especially you guys? Okay. So should we take them as a whole, all of them? Is there any -- well, has anybody had a chance to read them?

UNIDENTIFIED MALE: They were circulated.

MARK GIBSON: They were circulated, yeah. So are there any questions? All right. So is there a motion to approve all of them as they stand? Second? Any further discussion? All approve by saying Aye. All disapprove by like sign. I got up at 3:30. Okay. And any abstentions? Okay. That was easy. Okay. So that's it. Thank you, guys. Yeah, right. I'm afraid the people -- can the people on the phone hear?

UNIDENTIFIED MALE: Don't ask. No.

LARRY ALDER: Mark, I just wanted to make a comment that I particularly found the report generated by the 5G group very useful. It's something I'm sharing with other people -- hey, this is something you can really look at to see what's going on. So thank you.

MARK GIBSON: You should publish that bad boy and --

CHARLA RATH: Yeah, just a quick comment. I just sent it to the (indiscernible) on the same issue.

MARK GIBSON: I hear Janice. Go for it, Janice -- two minutes from now. Janice, you're on. Go

ahead. Janice, are you listening?

JANICE OBUCHOWSKI: I am, but I don't have anything to say. You were just asking --

MARK GIBSON: We thought you had a question.

JANICE OBUCHOWSKI: Oh, no, no, no. I'm -- for once, no, nothing.

MARK GIBSON: All right. Well, at least we know you're there.

JANICE OBUCHOWSKI: I'm alive.

MARK GIBSON: All right. Thanks. I'm just going to stay on this (indicating the hand-held microphone). So that's it. It's approved. Rick?

RICK REASER: I just wanted to second. I thought that report was excellent. I passed it around. So that was a very good piece of work. I have one other observation. Why is it that DISH and Samsung don't have echo like Raytheon and T-Mobile do?

ROBERT KUBIK: We're better coordinated.

UNIDENTIFIED MALE: (indiscernible) in the spectrum.

MARK GIBSON: All right. Let's move this along. I think they turned the gain up on these so they can hear them on the phone, but I'm going to use the hand-held. Okay. So I think we're -- okay. Go ahead. You want to use that?

(Mr. Gibson gave hand-held microphone to Ms. Atkins).

PAIGE ATKINS: I just wanted to thank the 5G subcommittee for continuing to tighten the recommendations and create a great document, as others have said, as well as helping us have something we can take hold on and do something with as we look at our response to the recommendations. So thank you.

MARK GIBSON: So I think we're done with the committee outbriefs, so, yeah, unless anybody has any other comments, anybody on the phone other than Janice? Well, Janice, you can comment, too, if you've got one since five minutes ago. Okay. So, Paige, you have -- you want to use this?

(Mr. Gibson gave hand-held microphone to Ms. Atkins.)

PAIGE ATKINS: Okay. So we're going to speed up here significantly as we head toward the afternoon. That will give us more time to talk about ideas for the next term of CSMAC and have that brainstorming session that we talked about.

So the original intent of my session to give you some preliminary views on the subcommittee recommendations has changed a little bit. Last December, I presented NTIA's initial response to and

planned actions to address the recommendations from the last cycle.

And we have actually made some significant progress in many of those actions, some which are related to perhaps what we will want to look at on the next cycle to include things like, from an enforcement standpoint, what did we learn from the Terminal Doppler Weather Radar (indiscernible) license interference cases.

So we're going through that case study, as we mentioned, as an action. So we will learn things that we can also integrate as we think through what the next set of questions will look like.

Now, due to the complexity and timing of these recommendations, we really haven't had the kind of time and due diligence to peel these recommendations back and fully understand what we're going to do with them. But we have started looking at them.

And as we've talked about with previous recommendations, we really need to digest and decompose them, so we can make the right decisions of where we invest resources and the sequencing of those resources.

And I do want to thank folks for taking a look at priorities within the subcommittees and also that taxonomy, so to speak, of how we would define those

priorities. I'd like to look at that for potential guidance into the next term, so we can shape how the subcommittees look at their recommendations.

So, again, today the discussion around our response will be very limited. We've started looking at the recommendations to determine, first and foremost, do we concur with each recommendation and how actionable it is. What can we do with it. How they may be related to prior CSMAC recommendations. Because there is some interrelationship in many of those, and how those interdependencies manifest themselves with prior actions,

And then what actions NTIA would propose, based not just on the recommendation, but how they align with our strategic priorities within NTIA and particularly from a spectrum standpoint. And then, ultimately, we will identify, as we did last time, those actions that we will move forward with, based on the never-going-away caveat, resources of both money and people, as well as evolving priorities.

Because as we've seen, as I mentioned with the PCAST report four years ago, how much has changed. You know, our landscape will change over time. So we'll continue to revisit and reprioritize, if needed, as we move forward to respond to the recommendations.

And so our challenge is to continue to digest and decompose the recommendations and identifying what we would all call the important trends, interdependencies, and actions that can collectively help us move forward to address some of the most significant spectrum challenges, not just from a technology standpoint, but, then again, that intersection with technology or with policy process and regulation, which is really key to making all of this work and work well.

So our assessment will inform the future topics. Unfortunately, we don't have that here today. But we will certainly be listening to the discussion this afternoon. I hope it's a robust discussion in terms of your thoughts. And think of it as a brainstorming session, as was mentioned earlier, and somewhat open-ended, but remember we are being publicly webcast.

And what I would ask as we have this brainstorming session, is to think about potential topics that we've talked about before for potential collaboration with the FCC TAC, as an example. Other topics may be, also, more appropriate for other forums. They may not be CSMAC topics, but as we build this more robust and expansive collaboration mechanism or things

like WInnForum, we may want to toss topics to other activities.

And then, again, we will also be capturing some lessons learned, like this taxonomy for prioritization and how can we have used those lessons learned from this cycle to better shape how we move forward in the subcommittees.

And I will say, don't let perfect be the enemy of the good, and we're looking for ideas. And I will open it up to any questions you might have as we've begun to look at these recommendations. But, as I said, we're really just now still going through and peeling back the recommendations and how we should best respond.

So we've got all this extra time for the brainstorming session, so I'm looking forward to the discussion.

LARRY ALDER: So I thought what we'd maybe do is start off by going through recommendations for the different subcommittees that wanted, that thought future work was appropriate, because I know there was definitely some around the sharing the federal and nonfederal spectrum. So shall we do that to kind of kick things off and then we'll go from there?

MARK GIBSON: Yeah.

LARRY ALDER: Charla, I'm looking at you.

CHARLA RATH: Yeah, and I've already mentioned the one that we talked about as a group, which was literally to map out the workshop that we had recommended. And then Janice, who we all know is on the phone, did actually send to everyone, but I wasn't sure she wanted to just, you know -- but if she wants to sort of talk about it or present it, it was not the group's recommendation, but I'm sure that several of us would agree with parts of it.

MARK GIBSON: Hers were multijurisdictional.

CHARLA RATH: Yes, well, that's true, too.

LARRY ALDER: Janice, would you like to walk through your suggestions? Janice, are you there? I'm waiting 10 seconds.

UNIDENTIFIED MALE: She sent it to all of CSMAC.

CHARLA RATH: Yeah, she did. She sent it --

UNIDENTIFIED MALE: Yeah, but it was yesterday --

UNIDENTIFIED MALE: Or three days ago. Today's the 1st --

JANICE OBUCHOWSKI: Okay. So this is going to be a little unusual. I'm going to turn off the feedback, so you'll just hear me. I'm not sure, you know, if we'll have this time lag here.

Sure. I'd be happy to. You know, I had two generic ones, although they go to two-way sharing, you know, importantly. One was on the topic of general incentives. You know, sharing is the name of the game. We'll be, I think, (indiscernible) increasingly going forward given the plethora of demands for spectrum.

And, you know, a lot of the discussion historically at CSMAC has been about financial incentives for sharing. But as a general matter, I'd be interested in hearing more across several topics of potential other levers.

And some of these have come up already, but in my view could use further amplification -- shared access to technology perhaps. The ease of access to the spectrum is another incentive at times for sharing, of course.

The second sort of generic that I have which pertains very importantly to federal commercial spectrum, and it comes up -- I know it's controversial. It came up in the Spectrum Frontiers proceeding. And that is the issue of cyber security.

I'm not sort of ascribing -- I'm not specifically talking about Spectrum Frontiers, but the reality that is inescapable is that access to networks, access to technology, in general, is -- you know, it is

increasingly a terror weapon; it's an economic weapon; and we've heard it said to be a political weapon.

So, you know, that notion is not going away, and it is inevitable in the sharing context. I don't think we can escape it. We don't necessarily have to resolve how we address the cyber issues, but they have to be raised, and they have to be directed to someone.

Because I think it's irresponsible to talk about sharing and the sorts of databases and sharing technologies that we would support if we don't flag cyber issues that need to be resolved simultaneously. If you don't flag them, you do something that I think, you know, I've seen at least the beginnings of at times. It's sort of a runaway solution that doesn't flag a key strategic problem.

And that, of course, comes up most readily in shared commercial, federal. But it could be across the board, or it is across the board. And then, specifically, the bidirectional sharing -- I don't want to belabor the various points that I raised in the memo.

I think, Charla, of course, raised the key one, which is making sure that the workshop gets off the ground, and that it's needy and that it's timely. It's obvious, you know. Three years ago, nobody was talking about commercial (indiscernible) wireless

(indiscernible) access to high band spectrum. And now it's already, you know, well down the regulatory path.

So if we can't put this workshop together quickly and in a needy fashion, it's going to be an academic exercise. I was specifically concerned that it wasn't -- you know, I had made a recommendation that this not be a workshop, that it be perhaps an MOI or a NTRM between the two agencies, federal and NTIA, that wasn't ascribed to in the broader group, but I do think, you know, time is of the essence.

A lot of bidirectional sharing is focused on areas around military and other federal properties. Going forward, this topic of geographic bounding has to be revisited. That's critical for certain kinds of testing. It's not going to be central to the development of robust bidirectional sharing.

Sharing templates, I think we made a lot of progress in our committee talking, for example, about the model MOU that has been advanced. But I believe that Julie, who is always intellectually honest, alluded to the fact that, you know, in response to the question, that now that sharing between federal and commercial is more important, more necessary, given conflicting spectrum demands, there is just not an easy way forward for federal users to access commercial spectrum. And at

times vice versa.

It's encouraging that, you know, both the NTIA head and Chairman Wheeler have raised this. But to go from there to developing technologies and getting them through the process where with the steps really aren't easily understood or easily promoted are just obviously not going to move the ball forward.

And then the last recommendation I had for consideration going forward, and this is (indiscernible) NTIA, but it would be at least equally applicable to the FCC -- how to handle high-volume requests. Obviously, you can't build a commercial network without getting a license and that license entitles you to deploy in a very robust fashion.

Well, in a sharing if you're operating in onesy, twosy fashion, well, those are good for trials, maybe good for testing. It's not good for development of dynamic new technology. So that would be my sort of fourth suggestion on bidirectional sharing.

So that covers the topics that I wanted to raise and I appreciate you bearing with me, especially given the call-in. And thanks for that.

LARRY ALDER: Thanks, Janice. I don't know if you can hear our feedback, but we did hear your presentation, and it was very helpful, and thank you.

And Mark is now trying to, going to capture -- he is displaying stuff and he'll try and capture some of this dialog. The next subcommittee that I knew had suggestions -- oh. Go ahead. I don't know if she's interactive or not.

PAIGE ATKINS: And so, Janice, you may or may not be able to answer these, but just to clarify the high-volume request, if I understood it, is really how do you enable dynamic sharing between federal and nonfederal users that would require a much higher volume of interaction and coordination.

JANICE OBUCHOWSKI: Yeah, I think that's a better statement of the situation.

PAIGE ATKINS: Okay. And then I just want to highlight that what I would suggest as we think through key areas that we need to focus on as we move forward, again, remember CSMAC may or may not be the best vehicle.

The last cycle we talked about this multilayered collaboration framework that we are fleshing out as we speak. And there may be good strategies of how we address some particularly relevant and important topics, just not through CSMAC. Partially, quite frankly, maybe due to time lag or other things where we want to be more responsive to the topic.

So I just want you to think about that as we talk about these future issues.

JANICE OBUCHOWSKI: Paige, I think you're absolutely right on the money there. And, you know, you mentioned CSMAC-TAC cooperation going forward. Of course, Dennis is on both and leads one of the groups. I would certainly endorse that, because, you know, it's been stated, I think it's inevitable that CSMAC is delving deeper and deeper into technical issues.

You know, policy and technical are sort of interwoven, because you're always talking about the art of the possible when you're making policy. So I think that dialog -- as somebody mentioned, there's a shortage of -- there's a shortage of -- there's not a shortage of experts, but there's a shortage of time and, you know, breadth of expertise. And, you know, working on parallel tracks is a good idea. Much more tight collaboration I think would be terrific.

LARRY ALDER: So I see a number of tents up. So what I want to do is avoid spending a lot of discussion on particular topics. I want to make sure we just flesh out the ideas. So real quick, are the tents for ideas? Because what I wanted to do is I wanted to walk through the different subcommittees first.

CHARLA RATH: Yeah, one thing I wanted to

add to this. I thought about it when Julie was saying what are the reasons for bidirectional sharing, and I'm wondering, I'm not quite sure what it is, but the idea that there may be technologies where we need to be thinking about jointly developing technologies to actually to help implement sharing.

And we did that a fair amount. There was a lot of that in AWS-3, but I'm wondering, and I'm not quite -- you know, I just throw it out there. When he mentioned it, I did think, you know, that that might be a good topic for the next iteration, if there is one, of bidirectional sharing. I'm not quite sure what it is yet, but it just strikes me that there could be some additional work.

LARRY ALDER: Let Mark capture it here. What would he --

CHARLA RATH: Yeah, you can capture it, Mark.

MARK GIBSON: (indiscernible)

CHARLA RATH: Not good for the person taking notes. Yeah, let me see if I can do it more succinctly. Julie brought up the idea that one of the reasons that the federal government is particularly interested in bidirectional sharing is the ability to sort of use the technology development that's going on in the commercial

sector to develop, you know, more services in the federal government that can actually use the same sorts of technologies.

But I've always had a question about what does that really mean, because, you know, you've got different missions, you have different -- you know, how applicable is that? And I'm just wondering if there is something for us to be talking about along those lines.

LARRY ALDER: So it's kind of a technology question around federal and non-federal --

CHARLA RATH: Around federal sharing and how real is that. I mean, that is something that we talk about a lot and how real is that, and is that something that CSMAC can make recommendations on for NTIA to take action on.

PAIGE ATKINS: So I would -- actually, I would -- how I think of it is how do we leverage dual use technologies to enable federal and nonfederal sharing.

CHARLA RATH: Is it leveraging dual use, because we're not even sure yet whether -- you know, it's almost exploring whether --

PAIGE ATKINS: Well, I'm thinking you have to explore it to understand how to leverage it.

CHARLA RATH: Yeah, true.

PAIGE ATKINS: I think as we look at Frontiers, many of these topics are directly relevant to Frontiers, so I think as we look at the topics, we may want to tie it to something like Frontiers that allows us to focus it in the process.

LARRY ALDER: All right. I'm going to --

MARIAM SOROND: Can I make just one comment? About the -- that's what we were trying to do in the 5G just to clarify, that's actually the recommendation (indiscernible)

LARRY ALDER: I'm going to move to Michael because he's had --

MARK GIBSON: Charla and Paige are saying the same thing more or less so (indiscernible) --

LARRY ALDER: Yeah. I don't think we really (indiscernible) wordsmiths here. It's broad concepts at this point. Michael.

MICHAEL CALABRESE: Yeah, and I just wanted to add on to -- I hope this is an add-on to support for what Janice said, rather than have to bring it up again, you know, separately, later.

So Janice mentioned, I thought it was when she was talking about the high volume requests and the need to, you know, signal to agencies that this is possible and to reduce the friction in federal users and

NTIA getting access, and that is that it might be very useful as a continuation of bidirectional sharing to look at whether there isn't a framework for at least temporary and nonharmful access to any band for federal agencies.

And what would be the framework for that, what would be the mechanism? Is it a geolocation database or a leveraging of one of the existing ones such as the SAFS, because the PCAST report essentially said that that should be the case, that federal agencies should also be able to do that.

And I think we haven't really addressed -- we keep sidestepping, kind of, the direct question of, at least in this sort of, in this kind of easier case of temporary and nonharmful sharing, is there a workable framework for doing that, which would, I think, get at some of the high-volume, reducing-the-friction kind of ideas.

LARRY ALDER: (indiscernible) for any band -- I'd put that. You're up, Jennifer.

JENNIFER WARREN: Jennifer Warren. Just to follow up on that -- I'm going to save my new ideas for later. The question, though, if folks want to do what Michael was suggesting, I think is looking at least what we did two CSMACs ago in the first iteration of the

bidirectional sharing group, which was kind of looking at short-term, nonharmful and what were the criteria, and it's almost you're talking about, I think, implementation of the prior report, is kind of how I'm interpreting what you're saying, Michael.

MICHAEL CALABRESE: (indiscernible)

JENNIFER WARREN: That's what I mean, yeah. So just to throw that out there.

LARRY ALDER: Got that? Okay. One of the other subcommittees that had, I know had a suggestion for future work was the sensing subcommittee, and it's great Dennis is just walking back in.

(indiscernible comments)

PAUL KOLODZY: Okay. No feedback. There are three basic recommendations or actually suggestions, actually, I think would be. One was from the entire committee that wanted to continue on the effort of the subcommittee in the sense of picking either a few new bands or looking at another broader area in the sense of looking at the architectures, the measurement architectures for spectrum sharing.

And because we were just starting to get into the details as to where you want to go in certain of these places, we picked another couple bands that you have an interest in, they might be very good, even going

up into the 6 gigahertz and 7 gigahertz might be a very big help there, we think, to the community as well as you have a lot of enthusiasm by the group to actually continue on the subcommittee.

Now, there's two other recommendations that weren't the subcommittee's, that were mine, but we had discussed within the subcommittee, and I put them in the report -- not the report, the presentation. One of them is looking at something completely different.

Right now, you have a distinct change going on in the nation, if not the world, in a sense the development of counter UAV systems. And this is going to cause a lot of stress both in the federal and nonfederal areas as to how to do development and testing and actually implementing.

Because some of the counter measures that are being looked at will be very different, very harsh, in a sense, with respect to what kind of sensing systems they're going to try to put on the counter systems, countering the sensing systems that are being put on the actual UAS's that are being put out there. What are the counter measures in a sense of trying to bring them down or overtake them. What kind of technology might be used. How are you going to test those --

LARRY ALDER: Go easy on Mark, here. He's

trying to --

PAUL KOLODZY: Right. I've got them all written down here for you, Mark.

MARK GIBSON: (indiscernible)

PAUL KOLODZY: So it is a -- really it crosses the boundaries between the spectrum management and non-spectrum management, and it has a huge impact on commerce. And so thinking this is the time that you may want to take a look at this prior to something major occurs and you're trying to be reactive. This might be more pro-active. Though we're right now getting close to the reactive stage because of what is going on. That is Problem 2.

Problem 3 is something that -- I have not talked with the committee, but it's been put forward a lot lately. And this is something even further afield from what we've generally talked about with spectrum sharing. And that is, given that the technology -- I'm involved with a lot of the communities now that are developing technologies for distributed antenna systems (indiscernible) distributed transmitters and the like.

It changes the fundamental aspects of what is EIRP now. What is transmission quality? And also, it also changes what is interference, because now you're looking at coherence at a particular point. And so,

therefore, sharing now changes dramatically when you start looking at distributed antenna systems.

And I think that this community with getting both the policy folks to understand what the policy ramifications would be with the technical folks being able to discuss some of those issues might actually take you down a very different path.

And it's a path that we're all going to have to address, because these systems are going to be deployed probably within the next five, definitely within the next 10, and probably within the next five years.

LARRY ALDER: Paul, are you talking about distributed transmitter or distributed sensors or both? I was --

PAUL KOLODZY: Actually, I'm looking at distributed transmitters, though it could also be distributed sensing as well. But this was more transmitters, because EIRP doesn't make sense then, out of band emission don't make sense. A lot of things don't make sense at that point.

MARK GIBSON: That was in your (indiscernible) --

PAUL KOLODZY: That was not. I'll provide that.

LARRY ALDER: Anything else from sensing? Dennis? Did that cover it?

DENNIS ROBERSON: There was more to the bullet that Mark put up there. I think that's the point. Some of this relates to the -- well, most of it is in the thing there. But Paul has brought up the point on the studying the architectures.

One of the comments that we've made is that the new structures, MIMO, massive MIMO and so on, that that does not lend itself to any of the measurement or sensing techniques that we've historically utilized. So it's a very significant problem to be dealt with.

LARRY ALDER: And a topic that I'd throw out that's related to sensing is I'm definitely seeing, you know, this move towards with the 3.5 gigahertz, where you're having it distributed to permanently deployed sensing networks, and how would some of those permanently deployed sensing networks yield spectrum sharing help, open up more bands, should be there be defined APIs or something.

There could be a whole broad range of questions and topics around distributed sensing. I don't know if that's best handled in another forum, but I think it's an interesting extension of the sensing work that you guys did.

PAIGE ATKINS: So I would extend that description as federated sensing and then exposing, being able to expose data in a federated sense. Some may or may not be exposed, and some of the work that ITS is doing is related in that area, that ITS is doing in conjunction with NIST, so there might be some synergy there.

DENNIS ROBERSON: I would just note that one of our members strongly supports the use of federated (indiscernible).

LARRY ALDER: Okay. Let's move on to the other groups to see if there was suggestion for future work. Steve, I don't think there was out of the collaboration --

UNIDENTIFIED MALE: Keep it going.

STEVE SHARKEY: Yeah. There wasn't -- you know, I think we've been through this group a couple of times, and, really, I think the work is subsumed, you know, under the other group looking at bidirectional sharing as kind of a subset of that.

LARRY ALDER: Perfect. And then the next group is 5G. You guys had some suggestions for future activities formally or --

MARIAM SOROND: (indiscernible)

STEVE SHARKEY: I'll bring you the mike.

MARIAM SOROND: Thanks, Steve. I think we've outlined already most of our recommendations. Five out of six are actually future work, but beyond that, just personally, I wanted to also bring up, and maybe Julie touched upon this earlier, but receiver performance.

I think that it's really important, because sharing, I think, is 99 percent about receiver performance and 1 percent about transmitter. And we have relied heavily on transmitter specifications. And so I think it's important, and maybe this could be part of the joint work with the TAC as well, but I think receiver standards both from the commercial industry and the government, federal government side, so equally applied to both sides, are what will enable much better or different sharing.

So I think we really do need to look. Now, if you want to look up receiver performance standards, I think it's probably more suitable to look at future technologies, because existing technologies have already been deployed and are out there, and they are what they are.

So right now, 5G is an opportunity for us to revisit receiver -- and when I say 5G, I'm calling the federal side, also. They're going to go through a 5G

evolution kind of like the industry side, under that assumption, if we look at the receiver performance.

LARRY ALDER: Mark, you got that (indiscernible) receiver performance.

(indiscernible comments)

MARIAM SOROND: And then that also -- then therefore maybe a second (indiscernible) would be related to this is the baseline of sharing, so defining the baseline. I think baseline assumptions moving forward, which then leads to the technology collaboration and technology evolutions and things like that.

And then one particular one was I was going to suggest that, you know, CSMAC did a lot of good work on the AWS-3 spectrum. I think I was going to suggest that we, not revisit because there was something wrong with it, but just go back and apply 5G, because a lot of the work that was done at that time was for LTE and not 5G.

So I would say, specifically, I was going to propose 1695 to 1710, but it could also be 1755 to 1780, no particular preference. But essentially taking those assumptions and looking at 5G and how that changes it, and if any would be useful. It's an existing piece of spectrum. A lot of the learnings over there would also

help the other spectrum.

I think a lot of the -- for a while -- some people still think of 5G as a millimeter wave and that's really not the case. I mean, it is a centimeter wave, a millimeter wave, and the existing spectrum is definitely a part of it. And it's going to evolve into that. So even the current sort of technologies today in these bands are going to evolve to 5G.

So if we don't go back and take at least one of them that is still fresh sort of and like does not have millions of users on it -- it would be a good opportunity to do this at this point.

And also you could take another band -- again just throwing out 37 gigahertz just because it came up earlier today, but you know -- so that is the alternative. So the lower band. One of the AWS-3 ones and then a higher one like 37 gigahertz.

MARK GIBSON: When you say the higher band, you started off by saying go back and look at AWS-3 considerations. I got that. Are you saying apply the same considerations to the higher --

MARIAM SOROND: No. No, it would be different. Yeah, just higher band under like -- just specifically -- different topic, whatever. Higher bands as applicable to the 5G.

LARRY ALDER: Thanks, Mariam. Any comment on that?

DALE HATFIELD: Just quickly. I'm really a strong fan of the harms claim threshold thing. I'm getting very -- I get very concerned about government getting in and actually designing receivers and things like that. I think the harms claim threshold is a much better approach, and I would urge us to continue to think along the harms claim threshold line. Of course, a lot of that work is being done, a lot of work on that is being done in the TAC.

UNIDENTIFIED MALE: That wouldn't necessarily be a 5G. That would be sort of be on its own, don't you think?

UNIDENTIFIED MALE: (indiscernible).

LARRY ALDER: Carl.

CARL POVELITES: Carl Povelites. Going to Mariam's --

LARRY ALDER: Hold on a second, Carl. Can you run the mike over --

MARK GIBSON: Here, I've got it. I'll be the mike runner. Here you go.

CARL POVELITES: Going to Mariam's, one of her recommendations, and also going back to Paige's start of her presentation earlier where we've now

reached about halfway through the president's target for 500 megahertz. I'm not sure what necessarily going back to AWS-3 for 5G necessarily, what that whole process would do, particularly when it's already been auctioned. But there are other lower bands that, you know, it was on the 6th report and all that. We may want to go back, and we may want to go into like 1300 to 1390 or some other band to do a similar study that we did with the AWS-3 band.

LARRY ALDER: Okay. Give Mark a chance to catch up here. And I think Carl's point is just looking at some non-AWS-3 lower bands might also be an idea.

CARL POVELITES: (indiscernible) report that NTIA is currently studying and seems like it might have an opportunity in the future.

LARRY ALDER: Okay. Michael, since you're right next to the mike.

MICHAEL CALABRESE: Yeah, I'd like to add on to the 5G. Again, kind of building on what Julie mentioned earlier, specifically with respect to 37 to 37.6. Julie mentioned that the federal users would like to optimize, I guess, their flexibility for perhaps introducing or altering uses in the future that they may not even know about yet.

So it may be worthwhile to, right at this

point, if we do it quickly, to look at, to explore mechanisms for sharing that particular 600 megahertz that will speak to those federal agency needs; in other words, particular sharing mechanisms look at, you know, whatever they are. I mean, I realize there will probably be comments on that coming this fall as well, but it may be worth kind of drilling into that as a group.

LARRY ALDER: Okay. Thanks, Michael. Bryan.

BRYAN TRAMONT: Are we using both or just this one? All right. Anyway. So I feel very strongly about this ill-informed idea or ill-formed idea. That's why I have both mikes to make sure you really capture how ill-formed this is.

So I feel as if we have at times, and I think this is somewhat based on my own regulatory experience, too, that in developing policy, sometimes we focus a lot on figuring out something that is capable of working, but we don't always go back to figure out if it actually did work.

So I'm wondering if by the time we reconvene with the new group, what have you, if it isn't time to go back and look at particular dynamic sharing experiences. White spaces springs to mind, but we may

have stuff developed to 3.5. We may have other -- AWS-3 there may be lessons. And trying to figure out what did and didn't work and why.

I had occasion recently to go back and look at the original white spaces decisions in 2004, I think, when we did the original. You know, it's now 12 years ago, and we've learned a lot along that (indiscernible), but we still don't have a widely deployed white spaces infrastructure, and I suspect there might be things we can learn from that experience.

I just want to make sure we're not creating regulatory regimes for sharing that don't have any public interest benefits to both sides, either because the federal government can't use the spectrum the way we had envisioned or because there is no commercial demand for it, so people aren't putting the investment dollars into it.

So my ill-formed idea is that we would figure out what the lessons learned are and then perhaps think about what the public policy test is for whether sharing has been a success and when we call that question.

Because I think there are a lot of ideas out there, and I think we are trying to experiment with a lot of the different ideas, but we need to -- I think

because there's such increasing demands so quickly, we need to focus on what ideas are working as early in the process as possible so that we thin out the herd a little bit.

LARRY ALDER: Mark's got that.

UNIDENTIFIED MALE: (indiscernible)

LARRY ALDER: He's got the general category.

BRYAN TRAMONT: (indiscernible) sharing.

MARIAM SOROND: (indiscernible)

BRYAN TRAMONT: I don't think we should limit it to federal and non-federal because we have some examples that are commercial on commercial and some federal on federal. I took out Jennifer's tent on the way.

LARRY ALDER: Hold on, hold on. I've got a few questions. Going to hit these questions and I just wanted to check before I do these questions, did the International SAS, did you guys have follow-up for future work?

KURT SCHAUBACH: We didn't really have specific recommendations related to the international extension, but maybe a related topic might be to -- this was something that came up in the recent wizard workshop on enforcement was metrics or measures of, for example, spectrum access systems or other sharing technologies on

their way to the market.

How would you measure the effectiveness of them? Are they performing sort of roles or functions that they're supposed to? So sort of beyond the measure of initial certification, I think there's this notion of perhaps like a monitoring facility, you know, or even like a network operations center that, you know, could be looked at for sharing technologies.

MARK GIBSON: (indiscernible)

KURT SCHAUBACH: Yeah, and perhaps the feasibility of that and what role NTIA could or should play in that.

JENNIFER WARREN: (indiscernible)

KURT SCHAUBACH: No, I think this is a little more technical in nature, Jennifer, so this is --

UNIDENTIFIED MALE: (indiscernible)

KURT SCHAUBACH: Exactly. And this is also sort of more focused on the systems themselves versus the policy, perhaps.

LARRY ALDER: Okay. At least we've gotten through the groups. Your questions just went down.

(indiscernible comments)

UNIDENTIFIED MALE: Just to clarify, wireless (indiscernible) --

DENNIS ROBERSON: My comment goes with the

earlier comment I made about LSA, inserting it into the, going back and looking at success. LSA is not that. LSA really is the looking forward. So it would fit under that one.

But I think it is important that we look at this point that Kurt's made around metrics and efficiency, look at this on a global basis, using LSA as the example. LSA there's a lot of pursuit -- Mark, I'd put that on the next one, not on the go back.

Because LSA isn't something that we've really embraced here in the U.S., Qualcomm notwithstanding, where Europe seems to be on a path to move that way. So looking at and checking on the efficacy, as you've described it, of other systems around the world -- I think that is an important one for us.

LARRY ALDER: Okay. Thanks, Dennis. Okay. I think we've covered all of the subcommittees. Michael, do you still have a question or is that just a leftover?

MICHAEL CALABRESE: No (indiscernible) --

LARRY ALDER: What?

UNIDENTIFIED MALE: (indiscernible) open --

LARRY ALDER: Yeah, we're going to open up for just -- I think we've covered the subcommittees, so

right now it's just free form, whatever the ideas are. Dale, it sounds like you have one.

DALE HATFIELD: It relates a little bit to bidirectional sharing, but one of the key things here I think is if you're, when you have an incumbent, let's say the feds, and they do entrance on the commercial side, one of the things you need to know is the waveforms or you would like to have as much information on the waveforms as you can to be able to avoid causing interference, at least with certain forms of dynamic sharing.

In the same way, when the incumbent's commercial, you have the same issues, needing waveforms. And I realize the sensitivity to the waveforms from the federal government side, but when you're out there looking for these waveforms, especially at the lower frequency, there's going to be an awful lot of other signals in that band, and they can be harmonics, all kinds of interfering signals.

So I'm coming back, I always do, to interference issues. But if -- what we need, I think, is a catalog of not only the signals you expect to see in this band, but a catalog of signals that are interfering signals like switching power supplies in grow lamps in Boulder. I thought I'd get a laugh.

No, to be serious, you know, these different types of devices have different signatures, and what we need is a catalog of interfering signals that we don't expect to get in there. I mean, when we're looking for the signal that we want to see, to be able to avoid, for example, we're also going to be picking up others. And that leads me to two comments.

One, it would be interesting to share that information among different people so we have this catalog of these waveforms. The other thing, it could lead you to automatic, some sort of automatic interference enforcement thing.

In other words, you're seeing a signal that they shouldn't be in there, even though you're looking for the other guy. I'm not saying this very clearly. But if you see it, then, of course, it could trigger -- then there needs to be some sort of an enforcement action, because this is a harmonic, 7th harmonic of an FM radio station or something like that, and you would want to take action to mitigate against it or to actually start enforcement actions. Maybe somebody else can say that a little clearer.

LARRY ALDER: I think we -- I think Mark summarized it kind of briefly there. Pass the mike to -- go ahead, Jennifer.

JENNIFER WARREN: Jennifer Warren. So I'd like to suggest -- it goes back to, again, the presentation that Dr. Gremban did, which is one of his areas of work, is kind of the technology side of aggregate interference.

And I wanted to look at the companion side of that, which is the regulatory mechanisms to actually then implement a decision on aggregate interference. What are the policy challenges? What are methods and options that a regulator may have, or maybe there's only one conclusion, on how to implement -- I don't want to use the word enforcement -- but enforcement of an aggregate interference level.

Internationally, it's been a challenge. Domestically, you know, hands have been thrown up. Maybe this is a question that we could look at. The only example of that internationally that I know of is in the ITU with a group called Resolution 609. But I do think that that is an area that we could perhaps bring some effort. Thank you.

LARRY ALDER: Jeff.

JEFF REED: Okay. Jeff Reed. I have three suggestions. The first one is very similar to what Janice said. Does NTIA have a role to play in communications security? If so, what? Just a very

broad look at that, a very philosophical issue.

The second suggestion is, how might NTIA be able to best leverage the new research programs that are coming. With the advanced wireless technology, that's $400,000,000 worth of research that's coming out of the NSF, and there are a number of darker programs as well. How might NTIA be able to best harvest the research that comes from those programs.

And then the third one -- the third one is a bit different, and I suppose it's -- in some ways, it's a different sort of study or role for CSMAC. And that is doing some external reviewing of some key reports that come out of NTIA.

For instance, one of the issues that is being looked at now is 1.3 gigahertz spectrum sharing. And there's a lot of smart people in this room who could do some sanity check on what comes out of those reports. So those are my suggestions.

LARRY ALDER: Thanks, Jeff. Those sound very well thought out. Michael.

MICHAEL CALABRESE: Okay. I think there's a couple more I'll throw out there. The first one, you know, NTIA would have to judge whether they have had enough of this or not, but the idea of --

(indiscernible comments)

MICHAEL CALABRESE: No, it's not that painful. But, actually, you know, when we -- eventually we'll get through, hopefully, some of these bands we're working on like 5 gigahertz. The notion of, you know, developing more explicit criteria for identifying the next band or set of federal bands that are best suited for sharing, and you know, how do we -- so how do we decide that, you know, it's much better to target this here rather than that over there?

And, you know, I think when (indiscernible) would say it's always easier when there's fixed, the federal uses fixed rather than mobile, for example. So we've heard rules of thumb. I'm not sure we have a set of criteria that are very well developed for that, and it might help point to some future bands with a long lead time.

The other is, I don't think there has been enough attention to beaconing as a potential mechanism for sharing. You know, we've been able to bring, obviously, geolocation databases and now sensing with 3.5 band into the mix, and there's some obvious potential downsides with beaconing, depending on the service, But I think maybe exploring the pros and cons of that for federal users and different types of federal users, some of which want to be identified and some

don't or some who could obscure even while beaconing or not.

So it's a good tool, I think. It could be very useful and built in ahead of time. But I'm not sure we understand its implications completely.

LARRY ALDER: Thanks, Michael. I think we've got about five more minutes left in our brainstorming. You want to add some --

PAIGE ATKINS: I think we covered, I think, most of the general areas I was thinking about. I would ask on -- we talked about counter UAS as a focus. There is quite a bit of activity going on in the area. So it might be not right for CSMAC, specifically, but what about the broader category of UAS, not counter UAS, but UAS in a general sense.

PAUL KOLODZY: Yeah, I think that UAS has (indiscernible) of problems we're talking about that Julie was looking at and the TAC -- is it on? It's on. Yeah, so I think the FCC TAC has been trying to look at that, so trying to do some parallel efforts and ask the question is also useful.

I will counter you a little bit on the counter UAS. In a sense, there's a lot of effort going on, a lot a swirl as to what they should be doing. But what people have not been asking the question, which I

think is a very hard question is, what spectrum and how do we test in these areas, especially if people are doing -- make modifications to classic commercial UAS's and you're going to have to somehow develop systems both for your federal and non-federal users to counter those. But, again, that's your choice.

LARRY ALDER: Other topic areas that people want to bring up and put on the radar? Dennis?

UNIDENTIFIED MALE: Pass the (indiscernible) again.

DENNIS ROBERSON: It's the Olympics. We've got to be prepared. Michael, I didn't tell you about our role in one of the teams, but anyway.

One of the areas and some of you, many of you would know why this is on my mind, but it's a much broader topic than what has been occupying some amount of my time, and that's the whole area of navigation. We've become very dependent -- I got here this morning using my GPS system. And that is a normal and standard part of a what we do.

But we're also in a place where we're navigating using Wi-Fi, we're navigating using our cellular, the combination of those things. In the U.S., it is still the law of the land that you use GPS, whereas there seem to be a lot more satellites up there

that people, some of them -- Rick can tell you -- can't get away from the satellites.

But this whole notion of geolocation and navigation and so on, even time for that matter, since we're in this facility, the future of that, particularly as it applies to the needs within the government systems, the government environment, this is a big topic. Maybe it's too big for the CSMAC to take on.

But it's becoming a really significant topic in how to get from here to there, how you establish the time where you are, and so on and what the alternatives are and where this should be steered as we go forward.

PAUL KOLODZY: I just want to -- that's a great topic area. That comes back to something that I was mentioning to Julie, which was a systems of systems, meaning if you're doing PNT (indiscernible) it's not just GPS. It's so many other things and so many other satellites and components, that we don't really look at our, an analytical tool set of how to actually start addressing the service -- not the service, meaning the radio service, but the service that is trying to be provided.

LARRY ALDER: Yeah, I mean, if you want to go extreme, coming from Google, you'd say, you know, machine learning solves all known problems. So how to,

in this new world, with all these devices out there, how can you apply some of these techniques. You even have a question, what emerging technologies -- that the Smart phones enable the power of machine learning, cloud.

It would be a very open-ended, broad question, but how would all those topics maybe facilitate spectrum sharing in unusual ways. You have mapping, you have satellites, you have phones. So just that would be a broad technology question.

DENNIS ROBERSON: And even gyros -- I mean, even, you know, embedded gyros, so when you lose all the other signals, you still have ways of getting --

LARRY ALDER: Okay. I'm seeing two tents. I'm going to go with Rick because he has the mike near him and then we'll bring it over to Dennis.

RICK REASER: Okay. This is Rick Reaser, Raytheon. I wanted to mention, it was mentioned last meeting, and this is a totally different tack, but I think that given all the things we're throwing on NTIA's plate, the question I would wonder is if NTIA would be interested in having someone take a look at ways that they could, you know, with their limited staff, other ways they could augment what they need to do by other strategies.

Because right now, you have a limited number

of folks, and you might need some help in terms of figuring out how to -- you know, what other mechanisms are out there for you to do your job rather than just with your existing staff. Whether that's through a bunch of -- there's lots of strategies out there.

But I think that -- I mean, look at this list of things. This is just more work for NTIA with staff they don't have. Because once we get done making all these recommendations, then what? So there's some strategies that they can use. They're not going to get an influx of new people and money, in my opinion. So are there ways we can help?

LARRY ALDER: That sounds like an interesting idea, Rick. Thanks for suggesting that. Dale.

DALE HATFIELD: Yeah, just real quickly. One of the things that we had, one of the sessions that really sort of interested me was this notion of going from open loop interference to closed loop. For example, when you have ducting, for example, you could be operating at high power most of the time, but if you have ducting, then you get feedback and you reduce your power. We tend not to do that.

The aggregate interference issue is the same way. You've got a whole bunch of transmitters turned

on, so you turn off half of them and gain (indiscernible) or whatever, whatever the number is. So this notion of closing the interference loop is not original with me, but it did catch my eye in one of the sessions we had as something that might be useful to look at.

LARRY ALDER: Thanks, Dale. I think we're about ready to wrap up this brainstorming session. Any final comments? I assume that's an old tent, Rick.

PAIGE ATKINS: Just a quick comment to follow up on the navigation topic. Like we discussed with the FCC TAC, there are other advisory committees like the PNT Advisory Board, so we might want to think about looking at other committees, other advisory committees that exist, and if there are opportunities to either partner with them or at least understand what they're doing and potentially influence their topics as well.

UNIDENTIFIED MALE: Is there one for (indiscernible)?

PAIGE ATKINS: There are different ones that are related.

(indiscernible comments)

LARRY ALDER: So thanks everyone for the brainstorming session. We talked to Paige beforehand.

You know, clearly, this ends this CSMAC and this idea and these charts will feed into Paige, and when the new CSMAC forms, there will be some kind of process around figuring out the questions and that will evolve.

I think this will be helpful, just some of the ideas from this membership, and it was good to collect it as we come to the end of this CSMAC term. So, Mark, thanks, also, for capturing all that.

So I think this is the time in the agenda where we have the opportunity for public comment. Is there anyone in the room who is a member of the public that would like to comment?

(indiscernible comments)

LARRY ALDER: Fair enough. Oh, we do have -- we have two people who would like to comment. Please state your name so we know you are.

ALLAN BERLINSKY: Okay. I'm Allan Berlinsky. And I'm with LGS Innovations. Janice's comment of cyber, I think is actually more important than or it should be a certain high priority.

And you have to look at, really, spectrum sharing as being an overall control system. And being a control system, it has to be secure. Now, with spectrum sharing, though, there could be lots of different ways to be able to maybe sabotage the system or to make it do

things that it shouldn't be doing, both on the sides of the commercial and on the government side.

On the government side, they probably would call it maybe EW warfare, okay? But on the commercial side, there can be ways that you might say of getting into, you know, a commercial service provider's system and basically hijacking the entire, hijacking the system so that it's not operating in the appropriate manner.

That can be, I think, at a lot of different levels from not only with regard to his operations and management types of systems to be able to handle this problem, but it also could be at other echo system type of levels, of how being able to control that transmitter, okay, or to be able to control that receiver so it's able to combat the problem and to actually being able to mitigate it.

You know, if an overall system is being attacked in a certain way, there could be probably ways that you may not be able to even control the power of that base station, okay, or even to take it offline. And other mechanisms could be working there that are stopping him from being able to do that, that someone actually got into the power grid to be able to do this.

So it can touch a number of different areas, but basically an overall control system, if you look at

it from that perspective, has to be secure.

LARRY ALDER: All right. Thank you. You can pass the mike to the gentleman in front of you. n

DANIEL: Thank you. Daniel (indiscernible) and I'm from the Idaho National Lab. I had two thoughts. One was, I believe, a comment made by Mr. Calabrese. My old boss, Don Cox, used to say, Wireless gets reinvented every 20 years.

And the idea of beaconing, in fact, was well known and discussed. In fact, there's a patent of which I have one, but it's more than 20 years ago so it's expired. But the idea of beaconing is a very significant one, and, in fact, there's an I triple E paper on that as well, which I'd be happy to send you.

The next (indiscernible) was related. I think there was subsequently a follow-up thought that came from, I think, Mr. Hatfield, and which I have always talked about as a spectrum (indiscernible) incumbent systems. Because today we have incumbents and all the spectrum people are trying to dance around it. Wouldn't it be nice if, as future systems get built, as incumbents, that they can, in fact, give feedback, saying, I'm beginning to hurt.

So it's not quite bidirectional sharing, but it's really more a question of feedback to close the

interference loop (indiscernible) so that you have better ideas as to how to do that.

So those are two thoughts that I'd like to suggest to you for your future consideration. Thank you.

LARRY ALDER: All right. Thank you very much. I'll also ask if there's any public comment on the phone. I know it's risky to even ask that given the phone situation, but public comment from the phone?

All right. Hearing none, I think we are wrapping up. Mark, do you have any closing comments that you would like to make?

MARK GIBSON: No.

(indiscernible comments)

LARRY ALDER: I have a few closing comments. First of all, as we come to the end of this term of the CSMAC, it's been a pleasure working with everyone, as we said before. It's been a particular pleasure working with Paige in her first -- this is your first full CSMAC, am I correct?

So it's been a particular pleasure working with Paige and I would like to thank her for her leadership in guiding all this. And to all the NTIA liaisons, it's been mentioned once, but it's been very, very helpful to all of us to have your input and

guidance. So we thank everyone for that. I don't think I have anything else.

PAIGE ATKINS: Just to close, we, NTIA, do owe you a debt of gratitude, and we're very appreciative for all your insights and, again, your wisdom to help us do a better job. And I know Larry Strickling would also echo his gratitude for all the work that you've done over the last 30 months. So thank you very much.

LARRY ALDER: And then one final thank you to all the co-chairs who I know put in the double extra work being a co-chair. Having done that, it's been much easier -- except for Mark -- for me being a co-chair of the whole committee than being a co-chair of a subcommittee -- I know it's a tremendous amount of work. So thank you subcommittee co-chairs for all you do.

And I think with that, we're adjourned.

(End of meeting)

STATE OF COLORADO)
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