CHARLES COOPER: Good morning, ladies and gentlemen. Welcome to the fifth annual NTIA Spectrum Policy Symposium. I am Charles Cooper, and I run the Office of Spectrum Management within NTIA.

As most of you know, our office works with the NTIA front office and our colleagues at the Institute of Telecommunications Sciences – that's our Boulder research lab – to develop and implement spectrum policies we are going to discuss at the event today.

We are very pleased and happy with these discussions, which I'm confident you will find very interesting and productive.

The Symposium has obtained a kind of unique spot in the calendar this year, coming up right after Labor Day, as everyone returns here to DC and the fall season gets under way. You might think of it as a spectrum homecoming of sorts, and perhaps even more so after we're coming back from COVID.

NTIA holds a symposium each year to bring the policymaking community and individuals together to take stock of our work of managing the nation's most vital resource, spectrum. We are grateful to have this wonderful cross-section of keynotes and panelists with us today, both this morning and also in the afternoon.

Just briefly, going over the schedule for today, we're pleased to have in a few moments the Department of Commerce Secretary speak, following by the NTIA Assistant Secretary. We'll have a couple of panel discussions focusing on digital strategy, and then right in the middle of that we're very pleased to have the CIO of the DoD, John Sherman.

We'll take a break for lunch around 12:30, come back in around an hour, around 1:30 or so, where we'll pick up with some Congressional members. We're very pleased to have remarks by Senator Luján and also Senator Wicker this afternoon.

After those remarks, we'll have a keynote by Doreen Bogdan-Martin from the Telecommunications Development Bureau with ITU. And then we'll pick up our panel discussions again for the remainder of the afternoon, including focusing on the WRC, which his coming up in the not too distant future, and also with US Coast Guard Space Operations.

In between those panel discussions, we'll also have a keynote address by NASA.

So don't let me hold up the activities starting right now. Let me introduce the NTIA Assistant Secretary Alan Davidson. Alan. [laughter]

ALAN DAVIDSON: Thank you, Charles. And good morning, everybody, and welcome. We are so glad to be here and to have you all here. I'll just say, before I give my opening remarks, I have the honor, actually, of introducing who will be our first speaker, my boss, the Secretary of Commerce Gina Raimondo. We are extremely fortunate, I will say, at the Commerce Department to have a leader like Secretary Raimondo. I am particularly grateful for her support of NTIA. Her leadership and the occasional whipping, I will say [laughter], of our efforts has been fundamental to our ability to tackle the big issues in front of us – closing the digital divide, connecting everyone in America with highspeed, affordable internet service, advancing America's competitiveness in this space, promoting digital equity, creating thousands of good-paying jobs and a more diverse workforce, charting a path for continued innovation in the world.

I know that she cares deeply about our nation's continued leadership on spectrum issues, and I suspect you may hear more about that shortly. So please join me in welcoming our first keynote, Secretary Raimondo. [applause]

GINA RAIMONDO: Good morning, everybody. We are excited to be hosting this event. I have to say I feel very fortunate to have Alan as the leader. He's incredible. We went to law school together many years ago, so I've known for a long time how brilliant this guy is. And 30 years later, we've figured out a way to work together. But you're doing a fantastic job, you and your whole team, and I can't thank you enough.

I often say that everything we do at the Commerce Department is around enhancing America's competitiveness. The Commerce Department is a broad grab-bag of things – NOAA, space commerce, ITA, NTIA. But the through line is competitiveness. Everything that we do is aimed at enhancing America's ability to compete in the world – our entrepreneurs to compete, our big businesses to compete, our small businesses to compete. And the work of NTIA fits in perfectly with that.

So we are now hard to work implementing the nearly $50 billion that Congress sent to the Commerce Department, to NTIA, to make sure that every single American has internet – affordable, highspeed internet. And Alan and his team are doing an incredible job implementing the Bipartisan Infrastructure Law. And that's about competitiveness. How can you compete if you can't work from home or go to the doctor with telemedicine, et cetera? So that's core to competitiveness.

The same is true for the CHIPS Act, which we are now implementing. Congress also sent about $50 billion to the Commerce Department to implement the CHIPS Act. Chips are in everything. We're utterly reliant on Taiwan for our chips, and so this is about improving American manufacturing and ensuring that we are self-reliant when it comes to this critical piece of technology.

Well, the same is true about spectrum. Only, unlike chips where we can just make more, you can't do that with spectrum. It's a finite, precious resource, vital to American competitiveness. Without effective, efficient use of spectrum, we won't have innovation. We need to free up more spectrum to unleash innovation.

We rely on spectrum at NTIA for the lifesaving work of FirstNet. And I know, as a governor, that is lifesaving. Previously, I was the governor of Rhode Island and we used FirstNet. There's no FirstNet without spectrum. There's no innovation without spectrum.

NOAA's radars use it to track severe weather, weather satellites. We're in the middle of hurricane season right now, so this is top of mind for me.

In any event, you don't need me to tell you this, but I guess the thing I would say is, the work you're doing – and I know you're going to hear from the Chairwoman in a minute – with the work we're doing in partnership with the FCC – a fantastic partner to us – with the Department of Defense matters incredibly and vitally to our competitiveness, our ability to innovate, our ability to out-innovate.

There's so much talk. People ask me all the time; I can't do an interview without being asked about China: How will we compete? How can we slow them down? Because what we do at BIS is depriving China critical technology.

The real answer is running faster in America. There's offense and defense, and we'll play our share of defense, but offense – investing in our capacity – matters more. And spectrum is vital to that. Having necessary, available spectrum so we can continue to innovate is absolutely vital to our national security and our ability to compete and dominate in certain technologies in the world, which is what we need to do.

So I just want to tell you that I'm thrilled to be here. I'm grateful to our own team at NTIA. And don't believe what he says; I really a very sweet boss. [laughter] Sweet and kind and, you know, with some high standards. But this national spectrum strategy is something that Al and I have talked about from the very beginning.

The last thing I'll say is, given the rate of innovation, which is accelerating and will continue to accelerate, having a national spectrum strategy and having the most efficient use of spectrum is more vital than it ever has been. So get in the weeds of this. Get it right. And just know I appreciate it and know that I understand how much it matters to the overall competitiveness of the United States.

So thank you and have a fantastic session. [applause]

ALAN DAVIDSON: Thank you, Secretary Raimondo, and thank you for being here. If it's not obvious, this is an area that the highest levels of our department, the highest levels of our administration people care about.

We did shuffle the program a little to accommodate the Secretary's schedule, so I will give a few words of welcome now, and then I'll introduce our next keynote of the morning.

So welcome. I'd like to welcome all of you to NTIA's fifth annual Spectrum Policy Symposium. Think is actually my first symposium as Assistant Secretary. And our team has put together an action-packed and great program for all of you today. Thank you for joining us.

And I would be remiss if I didn't give a quick shoutout to our team. You heard from Charles Cooper. They are leading what I think of as the quiet, but vital work of modernizing and improving the way our nation manages spectrum. My congratulations and thanks to them and this terrific team for all that they've done, and particularly for bringing us all together here today.

As a starting point, the United States is the leader is deployment and adoption of advanced spectrum technologies in the private sector and by federal agencies. We need to maintain that leadership. To do so, we need a forward-looking vision for how we are going to support the needs of the private sector – we see this – as it works to deploy 5G, 6G, other innovative wireless technologies.

While we do that – and we feel this very strongly sitting here at NTIA – we also need to support the missions of federal users. And you heard the Secretary speak a little to that. Those federal users, for the same reasons that the private sector needs access, increasing access to spectrum, they are also relying on advanced spectrum technologies – to protect our nation, to preserve public safety, to predict the weather, to conduct next-generation scientific research. So we know that as a nation we can and we must do both of these things, meet both of these needs.

So how are we going to do it? I'll just speak to three quick things that we are very focused on here at NTIA – coordination, technology and trying to put points on the board in the near term, keep our eyes focused on the opportunities in front of us.

Coordination, I'll just say, that's a lot of why we're here today, it's a lot of what we're going to be talking about. You'll hear us speaking about this with our federal partners, with our private sector partners. It is sometimes the unsexy work of gutting it out and spending time together. But I think it's essential and a very important first step for us.

One of the first things that I did when I came into this job was to establish the Spectrum Coordination Initiative with Chairwoman Rosenworcel and the FCC. Efforts like that are critical to build confidence and make sure that we're working together in lockstep. That effort's already borne some fruit. Just this summer, we announced the first update to the memorandum of understanding between the FCC and NTIA; the first time that had been updated in nearly 20

years. We were still operating from a document that was created before the iPhone, before YouTube existed. And so it was time. And I was very glad that we were able to do that.

Looking ahead, as the Secretary said, I think it's widely understood now within the federal government that we need a national spectrum strategy that will meet the moment, serve the needs of both the private sector and the federal government. It's a process that we're going to go through that's going to need to solicit and incorporate feedback – from civil society, from industry, from stakeholders, from all of you. We'll be working closely with our interagency partners to put this together in the coming months.

I'll say that effort of necessity must also include a roadmap for future spectrum availability. And Chairwoman Rosenworcel has spoken eloquently about the opportunities in the 7-16 gigahertz range, the broad range. I agree. And we are keenly interested in working with the FCC and our federal partners to think about where there will be opportunities in that range.

So stay tuned for more on that. I think the spectrum strategy is going to be a very big part of our agenda going forward. And you'll be hearing more in the coming weeks and months.

A second big area for us is around technology and thinking about how we can use innovation to help meet our spectrum needs. We need to develop new approaches and innovative technologies that can help us surmount the challenges of scarcity that we face in spectrum management. NTIA has been working on a number of ideas in this area, including a new system for spectrum sharing. This new incumbent informing capability, or IIC as we call it, enables dynamical spectrum sharing among incumbents and new users. We feel it's very promising in ways that are not possible within our current spectrum management framework.

IIC builds on the success of the prior CBRS spectrum-sharing framework. The key concept is that we replace the environmental sensors that detect incumbent use with software-based

scheduling by incumbents for time and location. And we think there's a lot of promise in that in making sharing more reliable. So stay tuned for more on that and similar technologies that we think are going to be important in pursuing the more efficient use of spectrum.

The last thing I'll say is that we do want to keep our eyes on the live fire, as I think of them, debates of the moment and the opportunities that are in front of us. That includes– and I'll say we're quite focused on what will happen with the lower 3 gigahertz, 3.1-3.45 gigahertz, which we think is a big opportunity. If we can get this band right, we could unleash billions of dollars, maybe hundreds of billions of dollars in economic activity, create good-paying jobs, and be a huge boon for the economy.

More work needs to be done to get it right. But if we do, we also have the opportunity, potentially, to fund new opportunities – the deployment of resilient, interoperable next-generation 911 services, perhaps our IIC spectrum-sharing framework, the replacement of Chinese telecommunications equipment that we're worried about in the US wireless networks.

So this could be a real win for our nation's economic competitiveness, our public safety and our national security. We see a huge opportunity here in this band, and we stand ready to work with leaders on Capitol Hill, among our brethren in the federal agencies to chart the best path forward.

So this gives you a window into some of the ideas and things that we're thinking about at NTIA. We've built a program here today that actually touches on the very broad range of issues that we think are facing us in spectrum policy. More than ever, we need a common vision that serves federal users, private actors and the American people. And today's event is a reflection of that.

We have an impressive array of speakers. You've heard from the Secretary. We have the Chairwoman in a moment. We'll have other FCC staff, White House staff, the CIO of the Defense Department John Sherman; I'm very glad that he'll be able to join us. Later this

afternoon, as you heard from Charles Cooper, we're going to be hearing from Senators Luján and Wicker, very important voices in Congress and leaders in this space.

I'm grateful for the many private sector leaders who will be joining us today. And we also have a great talk by NASA later in the afternoon, which I hope you'll stick around for.

The one other person that I'm very glad is going to be joining us with remarks is Doreen Bogdan-Martin. And for those who don't know her, she is currently candidate for the Secretary General of the ITU. There'll be an election at the end of this month; actually just two weeks away. And she's a terrific historic candidate for the ITU. She would be the first woman Secretary General. She has a long and distinguished track record at the ITU. We're just excited to see what she can do there. And as many of you know, the ITU plays a key role in many, many telecommunications standards efforts, but particularly in the wireless space.

And as the World Radiocommunication Conference of 2023 sort of looms around the corner, I think it's very important, this plenipotentiary meeting at the end of the month is going to be very important for setting us up. And we'll have a panel that will discuss some of those issues.

So in closing, I'll just say if you want to know what spectrum coordination looks like, you've come to the right place. It doesn't mean we're going to agree on everything. It does mean that we want everyone to come to the table, raise issues in an open and transparent manner, and make a good faith effort to maximize our scarce and precious spectrum resources.

So we are really honored and pleased to have you all with us here in person today, out on the live stream as well, as we move into this new era of spectrum policy. Thank you for your partnership and your engagement. [applause]

I do now have the honor, really, if introducing our next keynote speaker, Chairwoman Rosenworcel. She has been both a personal friend and a great partner for NTIA. She's a historic leader for the FCC. Brings deep, substantive expertise to her role, which many of you have witnessed first hand. I have seen how deeply committed she is to ensuring that America continues to have the best advanced communication systems in the world, and that we promote equity and fairness in doing so.

We've worked really closely together on the Spectrum Coordination Initiative and on a host of issues related to closing the digital divide and bringing affordable highspeed access to everyone. I'll say on a personal note, she's been really very generous with her time and good counsel since I've started up in this role. And I continue to look forward to seeing what we can do in partnership together.

So thank you, Chairwoman Rosenworcel, for all you have been doing for our country, and particularly for our country's spectrum policy initiatives. Please join me in welcoming FCC Chairwoman Jessica Rosenworcel. [applause]

JESSICA ROSENWORCEL: Good morning. Thank you to Secretary Raimondo and Assistant Secretary Davidson for having me here today at the NTIA Spectrum Policy Symposium. Thank you, also, Alan, for those extraordinarily kind words.

So this is the fifth annual gathering of this symposium, and five years ago we wouldn't have marveled that we could come together to talk. [laughter] But today it's something to celebrate, and I'm really so glad we're all here.

Five years ago, the FCC was also finishing something up. We were finishing up the Broadcast Spectrum Incentive Auction. Remember that? It was the world's first ever double-sided incentive auction designed to use market mechanisms to repurpose old airwaves for new commercial uses.

It was a big deal. It was also messy because it was complicated. Repurposing spectrum is not for the faint of heart. The tools we have to do it are constrained by law, limited by physics, and the relocation of existing users can be challenging.

And yet, we forge on. Because when we look back on the last five years, or, better yet, the last ten, what we see is that wireless technology is remaking our world. The phones that are in our palms, pockets, and purses have forever changed the ways we connect. Wireless technology supports so much that is growing so fast in our economy, and it may contribute as much as $1.5 trillion to US GDP in the next decade.

So when you look back, you also see very clearly see the United States has long been a global leader in spectrum policy. When the going gets tough, we get creative. You see it with the broadcast incentive auction five years ago. And if you roll back further, you see it when we became the first to use auctions to modernize the distribution of licensed airwaves. You see it in the way we pioneered the use of unlicensed spectrum, which supports the airwaves so many of us now know and use every day as wifi.

So what comes next? How do we build on this storied history? I think the next chapter is going to require us to think anew. We can embrace what worked before, but we also need to get creative again because the future will be different than the past. The focus on phones is going to give way to connectivity that touches everything in the economy.

In fact, if we do this right, our phones will be the least interesting part of our wireless future because we are on the cusp of new forms of connectivity that will boost productivity and make industrial processes in factories, shipyards and warehouses more efficient and more effective. We'll see fresh competition in the delivery of household broadband, which will change the way that families at home get online. Plus, using next-generation wireless technology in the power,

transportation and manufacturing sectors could lead to emissions savings that will help us meet future climate targets.

It's exciting. And it's going to require a reset in the way we think about the opportunities in our airwaves. But tradition-bound Washington is not always so quick to change. I know, I'm the first woman to permanently lead the FCC in 87 years.

So I'm going to make up for lost time. In fact, when I took the reins at the agency, we made a lightning-fast pivot to focus on mid-band airwaves. This is the spectrum that has the mix of coverage and capacity that is essential for the widespread deployment of 5G service. So we held auctions in the 3.45 gigahertz band and the 2.5 gigahertz band, with the latter concluding just last month.

I also made it a priority to improve the way we coordinate with our federal counterparts. And here, let's be honest, a reset was in order because our ability to be successful in our mission to connect everyone, everywhere is as much about finding partners as it is about finding spectrum. The good news, as you've heard, is that the FCC has terrific partners in Secretary Raimondo and Assistant Secretary Davidson. So we memorialized that fact in a new Spectrum Coordination Initiative earlier this year.

And to start, we reinstated high level meetings between the FCC and NTIA. We also, as you know, updated the memorandum of understanding between the agencies for the first time in nearly two decades. And, as you heard Secretary Raimondo say just a few minutes ago, we are working together on a national spectrum strategy. On top of that, we are working together to support Doreen Bogdan-Martin as the next Secretary General of the ITU.

But process alone is not progress. We need to build on what comes next. So here are three ideas. Think of them as three near-term efforts to help us continue to reset spectrum policy in the United States so we can continue to lead the world in wireless.

First, we need to extend the FCC's auction authority [laughter], and get creative when we do. I'll take the laugh as support. [laughter] This is important. The FCC has had the authority to hold spectrum auctions for about three decades. It's been a powerful engine for wireless innovation and economic growth. In fact, using this authority, the FCC has held 100 auctions and raised more than $233 billion in revenue. It's a big reason why our wireless economy leads the world.

Now, this is leadership worth preserving. And to do so, we need Congress to extend the agency's spectrum auction authority. It expires with the end of the fiscal year. For those of you with a calendar, that's September 30th, and it's right around the corner. I know, there's an effort to fix this in a continuing resolution that would extend federal appropriations. And that's a good thing. It's also the starting point for broader discussion about what a multi-year extension looks like.

And when we have that discussion, let's talk about bands, exclusive use, shared use, licensed opportunities, unlicensed opportunities, you name it. But we should also talk about how funds raised from the auction of our public airwaves could be put to public purpose, because with the reauthorization of spectrum auction authority we have a golden opportunity to use the billions of dollars that FCC spectrum auctions raise to build the public infrastructure that this country needs.

And Congress can start with using future auction revenues to fund the nation's transition to next-generation 911. This creative approach has the support of first responders across the country because it would benefit public safety nationwide, and every one of us who dials 911 when the unthinkable occurs. In short, we can have an updated public emergency calling system that is built for the digital age, and we can use public airwaves to help do it.

Second, we need more mid-band spectrum in the pipeline, and we need it sooner rather than later. While Congress works on auction reauthorization, there is no rest for the weary. We need to keep up our efforts to find more airwaves in the mid-band spectrum pipeline, following our successful auctions of the 3.45 and 2.5 gigahertz bands.

As I said at the start, these mid-band airwaves are essential for 5G services to reach everyone, everywhere. But they can take us even farther. In fact, at Mobile World Congress this year, I announced that in the United States we are already thinking about mid-band spectrum for 6G service. I know, I know, it's still early days. But it's not too early to set our sights on bands with promise that can help lead us into the future, like the 7-16 gigahertz range.

And on this front, I am really pleased to announce that we are making progress and moving this mid-band effort forward. Earlier this month, I shared a draft notice of inquiry with our colleagues at NTIA that would explore repurposing spectrum in the 12.7-13.25 gigahertz band for next-generation wireless technologies. That could open up to 550 megahertz of new mid-band spectrum. And when this coordination is complete, I'll share the notice with my colleagues for consideration at our October agenda meeting.

Third, we need to consider receiver performance so we have more spectrum security in the future. So much in spectrum policy focuses on airwaves and auctions, distribution and deployment. And when we talk about spectrum efficiency, it typically has been a one-way effort. We focus on transmitters. But efficient use of our airwaves is a two-way street. And receivers matter.

But when low-quality or imprecise receivers are widely deployed, they can make it harder to introduce new services in the same or nearby frequencies. This has consequences that are broader than just spectrum policy because this equipment can degrade the spectrum environment for all of us by limiting its economic potential and innovative possibilities.

That is why the FCC recently launched a notice of inquiry on receiver performance. It asks about incentives, guidelines, regulatory requirements. It even asks about procurement practices that could help create a more transparent and predictable radiofrequency environment for all users.

It's time to consider these concepts because, if we get them right, we will have more airwaves available for new services.

So there you have it. Those are three ideas to push us forward at the fifth annual Spectrum Symposium held by our colleagues at NTIA. And they are all tied to one essential principle – the belief that in the United States we have led the world in wireless because we are hardwired to seek out the creative possibilities of the future.

And as we develop what comes next in spectrum policy, let's be sure to keep that front of mind. I know I will. Thank you so much for having me here today. [applause]

CHARLES COOPER: Thank you, Chairwoman Rosenworcel, for your remarks and your initiative and energy in revitalizing the relationship between the FCC and NTIA.

At this point, we're going to take a short break, just a few short minutes, five minutes, to set up for our first panel discussion. Leading that first panel discussion will be Derek Khlopin, the Deputy Associate Administrator of Policy Issues within OSM. And he'll introduce our panel at that time, which will be comprised of key officials who are actively participating in discussions surrounding the national spectrum strategy. Thank you very much. We'll be back in five.

[break]

DEREK KHLOPIN: Appreciate the opportunity today to lead this panel, and I want to thank, as my colleagues have, everyone for being here today. Really excited to kick this one off. It's a great transition from the morning keynotes we heard this morning.

This panel is on perspectives for the progress towards a national spectrum strategy development. As demand for spectrum continues to grow, policymakers are grappling with these issues, and we've converged on the need to develop a more comprehensive approach.

So I have an exciting panel of federal government representatives with me today, and I'll go ahead and do some introductions, and then we'll jump right in.

First is Austin Bonner, and Austin is the Assistant Director of the White House Office of Science and Technology Policy for Spectrum and Telecom Policy. As part of a growing tech team inside OSTP, Austin develops telecommunications policies that advance prosperity, security, environmental quality and justice for all Americans. She provides expertise and OSTP leadership in a variety of interagency processes and White House working groups on spectrum policy, communications security and reliability and wireless innovation. Austin joined OSTP from the FCC, where she served as legal advisor and acting chief of staff to Commissioner Geoffrey Starks, helping to shape new FCC programs designed to promote broadband access and affordability in response to the COVID-19 pandemic, including the Emergency Broadband Benefit and the Affordable Connectivity Program. Prior to the Commission, she practiced communications and appellate law in two leading DC law firms, and clerked for a federal appellate judge. Austin serves as an adjunct professor at the Georgetown University Law Center, where she received her JD after earning a bachelor's degree from the University of Texas at Austin.

Next to Austin is James Linney. James is the FAA Director of Operation Support under the Air Traffic Organization's, the ATO, Technical Operation Service Unit. Operations Support is on the

leading edge of changes to the National Airspace System, or the NAS, which also supporting national policies and engineering needed to run the safest and most complex air traffic control system in the world. Operation Support is responsible for developing and ensuring adherence to NASS policies and managing requirements affecting technology changes to critical air safety systems. Operation Support also manages the FAA's spectrum policy services.

Next up, we have Phil Murphy. Phil is Senior Advisor to the Assistant Secretary of Commerce for Communications and Information, and NTIA administrator. Phil advises the Assistant Secretary and NTIA leadership on broadband, spectrum and other telecom and technology policy matters. Before joining NTIA, Phil has served as Senior Advisor and Legislative Director to Congressman Mike Doyle, Chairman of the Communications and Telecommunications Subcommittee of the House Energy and Commerce Committee. He has directed and overseen the Congressman's legislative agenda and his chairmanship of the subcommittee. He also served as staff director of the Congressional Robotics Caucus. Previously, he served as a legislative clerk for the Subcommittee on Telecommunications and the Internet under then-Energy and Commerce Chair John Dingle. Phil grew up here in Washington, DC, and is a graduate of Union College.

And then to the left of Phil is Umair Javed. Umair serves as Chairwoman Rosenworcel's chief legal counsel. From October 2017 through January of 2021, Umair served as then-Commissioner Rosenworcel's legal advisor for wireless and international issues. Umair joined the FCC from Wiley Rein LLP, where he was an attorney in the firm's telecom, media and technology practice group. He's also served on US delegations to treaty-writing conferences and meetings of the ITU, and is Commissioner of the Consumer Protection Commission of Fairfax County. He graduated from the University of Virginia and received his JD from the University of Virginia School of Law.

Thank you, all, for joining. We'll jump in here. I want this to be a conversation. I may direct some questions to some panelists, but everyone should feel free to chime in.

We just heard from the Secretary of Commerce, Gina Raimondo. Again, she cited the need for a comprehensive national spectrum policy. We heard that from our Assistant Secretary as well, as well as Chairwoman Rosenworcel. So I guess my first question may be for you, Austin, to lead off, if you can give a little more thoughts on why this is important to the administration right now.

AUSTIN BONNER: Sure. Thank you so much, Derek. And I hope you'll indulge a point of personal privilege for me to say, many of us have worked together in this room for years, but it's a real pleasure to see you in person and to see you in my new role. I have a slightly redundant title at OSTP, working on spectrum and telecom policy. I hope the emphasis on spectrum is clear how much OSTP values that part of the work and sees it as really essential to so many of the other missions that OSTP is engaged in.

I also want to say while I'm here with you today and so excited to be, there are many other folks inside the White House who care very much about these issues – on the National Security Council, on the National Economic Council. We work together to help shape this interagency process and to underscore why this is so important for the administration.

Why is this important? I think everything that the administration is trying to do has somewhere in it, somewhere in the stack of things that we need to get right to make it happen, getting our spectrum and telecom policies right. We want lower cost for Americans. We want equity for the many low income Americans who rely on their smart phones primarily. We want telemedicine that meets people where they are that tackles our big needs right now, even as the, I think, environment is changing around COVID. We want cutting-edge research that fights climate change. We want a national defense system that's ready when we need it.

All of these priorities require us to get our spectrum resources lined up, and in the places that we want them. I think when we talk about spectrum, we often start from talking about the scarcity. And that makes sense; we have a limited resource. We have to figure out how to divide it up amongst many competing priorities.

But I would like us to start from the place that that scarcity is happening because so many federal agencies, so many people in industry and academic, in state, local and tribal and territorial governments, and many others have developed wireless technologies that make our lives better. We have a good problem, that we have so many great things we need to balance across the spectrum. [laughter]

So I think that's a good place to start for why it's important.

DEREK KHLOPIN: That's great, I appreciate that. I don't know if others have comments on why it's important. I think we could probably fold that into some initial thoughts on what elements you might want to be included there as well. Umair?

UMAIR JAVED: Thanks, Derek, first, and thank you, Austin; I agree with everything you just said, I think that was great. We need a national spectrum strategy because we need a plan for the United States to continue to lead the world in wireless. It's important for our economic security and it's important for our national security. So we have to get this right.

If I could add one thing is that I thought all of the speakers this morning did such an amazing job of really defining the task before us right now. Count on Secretary Raimondo and Chairwoman Rosenworcel and Assistant Secretary Davidson to really capture the essence of a complex problem in really just a single sentence. I thought it was great. Each of them, in their own way,

emphasized that we have to rethink what the future looks like. That's what the job we have before us is.

And I think Austin is exactly right. As we do that, we have to think about the fact that spectrum policy is under stress and strain from so many new challenges. Good challenges, right? There's the constantly evolving technological capabilities that we have. There's evolving threats to safety and security. There's the radio congestion we have from receivers that we heard from Chairwoman Rosenworcel this morning. And there's, of course, as Austin started out with, the finite nature of the spectrum itself.

So all of these are things we're going to have to struggle with. Now, Chairwoman Rosenworcel in the past has said that these are challenges that no single entity can meet alone. I think that's right, and I think that's why we're having this discussion, to develop a plan for coordinating and tackling some of these challenges. So I'm very happy to be here with my colleagues having that exact discussion.

PHIL MURPHY: First, I just want to say it's great to see everyone as well. It's good to be in person. What's amusing when I came into this room is, the last time I spoke here, I realized, was at my high school graduation, which was hosted in this room. [laughter] And I was just getting some PTSD about that experience.

UMAIR JAVED: You've come a long way.

PHIL MURPHY: [laughter] A little bit. Big leaps, short steps. I just want to echo the things that both Umair and Austin were saying. We need a forward-looking document that accounts for both the needs of federal users and the commercial sector. We need a really inclusive process that accounts for the needs and the feedback from both the private sector and federal users. And

we really need that to result in a durable result, of something that comes together and that we enact, and that sticks.

And I think those are NTIA's top priorities. When we think about the needs of the federal user community, I think oftentimes folks talk about federal users not using spectrum efficiently. I think coming from the Hill, spending a lot of time working with commercial wireless partners, I think seeing the other side of the rainbow at NTIA has opened my eyes to just how innovative federal use can be. And not only that, but how innovative they want to be. I think in the same way that the commercial wireless sector's thinking about, what are all the ways that we can leverage spectrum to achieve our missions, federal users are thinking the exact same thing. And they're working to develop next-generation technologies that make our nation more secure, that enhance public safety, that allow us to do that next-gen cutting-edge research, that allow us to predict hurricanes so that we can warn people, like what's going on in Puerto Rico right now.

Those things are essential, and it's hard to quantify the value that's attached to those because we don't think about those public goods in terms of dollars and cents, right? But they are essential to the economic prosperity of our nation.

So as we think about what the spectrum strategy is looking to do, I think our focus is on making sure that we can account for both of those domains and achieve both in a way that projects excellence, not just now but in the future.

JAMES LINNEY: Yeah, I'd love to pile on one more thing. As a user and an internal, if you will, regulator around delegated capabilities, we think at the National Airspace System in 20 to 30-year windows. So we have a roadmap that we're trying to follow. Without the spectrum strategy, we're really laying out a roadmap assuming nothing's changing around it. And the world is changing. So for us, having a strategy that we can point to helps us plan well in advance of the technology changes.

A year or two before we're getting ready to sell or share is too late because it takes years of acquisitions and research and development and technology-proving. Especially on life safety-critical systems that we use. You wouldn't want a heart transplant that was designed in a year; you'd want lots of peer-reviewed study analysis. We treat the National Airspace System the same way.

So I really liked what you said around, there is a huge desire on my team to innovate. So I think just opening the gates and getting out of the way for my team will help with a strategy in place.

UMARI JAVED: First, I should say Phil is being humble. He was actually voted, at his high school graduation, most likely to be back in this room giving a spectrum speech. [laughter] So it came true.

Derek, you also asked what elements do we want to see in that spectrum strategy. And there, I think the most important thing, from the FCC's perspective, is that we move beyond high level principles and we start talking about an action plan that we can complete in the next two or three years. That's how we're going to get to spectrum processes that are delivering value to American consumers. that's the most important thing that we want to see.

So Chairman Rosenworcel said three things in her speech earlier this morning that I think provide a good map for us to do exactly that. First, she said that we need to refresh the nation's spectrum pipeline. So that means we have to start a conversation about spectrum, about actual bands, starting in the 7-16 gigahertz range. To do that, you heard her say this morning that the FCC is hoping to move that conversation forward with our colleagues at NTIA with a notice of inquiry on a new slice of spectrum, the 12.7-13.25 gigahertz band.

The second thing she said is that we need to use this moment to think about statutory reforms. And so, one thing we're looking at there is how we can take the funds from the auctions to do some of the infrastructure projects that this country needs. Short-term goal there is funding the development and deployment of next-generation 911 across the country. That's something that'll benefit public safety in every state.

And the third thing that we're looking to see in a national spectrum plan is that we start to clarify spectrum rights and responsibilities. And again, you heard Chairman Rosenworcel talk about that as well in the context of receivers and the impacts that they can have for spectrum access in this country.

So those are three quick things that I think we would be looking for discussion of in a national spectrum strategy.

DEREK KHLOPIN: Thank you. That leads me to maybe ask– last week, when we talk about specifics of a plan or strategy, the Aspen Institute released a report. And I know some folks have probably had a chance to take a look at that. It's called "Toward a National Spectrum Strategy," with the core premise that the federal government – surprise, surprise – needs to issue a strategy, one that would be issued and periodically updated. It's very consistent to the calls we've heard this morning.

So I'm not going to bring up all the specific proposals, but I'm wondering if anyone has any initial reactions to that report, whether it's a useful contribution, any specifics, any thoughts. Phil, I'll toss it to you first.

PHIL MURPHY: First of all, I think we appreciate the work that the Aspen Institute did and that some of the authors and contributors of the report who I see here worked on. I'd just say, at a top level, it's always nice when you have a group of experts working on something. They deliver

a product and you sit there and read, like, Oh, we thought the same thing; we're not in total disagreement.

So we really agree that this is a priority. We need to update a strategy. I think we kind of think this is an evolving document; this is something that needs to be able to meet the moment because spectrum management is increasingly challenging.

I think one of the things that we thought was good to see in it was part of the focus on advanced sharing technologies. I think at NTIA, our assistant secretary talked about the incoming informing capability and our need to leverage innovation to attack some of these challenges. I think there are not a lot of easy bands left, if any. And we need better tools to be able to innovate our way through it.

The Secretary talked about how we're focused on competition. I think unleashing the power of innovation and American innovation is the way we outcompete other folks and we create new opportunities.

So I think we're really excited about the potential for advanced sharing technologies and the possibility for IC. I think in particular, when we think about that technology, we think about the possibility of creating a platform for sharing, that's validated, that's off the shelf, that when we're looking at a problem we have a solution that's available. Because right now, when we think about sharing, we really have to develop a bespoke solution for each individual band. And that takes time; it takes time to validate. I think for federal users in particular, they want to be sure they can depend on those kinds of systems. They want to do their own safety checks at times. There are other kinds of issues that are in play.

And so, if we can really work together and create a system that works for folks and that people feel like they can rely on, we think that could be a real tool for, I think, creating a better future.

Another area that we think about a lot is just the methodology of how we get federal agencies to better understand the FCC's processes, the way they think about problems. Because federal users don't think about things in the same way. They don't think necessarily in terms of harmful interference. They think about national security, they think about public safety, the impacts on the national airspace.

And so, how do we bring federal users and the FCC closer together? I really was encouraged by some of the discussion on cross-pollination and how we can do staff sharing to enhance that pipeline of workers who can do this kind of work. I think particularly at NTIA, we certainly feel the bite of that pipeline when we're looking for new RF engineers. When people are thinking about what's the hot, new thing to go into, RF is not necessarily that thing. And so, we need to figure out a way to incentivize folks to go in.

There's a lot in that document. I think it's going to really, hopefully, accelerate this discussion. And I think there's a lot we're excited about in there.

AUSTIN BONNER: Phil, if I could just add on the Aspen report. I want to underscore that talent pipeline point. I think that's really maybe an underreferenced part of the challenges that we're facing. Building a strong STEM pipeline across industries is an important priority for OSTP and for the White House, but in this particular case, it's something that I think we need to move fast on, given where our federal workforce is.

I also note they point out the need to provide some technical training for folks of us who are, like many of you in this room, voyeurs and not engineers working on these problems. I was saying to these guys, I feel like I really benefited as a young lawyer from having some folks around who were able to give that training. I remember pretty distinctly working on a set of comments early in my career and getting called in by an engineer who said, So what we're going to do today is

I'm going to reteach you how to do logarithms, and then we will have the conversation we need to have.

Not everybody gets that kind of intense training, and I think a lot more of us need it, actually. And I think Aspen did an important contribution pointing out those needs.

DEREK KHLOPIN: Any other comments?

UMAIR JAVED: I'll just echo what Phil and Austin just said. I know a lot of you in this room contributed to that report. And thank you to Vivian and Trisha at the Aspen Institute for, one, bringing all of us together, facilitating that conversation and shepherding that document to the place where it is today. I think it's very helpful. We're looking at it. I'm certainly not one to complain when others want to do our work. So thank you. [laughter]

It will surprise no one in this room to hear that the part that I enjoyed the most about that report was the discussion about spectrum band. So I think you guys did a lot of heavy lifting in cataloguing some of the places where can look next. So I'm looking forward to having that conversation with everyone at this table as well.

DEREK KHLOPIN: Excellent. So maybe this is for Phil and Umair who are drilling down, and James, and whoever wants to comment. How can a strategy or development of strategy further enhance the coordination between the agencies? I think we've heard some references to some things already today.

PHIL MURPHY: I think Alan talked about– I think one of the first things that he did when he started at NTIA was to launch the Spectrum Coordination Initiative. So you can see that the first step, I think the first major step for us has been to focus on coordination. I think following that up, we worked on the MOU with the FCC.

One of the things that we found is that we need to get back to regular order. There really needs to be this renewed focus on the processes that we have in place, working thru the IRAC, the PPSG, basically our internal governing bodies and advisory bodies inside the federal government for spectrum use. And to figure out how we can leverage those in new ways to attack some of the new problems that we're facing.

All too often we have good structures in place when it comes to issues that have to do with federal bans, and even federal adjacency issues. But increasingly we're seeing challenges in bands where agencies have federal equities. And I think what we're trying to do is build a system that can account for those challenges. And I think the piece of it that we think about a lot is long-term planning, as James said. Most agencies don't think about issues in terms of one-year, two-year or five-year terms. And when they acquire a system, they acquire it for 10, 20, 30 years. And they don't think about upgrading that system for 10, 20 or 30 years.

And so, we really feel like the important thing on the coordination side, and the reason why the strategy is so important, is that it gives us an opportunity to have that big holistic discussion with federal users to understand what they need, and when, where they can share, where they can't, where they think they want to modernize, and where they think things are going to be really challenging.

And I think we knew a lot of that already, but this is a real opportunity to build a process that's inclusive and that gives the agencies an ability to stand up and say, We have this need, or We want this need, and for us to have a real discussion about how we get there and how we do it in a way that also creates space for commercial opportunity as well, to meet the commercial side spectrum needs.

UMAIR JAVED: I think that's exactly right. The way that I think about this is, there are so many challenges facing spectrum policy, but the one thing we have in our power right now is to deliver real and effective cooperation. And cooperation that can helps us build a more prosperous and a more sustainable future. So that's something that's important.

The good news is that we're not waiting for a national spectrum strategy to start that work. And you heard some of that this morning. To start, the FCC and NTIA have a long history of working together and delivering real results for the American people. I think anything that we do going forward has to build on the fundamental strength of that relationship.

And the next thing you heard Chairwoman Rosenworcel this morning is that she has made a priority to improve the way that we coordinate on spectrum policy issues. And so with Assistant Secretary Davidson, they have announced the Spectrum Coordination Initiative. As Phil was saying, they've already delivered an updated memorandum of understanding for the first time in nearly 20 years. And thank you to Ethan in our office who helped represent the FCC in those discussions.

PHIL MURPHY: And Derek, too.

UMAIR JAVED: And Derek as well, that's exactly right. So we're very excited about that.

Now, where do we go next? We have to expand that conversation. So we have to expand the conversation beyond the FCC and the NTIA. And so I'm very happy that James is here, and I think it's a good sign of that effort, of, how do we give voice in the appropriate ways to other stakeholders that have spectrum interests.

A lot of times what we hear when we try to have that conversation is that we need to rebuild trust, that trust in the process has been lost and we need to restore it. I think that's true, I think we do need to do that. But I have two reactions to that.

First, as we think about how to rebuild trust, let's also think about how do we make spectrum policy work in a zero-trust environment so that we're not put back in those same situations in the past.

And second, when we talk about trust, I think it's really just another way of talking about risk allocation. And here, I absolutely appreciate and acknowledge that for some of our federal agencies, the risks are asymmetric. And this is especially true when you're talking about adjacencies. When the FCC introduces a new use and there are adjacent federal or other users nearby, those risks can be asymmetric. They take the risk that the interference environment will be what the FCC will be, that the costs to upgrade equipment will be what we all estimate them to be, that whatever the new use is will be as beneficial to their environment as we think it will be.

And this is why Chairwoman Rosenworcel has started to talk about risk allocation and has said that if we really want to tackle this problem and get to a better place, let's think about how we change that conversation. And she's pinpointed the Commercial Spectrum Enhancement Act as a place to do some of that. Right now, it funds the relocation of incumbents in spectrum bands, but what if we expanded that? What if we also started looking at how do we make whole federal interests that might have adjacent interests? How do we create opportunities not just to relocate but to upgrade federal systems? How do we change that risk dynamic in some of these conversations? I think that's another conversation we're very interested in having.

JAMES LINNEY: I wanted to stand up and clap. [laughter] I think that's a great point. A lot of our systems, as I've said before, are 30-plus years old. The aircraft industry, the aviation

industry, they buy an airplane, they don't want to touch it; they lose money every time they touch it. So it's an economic issue on them.

But I do think if we can find a way where it's– the win/wins are there, if we look for them. For example, some of our systems, we could benefit from an update, but maybe can't make a business case on the update alone because the update just makes it slightly more efficient to maintain, or slightly less energy consumption for that system.

But if upgrading that system I could be more spectrum stingy with it in its future design, either to narrow its performance or get it out of that band altogether, now we've got a business case that suits everybody's needs. Because it's got commercial benefit and it's got government benefit. Because we're always looking for driving down our costs and being more efficient with maintenance.

When we have to go out and replace circuit cards or motherboards in 30-, 40-year-old equipment, none of us want to do that. That's the only work I could do, because I couldn't do anything more modern; I trained as a technician. That was the only work I knew because the equipment was so old, whether it was military experience or in the FA.

So yes, yes and yes, I think it is the combination of benefits. And you said it a minute ago, Phil, the word that I like, that resonates with me a lot is transparency. Why can't everybody, while protecting national security interests, know what the problem space is? And know what opportunities bring to bear? And let industry be part of the solutions with us. Because we have a lot of vendors who sell us their traffic control systems who would love to come and sell us a another version of it. Well, what if they were part of the design and the solution? What if it was more of a crowd-sourced effort to solve the problem together? Because I do think there's hope there.

AUSTIN BONNER: I'll just add that I think the foundation of all the cooperation that we just talked about really is information sharing. I have started my tour of meeting with all the federal agencies who have major spectrum concerns. If I haven't gotten to you yet, I'm coming. Working my way through. And what I'm learning in those conversations is that a lot of the information that policymakers and people who are planning a national strategy really need is, with a lot of different folks inside agencies, and it's really important that those things be filtered up and shared across NTIA, shared with the FCC at an appropriate time. It's one of the things I think is so important and another reason we ought to congratulate the FCC and NTIA, their MOU is being really thoughtful about how to make sure all of that information sharing continues to flow in a way that's productive for everybody.

PHIL MURPHY: I was just going to add, I completely agree with Austin, but echoing Umair and James's comment on CSEA update, I think as we think about moving forward, I can think of a number of issues with FAA and with other federal agencies where they have systems that are end-of-life and all we can offer right now under the statute is that same system that's already 30 years old, but not at end of life. And I think getting more flexibility to think about things that go beyond just replacing a similar capacity. Because we need better incentives I think when we're working with federal agencies to help them think about how they can acquire these systems that could be more efficient or stingy, to give them incentives to come to the table. Because I think that's one of the challenges that we face right now with that framework, is, those incentives don't necessarily align with the value of the spectrum and with the mission of the federal users.

DEREK KHLOPIN: That's great. James, maybe I'll come back to you with this. You talk about the most capable technology. I think there's sometimes a narrative out there that federal agencies are inefficient with spectrum use and sometimes it's about the amount of spectrum that's available to the federal government, which is significant. But maybe as an opportunity to kind of debunk that a little bit, why does the FAA and the federal government in general need all the spectrum access? What's some of that balance that we're trying to achieve?

JAMES LINNEY: Yeah, that's a symposium all by itself, I think. [laughter] But if I think the diversity of our national airspace system is one thing that I don't think is widely understood. Most facilities don't look exactly like every facility. And a lot of our technologies were put in in phases as evolution of technology came in. And then every time we changed something on the ground that talks in aircraft, now you're talking about changing it on the aircraft, too. And that's a lot of change in a structure that is change-averse.

So we mentioned risk. So that's half of my job, is talking about risk, risk management. That doesn't mean no risk; it means managed risk. But for us, I think the challenge can be if it's oversimplified and we don't take the time to appreciate the complexity of a network of systems. It's not about just looking at the spectrum chart on the wall and saying, I see 2 gigahertz there; or, I see 50 megahertz of space. It's not that simple because it depends on where you're operating, it depends on the altitude, it depends on the geographic terrain; it depends, it depends it depends.

And we've seen it on the aviation side. And I don't work on the aviation safety side, we're on the operations. But on the aviation safety side, the extent to which they have to test a piece of avionics, the temperature extremes they run it through, the dynamic environments they put it through, all those things take time. And I think in my years of working programs in the FAA, I would get asked often from folks on the Hill, rightly so, Why do these programs take so long to go, why does it take them so long to get out the door?

Well, it takes two years to build a business case; two years to effect the budget. Then we've got to deploy it. And changing an engine going down the highway at 70 miles an hour is hard. So when we upgrade a major automation system, a radar system, we can't turn it off and say, no planes this week in Southern California while we upgrade the air traffic control system. It has to be seamless.

So I think it's difficult to understand the complexity that change represents for us. But internally, what we have to take ownership of is that not changing is not serving the taxpayers any better than being resistant to change.

We want to protect the taxpayers. We're all about serving the public; that's why we get into this job. But serving the public can also mean, let's find a way to modernize and serve the public at the same time. And it's difficult; it is a very difficult balancing act.

And in the job-sharing, I would welcome anybody to come in to the federal government and watch the change process work and watch how long it takes us to get through our own controls that are in place. For good reason.

When I went to, my first introduction a dozen years ago, to the Federal Executive Institute, I remember one of the instructors saying, The US government was built inefficient by design [laughter] by the forefathers, who did not want it running away with itself like the governments it modeled the best of. That does not mean it can't move; it just means it's got a lot of checks and balances in it. Rightly so.

Again, I go back to the optimistic view that I tend to have with things – we have people, some here in this crowd, who would love to innovate, who would love to go research a better way to go build a better mousetrap. But we're not incentivized that way. We're not funded that way. At least not my team; my team is 24/7 operations. We're watching radar systems around the clock, we're watching radar communications, navigation, weather. That's our job. So it's hard to put the pencils down and say, Let me go build a better transmitter or receiver.

So it's both.

PHIL MURPHY: Just echoing James's comments, I would say as we at NTIA look at this challenge and look at the challenge and the missions of other federal users, I think what we see is that one of the reasons the federal government uses so much spectrum is because the federal government is one, if not the most advanced user of spectrum in the world. I think the missions that the FAA does, I think I've heard may times from FAA that our national airspace is the most complex in the world. You talk to DoD about their missions; the kinds of things that they are doing with spectrum are incredible. And I think a lot of folks rightly so have no idea exactly how that all works, but I would say on the other side of the Rubicon, it is really incredible to see the kind of advanced uses of spectrum and the missions they're supporting with it. The same is true with NOAA and the work that they do. The same is true with NASA and the work they do. And the same is true with a whole host of other federal agencies, that without spectrum they could not do their missions. And those are things that we all depend upon in order to facilitate, I think, the economic prosperity that we experience here in the United States.

And so, when folks are saying, Well, can you quantify that dollar amount, it's really hard to because safety and security and prosperity, and all those things that we enjoy here in the United States, are things that we kind of assume. And I think as we think about what federal users can do with the spectrum, certainly they can be more efficient, but I think, as James said, they're open to that. And I think they want to be partners, and they see the opportunity here as well.

UMAIR JAVED: I think this discussion has been great, and I think if I would add anything it's that let's not look at this as an either/or situation – as a situation where we're either protecting federal missions or we're promoting commercial innovation. There are many instances where federal agencies are using commercial technologies to complete their missions. And so, when we grow our wireless economy, that's a rising tide that lifts all boats. And so, I think we should keep that in mind as well.

Spectrum is a scarce and critical national resource. And I think we should all agree at the front end that we should make decisions about it using the best information possible.

One thing that strikes me is that right now our spectrum pipeline discussions, they feel a lot like Go Fish. The commercial sector will shadow ban 10 gigahertz and everyone will look at their cards, no peeking, and inevitably someone will come back and say "go fish." Well, what if we were all better about putting our cards on the table? Imagine what we could accomplish then.

We could start with some kind of inventory, with some kind of long-term planning. We could go to the federal agencies and have a conversation about, what are your spectrum assignments and how are you using them? This was a recommendation that came out of the CSMAC back in 2010, out of their spectrum transparency working group. There was a concept that was incorporated in the Obama administration's Presidential Memorandum on Spectrum. I think it's a good idea. And I think that type of transparency and information sharing would go a long way to at least defining that gap between artificial scarcity and actual scarcity.

DEREK KHLOPIN: Thank you, that's great. Phil, you mentioned, all of you did a little bit, spectrum sharing as part of a strategy, but to dive a little deeper into that, what role can that play there? Secondly, how do we expand the tool kit for spectrum sharing, tools and techniques? And when I say spectrum sharing, broadly defined.

PHIL MURPHY: I talked a little bit about IIC; our Assistant Secretary did as well. I think when we think about the success of CBRS, it really has been a success. There's a huge amount of investment and innovation that's happening in that band. I think what we see is that there's a real appetite for shared spectrum and that there's a real set of use cases that the private sector wants to develop around increased availability and access to spectrum.

And so, we know that federal users aren't using their spectrum nationally all the time. And I think CBRS showed that there's a way that, even for a critical DoD mission, that we can share in places. That doesn't mean we can share everywhere, but I think it means that there's opportunities that we can leverage.

And as I said, developing a platform that's validated, that DoD feels confident in the safety and security of, that the FAA and other users feel confident that they can share in a way that doesn't impact their primary missions, for us we see a real value in standing up that kind of system. Because this is not getting any easier. And we need to think about this world as being more constrained going forward. And we need to think about how we can create these new tools and new opportunities for folks, and to see what the private sector can do with that kind of access to spectrum. Because I think increasingly, we all know that exclusive licensing is the gold standard on the commercial side. But that's becoming harder. And I think we also see that there's a real appetite for shared opportunities.

And so, I think what we want to do is create opportunities both for fully licensed exclusive use bands, but also for shared bands as well. And I think we see a lot– it's something we're very excited about.

AUSTIN BONNER: I just want to add, I think there's obviously a clear need for a mix of governance models. We need licensed use. We need unlicensed use. We need shared use. There are a lot of really interesting things going on in sharing research and development that we should be excited about. The existing world of sharing today includes a lot of different kinds of models that work there.

I was just saying to some folks this week that the sharing in the five gigahertz band with wifi is so successful that people forget it's shared and think about wifi operating pretty independently there. That can work in some places. But I think we are really looking for denser, more intense

kind of opportunities. And there's great research and development on this. I'd like to see investments that help move those folks who are operating at the academic level into the policy options level. But we're coming to this question at a great time, I think.

UMAIR JAVED: I think that's right. Let me say first that there's always going to be a role for exclusive spectrum rights. I think they've provided great value to the country and that's not going to change. But obviously, as our airwaves get more and more crowded, and as we move to higher frequencies, as well, I think that we're going to increasingly come up against the idea that sharing might be our best opportunity for creating new opportunities for investment.

And I think this is something that businesses and engineers are realizing as well. You don't build a single-family home in downtown Manhattan. And as our spectrum chart gets more and more crowded, I think some of this will move to more shared opportunities.

For Chairwoman Rosenworcel, sharing is a top priority as well, expanding the way that the FCC promotes sharing opportunities in the spectrum chart. One thing that we have considered at the FCC is that a lot of our policies are really still based on the technical characteristics of spectrum below 6 gigahertz. But the truth is, especially as you get higher in the range and to millimeter wave opportunities, those technical characteristics change, and sharing becomes easier and a lot more beneficial to some of the uses that you would do in those types of areas.

So I think that this is an exciting time for this discussion because the range of access products, the range of technologies that enable sharing are increasing.

But the last thing that I'll say on this point is that when we have these sharing discussions, it's important that we differentiate between sharing technologies that are available today and sharing technologies that are going to be available in the future. And I think a lot of time when we talk about, what can we do in this band, a lot of the input we get in is, well, wouldn't it be great when

we have this sharing technology five or ten years from now to do that? And that's good, let's work towards that, but let's also keep focused on what we can accomplish today.

JAMES LINNEY: And I hesitate to say it, but a cautionary tale around sharing that I think is mitigated again by communications and coordination is bounding what those, let's all them two systems in this case, will do. And realizing that their missions and needs may evolve. So as you are looking at ways for us to share frequencies, that can work if we can visualize on having the strategy, what's the future for that spectrum? What is the plan for that user and that system? And are they geographically contained? Or are they going to be spatially controlled in some ways?

And that just comes with good communications and cooperation. And everybody, again, laying all the cards on the table. I love that analogy. Because we have to look at that. Because for us, airports change. One of the things I'm glad I don't do in the FAA is field noise complaints. [laughter] Because airport approaches changed airports, and airplanes didn't go over your house yesterday and now they do today.

So we just have to recognize that the world is changing around us, and as we share, we just have to be mindful of what's the strategy beyond today for those frequencies and those systems so that we can share and maintain the sharing partnerships that are there.

AUSTIN BONNER: Cards on the table is a good plan.

DEREK KHLOPIN: Thank you, that was great. I was going to offer an opportunity for some parting shots, but it almost felt like those were really good wrap-ups. But if anyone wants a final word?

UMAIR JAVED: Just thank you to all my fellow panelists here. The thing that gives me optimism is that everyone at this table really does want to see the United States lead on all of its priorities. And so, I'm encouraged and excited about what we can accomplish.

PHIL MURPHY: I would just echo those. Obviously thanking NTIA, where I work, is a little odd, but the 07[?] team does a great job. I want to thank the panelists though. I think as you can see from the depth and breadth of this group, we do think a lot about this. We work really hard on it. I think it's not always apparent to folks outside the government how much time folks in the interagency and at the White House spend talking about these issues. But we are talking multiple times a day, every day. A little bit less often on weekends, but on weekends as well, about these issues. And it is something that we are really passionate about and we really are working very hard on.

JAMES LINNEY: Thank you for including us. That was a gracious invitation from NTIA, so thank you. Love to have a seat at the table in these discussions. And I'll put the shoutout, stealing from the Aspen Institute's recommendations about resource pipeline: the FAA is in dire need of RF spectrum engineers. Come one, come all.

But I do think it's going to be– I think there's a new era in place. And I'm excited about being involved in these conversations. And my team specifically – and I know my partners at DoD, DHS and others have the same – are some of the best in the world at this. And I'm looking forward to what we can do together. So thank you.

AUSTIN BONNER: Well, hear, hear! for that. I'm glad to see the cooperation that we're all hoping for embodied at the table and in this room. This is a great time for American leadership in wireless, and we're really looking forward to working with all of you. So thank you for being here.

DEREK KHLOPIN: Thank you. I appreciate all the panelists. I think Phil wrapped it up well from the NTIA perspective. We're really excited about the collaboration, and we're also really excited to have White House leadership and engagement. And to the public, too, we know that's a big part of our process, and we look forward to engaging with all of you.

So thank you very much, panelists. [applause] I believe we're going to have our national security keynote here without a break. Thank you.

CHARLES COOPER: Thank you, Derek, and to the first panelists. We're just getting started, if you can believe it. And kudos to Austin as well for the use of the word "logarithms" in the panel. As an engineer, I always appreciate that. Everything's not linear, for sure.

So it's now my pleasure to introduce a gentleman who is a key partner in this effort. John Sherman leads the Department of Defense's Information Management and IT Efforts as the Chief Information Officer, a position that gives him a key role as architect of the Department's spectrum policies.

With a background both in IT and intelligence communities, Mr. Sherman is one of the country's premier experts and policymakers on issues of network and cybersecurity in the national security aspects of cloud computing and interoperability. He oversees all of DoD's efforts to use spectrum effectively and efficiently to ensure our national defense.

Please welcome, the Honorable John Sherman, who will deliver keynote remarks. [applause]

JOHN SHERMAN: Good morning, everybody. It's great to be here with you on this wonderful September morning. I am grateful to be here. I want to thank Alan Davidson and the NTIA team for having me come here. And I also know we're live streaming this, so hello to everybody that's watching this virtually.

As mentioned, I'm John Sherman. I'm the Department of Defense Chief Information Officer. I'm also a kid from south Texas who grew up down near Victoria, Texas, near the oilfields down there. And I heard terms like mineral rights and other things as I worked summers in the oilfields there. And I mention that because, as I moved up to the technology space, and particularly working in spectrum, I often see echoes, as historian, as well to what we did in the energy sector in the last century with a finite resource that is critical for our national economic development, national security and the business of government and how we're going to make the most of it to our nation's advantage – economically, militarily and otherwise.

And I want you to know as the DoD CIO, we absolutely get it at the Department of Defense, that we need to balance our economic advantage by maximizing spectrum, as well as being able to observe our national security responsibilities. We have to be able to balance that.

At DoD, you'll hear us talk about our pacing challenge. And by that we mean China, a country who's moving along technologically, economically, militarily and otherwise at a very fast clip. And I talk about this a lot to defense audiences but having the privilege of talking to you, I would say they're challenging us in many spaces, not just with defense and military, but in economic, technology, spectrum and otherwise. And we all better be able to rise to the challenge of what they're presenting.

Defining the spectrum way ahead is critical to our nation. And I know the panel, I heard a little bit sitting in the green room here, talked about our way ahead, how we balance this. And there were some great remarks said by FAA and others a moment ago about the challenges of this and being able to balance the different equities.

And as a national spectrum strategy is coming along, this is going to be so key to getting this right. And we at DoD are excited about being able to provide our inputs to this. And indeed, we

have a foundation for this. In 2020, we published our Electromagnetic Spectrum Strategy that we put out, and then last year our Secretary, Lloyd Austin, signed our implementation plan. So we've got clear markers of what we need to do in the national security space that we're eager to contribute to the national spectrum strategy.

Now, we have success at DoD in making a lot of spectrum available to industry, particularly over the past few years. Most recently, there was America's Mid-Band Initiative Team, or AMBIT, making available spectrum to industry between 3.45-3.55 part of the spectrum, which raised in an auction last fall $21 billion. That took a lot of work and a sprint by our collective team at DoD and working with the interagency to make that happen. And we're very proud of that.

Of course, before that, there was a citizen's band radio service, or CBRS, and it was in the 3.55-3.65 part of the spectrum. And working with CTIA, and of course NTIA and others on that part of the area, now, here in 2022, we're working the 3.1-3.45 part of the spectrum through what we call the Emerging Mid-Band Spectrum Sharing – I know that's a lot of words – or EMBSS, activity there, which is built on the successes and lessons learned from those other exemplars we talked about.

And we continue to look for opportunities to make spectrum available to US industry for our economic development without any preference to one company or one organization to make us world leaders in 5G and NextG.

Now, with that in mind, I've testified as recently as May of this year to the House Armed Services Committee that our equities in the 3.1-3.45 part of the spectrum are critical for national security. And let me talk a little bit about this.

We have many radars, and I can't go into the details in an unclassified setting, but I can say they're land-, air- and sea-based, that are critical for our service members to train on before they

deploy into harm's way overseas, and also to protect our homeland, day in and day out, both against threats such as Russian Bear bombers flying off our coastline to emerging threats from our pacing challenge that can reach out and touch our homeland in a conflict situation, as well as border security and other very important missions to both training, as well as day-to-day homeland security operations.

And as I said during my confirmation hearing last fall, sharing of the spectrum space must be our watch word. Sharing is indeed what we're doing with AMBIT, CBRS and what we must do in the 3.1-3.45 part of the spectrum. It's not only about the operational and homeland security consideration I mentioned. For us to have to vacate this part of the spectrum would be absolutely untenable. It would take us two decades and hundreds of billions of dollars to be able to refactor and move those radars out of there.

Let me say that again: decades and hundreds of billions of dollars to move out of that space. But sharing offers us a way ahead out of this. And we've proven we can do this with the other initiatives I've talked about.

We can make sharing work in collaboration with all in industry and with our interagency partners such as NTIA, SEC and others. And indeed, last year we established – another long set of words – the Partnering on Advanced and Holistic Spectrum Solution, or PAHSS – that doesn't exactly roll off your tongue – task group with the National Spectrum Coalition; or, as I like to say, the other NSC.

So working the PAHSS effort starting in November of last year, this is with any member of the National Spectrum Coalition can join this, we've held ten meetings since last November. And this is to bring together DoD, interagency, industry, academia, to work through how do we do spectrum sharing in the 3.1-3.45 space, but really kind of writ large on this. But that's where we're most focused on this right now.

Now, this work of this group that we're working so hard with will inform the Dynamic Spectrum Sharing Study that we DoD owe[?] Department of Commerce coming out of last year's infrastructure bill. So this is our effort to reach out, hear other voices, not just look at it through the defense prism, but try to balance all the different equities there.

Now, I said we've had ten meetings of this group. We have our next one coming up this Wednesday on the 21st. Also, we have something called PAHSS-C – again, that doesn't roll off your tongue – C being for classified, where we've taken a subset of that group, 30 organizations, that's met four times where we're able to share classified information in the appropriate setting to get into another layer of detail about the radars and how we use them and what we use them for, for national security, and to keep all of us safe here in this great nation.

So we're going to figure this out together. And I need your help as the DoD's CIO to continue to get through this. And I don't say this with hyperbole about what it would take for us to move these radars. I want us to be successful economically, but I also want to work with you to ensure we can keep this nation safe and our women and men safe downrange, whether they have to deploy now or in the future. And that is a sacred obligation I have as DoD's CIO.

And it really is about working across with partners in government, in industry and academia. I'll give you an example. Last fall, around the October/November timeframe, our Deputy Secretary, my boss, Kathleen Hicks, met with several CEOs of telecom companies to hear inputs on what do we need to be thinking about; not only on spectrum sharing, but state of technology and other considerations.

And something we're also very proud of is, as recently as last week we held a summit down in Orlando to bring together – this was pretty cool – as we look at military electromagnetic

spectrum operations, or EMSO, this is how we operate in a military environment overseas, and in bringing together the gaming industry.

And I've got to give Ms Vernita Harris, who leads this for us, a big shoutout. I don't think she said this publicly – she got the idea watching one of her teenaged kids play videogames. I forget which game it was, but to bring in the gaming industry, who does data management, some of the backend, the visualization, to help us think through how we're going to do electromagnetic spectrum operations in a military context.

And it really resonated, from everything I'm seeing. Over 200 organizations and individuals, industry, military commands and others. But I just cite that as an example of how we want to listen and learn and get this right with all the different stakeholders.

So as I get ready to close here, I want to offer you this one thing. And I really thought about this. There's two directions we can really go right now as a nation, as a set of partners. The first way is, we're going to have a national spectrum strategy that balances the different equities, that approaches it smartly, that brings together the innovation and who we are as Americans to put our pacing challenge back on the hills, where we define what 5G and Next-G and our spectrum way ahead is going to be where we look back in a couple years and go, we got it right; and, indeed, the women and men who replace us in our organization say, You all got it right. That was a pivot point, an inflection point in what we're doing in spectrum and how we manage and lead this. That's Door A.

Door B is, we don't get it right. We go back to parochial concerns. We dig in. We don't consider all the different equities. We don't balance. We don't get it right. China leads in this space and our successors regret what we did or did not do correctly.

I'm all for Door A. And I know you are, too. And I want you to know the Department of Defense is committed to getting that right.

So I want to close by saying thank you. We're looking forward to working with you on this. Thank you, Mr. Davidson, for having me here today, and I look forward to working with you going forward. Thank you so much. [applause]

CHARLES COOPER: Thank you, Mr. Sherman, for those very kind and excellent remarks. It's always a joy to work with you and your staff. As you can imagine, within the Office of Spectrum Management, we work very closely with the Department of Defense. As a matter of fact, for all these years DoD has been a key and productive partner in spectrum management, not only to safeguard US national security interests, but also to shepherd federal spectrum use widely across the board.

So now we're going to prepare for our second panel discussion, this time looking outward and forward to our efforts on our policies on the real-world deployment and development of advanced wireless services. Moderating will be Scott Patrick, the Executive Director of OSM. And the panelists will include several top private sector experts on developing markets in advanced telecom technologies. They will offer their perspectives on how government policies and decisions can promote US competitiveness and benefit consumers.

We'll pause for a moment to allow the second panel to be established here. If you can give us fewer than five minutes, that will be appreciated. Thank you.

[break]

SCOTT PATRICK: Thanks, everyone, for coming. Good morning. It's great to be in person. I understand today is National Talk Like A Pirate Day. I think Harold already tweeted that out. I

warned our planning committee that that was a bad match. Tomorrow is Care For Children Day; that would have been a better fit. I'm not going to be speaking like a pirate.

Our panelists today, going quickly down the line: Harold Feld, Senior Vice President, Public Knowledge; Zach Goldstein, CIO at NOAA; Hank Hultquist, Vice President, Federal Regulatory at AT&T; and Colleen King, Vice President, Regulatory Affairs at Charter.

Before we get started, Zach and I have to note that the views expressed here are not necessarily those of the federal government or NTIA or NOAA.

Now that we've got that all clear, we're going to dig right in. Thanks again for being here.

So I'm going to start with Zach at NOAA, let him set the stage here. I'd like to hear, Zach, if you could tell us what are the bands that NOAA uses, the spectrum bands? And how do you see that changing in the future, if at all? And what are you using spectrum to do?

ZACH GOLDSTEIN: Sure, thanks. I'll give you the range that the Department of Commerce uses because I actually represent the requirements of the Department of Commerce to my colleagues at NTIA. The frequency range – this is not all the bands, obviously, in this range – go from 20 kilohertz to over 316 gigahertz. Which puts us squarely in the crosshairs of pretty much anything you want to do in spectrum.

To give you an idea of how we think about spectrum in NOAA, as the CIO I'm required to put out a five-year strategic plan for information resources management. And under the category of mission protection, which is the second goal after people – because you can't do anything without people– mission protection, you normally think cybersecurity, and of course that's a big concern. But that's where spectrum is. Because interference with spectrum can have just as much dire consequences as a massive cyber attack on our mission.

And to understand that, you need to understand the things we use spectrum for. Of course, we have the traditional stuff – communications; how do you command and control a satellite? Well, you use spectrum to do that. If you try to share it, you have lots of time horizon issues because you can't change the satellite that's in orbit. We have ground communications, law enforcement. There are special agents that work for the Department of Commerce. There are special agents that work for NOAA that enforce fisheries regulations. Very traditional kinds of telecommunications.

And with enough time and enough money, and a little patience and a lot of diligence and transparency, you can figure out how to cut deal that share those. Because you've got engineers on both sides – private sector's got engineers that are designing something that has characteristics; we have systems that have characteristics. Enough time and money, you can figure out how to share or move.

And we have a lot of experience with that in NOAA; we were one of the earliest federal agencies to do sharing. The advanced wireless service, or services-3 auction was of NOAA's spectrum, as well as some other agencies. And now we're into the– actually we've moved out of the band in some places. We've got monitoring where we're going to be sharing. So to understand some of the details of how to do that and have some ideas on how to fix or improve that and make it more incentivized to do that, I'll get to that later.

But before I get to that, I want to talk to you about a much more difficult problem that I haven't heard about this morning, and that is when the spectrum isn't for communications, but rather it's for sensing. Everything NOAA does begins with an observation. We have Hurricane Fiona that just did a job on Puerto Rico and is heading for other places where people live. And the hurricane track that you see on any device that you're looking at starts with observations that come from satellites. And when you see any device that shows satellite/radar, you're looking at a

NOAA satellite, you're looking at a NOAA radar, irrespective of who's actually providing it to you. And that's an image. And so, you see that. The image is very valuable, but even more valuable is the sensing of atmospheric parameters that we use to feed our models.

In a very famous example recently, 24 gigahertz is the frequency at which water vapor vibrates, oscillates and responds to the warmth of the sun. You can't change that. You can't up the gain on the atmosphere. There's no engineer that can move that; it's physics, it's the natural world. So in the last panel, Umair spoke about adjacency issues and risk tolerance, risk sharing. It is extremely asymmetric in this case; maybe this is what he was thinking about. The only thing we can do is prevent the interference. Maybe 10, 15, 20 years, science will let us know that we can make the antenna different; maybe there are things that can be done. But in the short run, it's not about cost-schedule and risk; it's about risk, and how do we minimize that.

And let me explain to you what the risk is. We did a data denial experiment, a hypothetical, after Hurricane Sandy a number of years ago. What we did is we said, let's imagine there was no data coming in from polar-orbiting satellites into our models. When you do that and then run a global forecast model and run a hurricane track, Hurricane Sandy never makes landfall. It actually doesn't even heard toward the Northeast of the United States; it actually takes a northeast track and arcs away from the United States.

Now, of course, that's not we're talking about. We're not talking about no satellite data; we're talking about maybe just accepting a little bit of risk. Well, let's say that little bit of risk moves landfall by five miles, a small amount. I'm not talking about the direction of the hurricane, just change the landfall a little bit. How many hundreds of thousands of people do we get the warning wrong for if that happens? That's the risk we're dealing with here.

And so, we've got a lot of ideas about how to share because we, as well as everybody else in this room, are consumers of 5G and hope to be consumers of 6G. As an observation-based

organization, we've got sensors all over the country. A lot of them are in places that are hard to get to; there's no fiber. And the best thing we can get is more bandwidth in wireless. So it's a real plus for our mission, but we've got to figure out how to do the balancing.

I'll yield to Scott.

SCOTT PATRICK: Thank you, Zach. I'll turn now to Colleen who's at Charter. Cable companies, I don't know that we've had a cable company at the symposium recently. It's a nice opportunity to hear Charter's view on things and Colleen's view on things. This panel is about aligning policy to get to 5G and 6G success. Colleen, what do you think about the cable industry's interest in spectrum? I know that cable companies are big users of unlicensed spectrum, and then Charter has experienced interest in licensed spectrum from time to time. Where do those things stand today? And what would Charter like to see out of a 6G world?

COLLEEN KING: First of all, Scott, thanks very much to NTIA and for having us here. Coming from Charter, which people think of as a cable company, we're really a connectivity company. I'm excited to be in a room full of spectrum nerds and talk about spectrum all day. So we appreciate being invited.

But as I said, Charter is a connectivity company. We provide broadband, voice, video and mobile to 32 million customers across 41 states. We're also one of the fastest growing mobile providers with over four million customer lines, bringing competition to the wireless marketplace and providing high-quality, highspeed products at lower cost.

We're excited about 6G because it's another step in connectivity. And so, when we look at 6G, we think of all of the great things that have happened in 5G and we need to use those lessons learned to continue that process. For Charter, and speaking of the wireless, we entered the

wireless market through wifi. It's a key part of the service that we provide, and it's really key to connectivity for consumers and businesses.

Today, our wifi service supports over 450 IP devices attached to our network, and as much as 80% of customer traffic is carried on the wifi network. We think it's an essential component to the wireless strategy and invaluable, too, for connecting and for innovation. Wifi has been a huge success. If you look at the different types of wireless services in this country, wifi really is one of the great success stories. It contributes hundreds of billions of dollars to the economy; approximately 995 billion in 2020, and is expected to rise to 1.6 trillion by 2025.

So as the majority of internet traffic is running over wifi, we think it's important to continue to look at that as a key part. So that is part of our strategy.

However, Charter has taken that success in the house and taken an inside/outside strategy, looking first at providing connectivity in the house. We've also entered looking outside the house and providing connectivity everywhere. So in 2018, we launched as a mobile virtual network operator, an MVNO, which allows us to leverage that wifi network and also expand outward.

And we also have recently participated in the first mid-band 5G auction. We purchased 210 CBRS licenses in 106 counties across the country. Using the MVNO and our extensive wifi network, we've really provided competition to the wireless marketplace, lowering costs and providing really highspeed, highcompute services.

We look to continue to expand our CBRS network. We're starting with an inflight field trial, and then taking those lessons learned and kind of expanding. Small cells really are helpful, using the CBRS network, and we think we can quickly deploy.

So we're excited about the possibilities of looking at really the comprehensive spectrum policy, looking at unlicensed, licensed and shared, which we're using all of those to provide connectivity to consumers.

SCOTT PATRICK: That's quite an answer, Colleen, to all of this. Five years ago, it would have been one kind of answer; another five years ago, it would have been a very different answer. These evolving technologies letting folks like Charter to do more and more.

I'll turn now to Harold. Harold, you've seen a lot of this evolution in technology, a lot of different use cases over the years, and of course exploding uses that perhaps weren't predictable. In light of these things, Harold, are there lessons that you see from the past that would be particularly applicable to policymakers and spectrum policy today?

HAROLD FELD: Yes. And I want to first say thank you to NTIA for including in this conversation representatives of consumer and civil society. There have been times when the discussion has not been inclusive of the end users, the civil society, which are all impacted by every one of the aspects of these decisions.

One of the important lessons I think that we need to take from this is, we routinely have these inflection points in wireless policy. About every five or ten years, wireless policy shifts. Really about every ten years we learn that for the next generation of wireless, you need greenfield to support the shift. So we're shifting in 5G. There is spectrum reclamation that is going on from 2G and 3G to help fuel this. But while that is going on, you need to be building out the new networks in new greenfield spectrum.

So you need some of that. At the same time, we are seeing enormous explosion in unlicensed spectrum use. Wifi is, of course, the one that everybody's most familiar with, but there are so many other uses, when we talk about things like the new over-the-counter hearing aids, for

example. A lot of these are using wireless Bluetooth type connectivity. All of these new devices need spectrum. The non-communicating uses; everybody depends on– NOAA, there are more sensing technologies that are coming out there, everything from how they improve archeology and mineral research through ground-penetrating radar, to saving lives, to the internet of things that we have been talking about now for 15 years and it keeps moving incrementally closer and closer.

So this expansion of the number of uses from different directions is telling us, I think, one really important lesson, which is ten years ago I used to say we've hit peak spectrum, that we reached a point of crowding where you just can't extract more from federal users, extract more from other commercial users without figuring out how to adjust for the use cases that are out there; it's just not possible. And every time Congress says, Well, find us another 300, 400, 500 megahertz to auction so that we can take a CBO-plus on the budget is harmful to good spectrum policy. We have to let spectrum policy work in these multitude of directions, where there is going to be give-and-take, where we have to recognize that, yeah, there are some things– although I could not help thinking, when you were invoking the laws of physics, I can hear Scotty in my head saying, "I cannot break the laws of physics, Captain," and then of course two minutes later the Enterprise does.

One of the things also that's an important lesson I would add here is that things that we traditionally accepted as immutable are changing and are changeable. And at an accelerating pace. It's not simply that, well, 10 years or 15 years down the line we'll have that. No, it's like in the next two or three years we will have better sensing technologies.

And the last thing I'm going to say is, if there is economic incentive to do it. Because nobody builds out new technologies if there isn't going to be a business case. Well, the federal government does now that we are actually investing money, which is important. I think that the CHIPS Act, with its components for investment and new R&D money, because we've realized

that the federal government has an important role of taking up the slack, where there isn't a business case, to invest in these new technologies that pay off.

But that's still a small piece of all of the investment resource that we need. That's going to come from the private sector. And for that, there has to be a hope of bringing the new products to market.

So all of this is to say, yeah, if there's one thing we can definitely learn from the past, it's that we've had a lot of change before, but the pace of change keeps accelerating, and therefore the need for new ways of thinking, the creativity that virtually every opening speaker mentioned, is desperately needed today.

SCOTT PATRICK: Thanks, Harold. So I'll turn to Hank now. This is all your fault, right? [laughter] I've said this before, I'll say it again. I think it's a real sign of respect and cred when an industry is so successful that people just don't even acknowledge it; we've all come to enjoy and rely upon the kinds of services that Hank and his competitors bring to us. The spectrum success story, maybe they'll talk about it more later. Or maybe not. But in any event, Hank, with all these successes makes folks like me at NTIA and FCC spend a lot of time thinking about how can we get more spectrum in a safe way to the commercial wireless providers. Are you going to stop this? At some point, will the success just say, Okay, we have enough spectrum? And if not, what are these future spectrum use cases that are going to drive demand?

HANK HULTQUIST: Are you asking if we're going to stop during my career, or at some point after I retire? [laughter] First, I want to thank NTIA for hosting this great event and for inviting me to participate. And I also want to start by riffing on a point Harold just made, and then lamenting that it's kind of in some ways the central problem, or a central problem.

It's critical that the people who use resources have incentives to use them efficiently, and that's one of the hardest things about spectrum policy, that we have certain kinds of uses, whether we're talking about users by non-market actors, the government, or we're talking about uses of unlicensed spectrum, where it's very hard to provide incentives and for the market to provide incentives.

And so, the challenge of spectrum policy is, how do you value those uses? And then, how do you take care of those uses? On the commercial side, auctions are a great way of identifying how much does one party value use of the resource versus another, but auctions alone cannot be all of spectrum policy because they can't account for these other circumstances where we don't have the market incentives, but we know that there's a value.

And Zach actually started out by saying something that really struck me, which is we have to figure out how to do the balancing. And that's just hard stuff. It's not easy.

I'm not trying to dodge your question, Scott. To get to your question, I think ultimately spectrum policy and spectrum strategy really requires us to look out into the future and to make our guesses about some of the things Harold talked about in terms of what technologies will be available into the future, and to figure out what are the opportunities to make spectrum available for more efficient use? What are the challenges to doing that? And how do we get from A to B.

And there's never going to be a one-size-fits-all answer. Each chunk of the spectrum has different kinds of incumbencies, different kinds of potential uses. And it's just a lot of hard work of rolling up sleeves and figuring out solutions.

SCOTT PATRICK: I'll turn back to Zach. Zach, you've heard all these demands and all these successes and all this innovation. These are good stories, and maybe these are the kinds of stories

that also open the door to NOAA to innovate as well, or benefit from 6G. What does NOAA want out of the future? Is it merely protection? I shouldn't say merely, but protection, or what?

ZACH GOLDSTEIN: There are a few things. First of all, the last thing I said, we do see opportunity for us to leverage 5G and 6G in particular because as an observation-driven organization with, now we're deploying uncrewed vehicles in the air and in the sea, and lots of other ground sensors, and the more sensors you have, the better you can have initial conditions for a model that give you a more accurate result for projecting climate change, protecting lives every day. That requires bandwidth. And that's bandwidth that we're looking to industry to provide. So we want that to happen.

I'm intrigued by your comment, Harry, about the– I'm a Trekkie, too. And I don't think in my lifetime I'm going to be seeing us traveling at greater than light speed.

HAROLD FELD: I keep hoping.

ZACH GOLDSTEIN: I do, too. I always look at stars and measure– anyway, it's an important point, that analogy. And that is that some things take a lot more time than others. And some things require more resources than others. And as a science agency, I'm looking forward to us getting the resources – this is my other pitch; time, money – getting the resources to be able to participate in the research to find ways to be more efficient in sensing. Maybe there's a way that one tags emissions coming from 5G or 6G in a way that we could filter it out. Maybe we need another satellite that monitors the 5G/6G deployment. There are some ideas.

We've thrown out some of these ideas. A couple years ago we were in the middle of– actually not in the middle, when we were in the aftermath of the 24-gigahertz discussions. So I'm optimistic that we can innovate. But we have to be realistic about what we can do when. And that's when people get confused and when the details matter.

So we are going to need more bandwidth, not just in 6G. We're going to need more satellite command-and-control bandwidth because we're going to small sats because of efficiency. Big satellites take a long time to build, they cost a lot of money. If you can get a sensor that gets a free flier on somebody else's launch, then you have a smaller satellite. The more small satellites you have in the same frequency, the more problematic it becomes, you need more bandwidth.

So some of the places where we're going are going to be putting more pressure. And it's not necessarily just us. We're buying observations from the commercial sector. So the commercial space sector is going to need more bandwidth. You're probably, maybe discussing that this afternoon. They're going to need more bandwidth for their own uses, but also for our passive remote sensing uses. So that's going to grow.

My ask, protection, sure. Consideration of the implications. Respect; that when we say this is going to reduce the accuracy by 3%, you say, well, gee, it's only 3%. How many people is that? So please give respect. They may be small numbers, but they have big impact.

The incentives in terms of how things are funded are all oriented toward auctions. I think this comment was made, you made it just now, and it was also alluded to by Umair. And we need to think holistically.

So if you want to be able to do this correctly, then you want to have resources, money and time, and people – I could echo the FAA's request from the last panel – time and money to actually do the analysis. You need transparency so that we can all be accountable for how the analysis works. We have more transparency in some places than others. In the international process, federal agencies have a lot less transparency to their analysis than you do the domestic process. And a little bit more of the domestic process applied to the international process from a

transparency perspective would go a long way in engaging all the stakeholders in these discussions. Especially when you have a highly valued, but unquantified resource.

When you make a decision to accept a risk in weather forecasting or in climate change projection, that's a public policy decision; that's not an auction decision, as you know. So if you want that to happen, you have to have transparency.

So transparency. Money to do the studies. Money to actually accommodate the sharing. One of the things I've learned from my AWS-3 experience is that you don't get the money out of the auction to cover anything other than transition. If you end up at a new higher level for operations and maintenance cost, you're supposed to go back to Congress and ask for that in appropriation. That's the way I understand how it works. Thanks for the disclaimer at the beginning. [laughter] But that's been my experience.

And so that's a disincentive to do it. You say, you take my operation, you're putting it in a place where I'm happy to operate; I know the technology works, I've made the investment, I can do the transition, but you're not going to support the higher cost, and that's not reflected in the reserve price for the auction and it's not reflected in the offset to the CBO calculation? And so on.

One of the principles should be: when you're doing sharing analysis, full lifecycle of cost analysis. I don't know a CIO who could get away with, except in this area, with not doing a full lifecycle cost. The tail matters.

So the money, both to do analysis and after decisions are made. The time to actually do the analysis. There's some quirks where you can theory if you get 15 days' notice– I know you guys are working on that. Thank you for all the work that NTIA is doing.

Oh, by the way, thank you for the invitation. Everybody said that. I really appreciate this. And thank you for the fellowship and trust relationship that we have with your agency, including Charles Cooper, my buddy. By doing quick analysis, we were able to prove that you could do a worst-case analysis and show the worst-case analysis is acceptable. And then you can move on and speed things up. My hope is that when the worst-case analysis shows oops, that we take the time to do it right.

And I'm optimistic. The changes that I see coming out of the agreement that you have with the FCC, the words that I see about transparency and all the things I'm hearing now make me optimistic about being able to eat the cake.

SCOTT PATRICK: Excellent. Thanks, Zach. I'm going to ask Harold a question, then I'd like to hear other panelists comment on it. We've already heard reference this morning the first panel to the Aspen Institute's report that was released last week, outlining a path to the adoption of a spectrum strategy. And as was mentioned, probably a number of you in the audience worked on that. And I think, Harold, my understanding is that you contributed to that as well.

And there's an interesting aspect of this, talking about incumbents and having more flexible spectrum rights. I understand that flexibility is– I'll let Harold answer this better than I can describe it. But the idea is that an incumbent maybe has some obligations to be aware of this innovation that we see. It's not just a snapshot in time, but times change and technology evolves. So do incumbents have to account for that in some fashion?

So what do you think, Harold, of this idea? And can you educate us a little bit about what that would mean for especially federal incumbents, but incumbents of all types.

HAROLD FELD: This was an idea that was also raised by the recent National Academy of Sciences report, which was primarily about Ligado, but if you look at the–

SCOTT PATRICK: I'm sorry, who?

HAROLD FELD: The National Academy of Sciences. The important element here is that, remember all that crowding that I was talking about. It now means that every change affects a lot more people. And I've got to say yes.

And one other lesson is, everybody's got a good reason why "if you don't give it to me, people will die." And they're not all wrong. I work on the CSRIC Advisory Committee and we're looking at the wireless emergency alert system. And if those alerts don't go through, people die. I have looked at a lot of telehealth applications, including the ones that we're now putting in people's home, which are dependent on wifi-6 and wifi 7 for the expanded gigabit throughput that those technologies bring. And if those technologies malfunction, people will die.

So there is a lot of risk assessment that we have to do and one element of that is in the realization that the spectrum environment will change. And that means not just you will innovate, but that there is a combination of– there must be sufficient certainty that people can deploy a technology and expect that my neighbors are not going to blast the equivalent of super loud music next to me that'll keep me up all night, but that are not going to disrupt where I deploy new technology. But at the same time, we're not entitled to the same thing forever. Somebody else referred to, don't build a single-use house in the middle of downtown Manhattan. There is the same idea here that you might build your nice, quiet house and then the city expands and it's not longer in a nice, quite neighborhood. You have to get used to this idea.

Now, that will have profound implications for industries that are used to these very long runaways. So if we say, you're entitled to expect the stability of the spectrum environment for five years, and what you're used to is a 20- to 30-year timeline for planning, that obviously means that you have some significant adjustments to make. It might be that for some industries

it's going to be, No, we can't do five years, but we can potentially bring it down from 20 years to 10 years.

And again, through different type of mechanism. The change in satellite is one of these things that is not a spectrum change, but is making it possible to reduce the timeframe for upgrades because, as we shift from– the conventional wisdom was, well, you can't do maintenance on a satellite, you can't change a satellite once it's up there in geosynchronous orbit; it's there and that's the technology you have to keep.

Well, as we're changing satellite technology, getting more space-faring nations having commercial space launch industry, we're suddenly being able to say satellite-based industries can adjust on a faster timeline.

So the flexibility that we have to build in for the changing spectrum environment is something that we think everybody has to take into account. And it goes against the grain of a lot of people, particularly those who say, Look, I do a good job at whatever it is that I do – I'm a broadcaster, I'm the C-band, we're an earth station receiver – I'm doing the thing you gave me the license for, why are you punishing me by making me change? And the answer is, well, we're not punishing. We're needing to upgrade the spectrum use for everyone. And that means that we are all going to have to learn to accept a much more fluid spectrum environment where there will be a period of certainty to make sure that you can actually deploy and get value out of the license terms that you have. But you can't expect the world to stop around you.

SCOTT PATRICK: Hank, this all sounds great to me. Flexible use means higher, better use. What do you think?

HANK HULTQUIST: I'll start by saying a lot of how I think of this has probably been shaped by my experience over the last ten months or so of working on C-band. And that's going to color

my comments. But as I think about it more academically, there's two kinds of situations that I hear Harold potentially raising. And forgive me if I'm not hearing this correctly.

One is, you, whoever you are, have been authorized to operate in a certain set of frequencies. You should have some expectation that that authorization to operate in those frequencies could change within some amount of time against your will. And I think for flexible-use licensees, which AT&T is, that would be a problem. First of all because since our licenses are flexible-use, if there's a better use for them, then they can go to that better use. If that's where the market wants to go, it can go there.

But I actually think that's not the biggest concern Harold's raising. It's more the one that I've been dealing with on the C-band front, which is the use of the spectrum adjacent to you could change in ways that have an impact on what you're doing. And I think that's the more interesting and important scenario to consider. And especially in light of another thing Harold, and has been referred to by others, is the kinds of upgrade cycles that we see in certain uses and industries are quite lengthy. If you put equipment out there, you might have an expectation that It's going to be in use for 20, 30, 40 years, potentially. Well, if your equipment is actually dependent on frequencies that are 200 megahertz or more away from you, in the case of C-band, remaining at extremely low power levels, I think, yeah, you shouldn't have that expectation.

And in general, I think I would take Harold's point and take it to the next step and say, we should develop some rules of thumb that say, if you can't design your– unless there's some really good reason why your use of your frequencies is dependent on frequencies that are adjacent – and we can talk about what adjacent means; it might mean a different thing in different settings – frequencies that are adjacent dependent on the use of those frequencies, you either need to be in a different neighborhood or you have to have improved performance in terms of receivers and signal processing, and things of that nature, so that those adjacent frequencies can be put to their best use.

SCOTT PATRICK: Colleen, what do you think? Are these flexible uses going to be good for charter, or would it be good for charter? And to Hank's point, it sounds like it might be a little more expensive for you to do this, to have more robust operation.

COLLEEN KING: I'd say it's obviously important, certainty, if you're investing in spectrum, that you have certainty of the use. But I think a lot of what the Aspen report seems to look at it is kind of innovation and competition. And also coordination; I think there's this early coordination. If we look at how people are looking at new spectrum bands that are becoming available and thinking through the possible use cases, clearly we're not going to be able to forecast everything that's going to be done in ten years and how you're going to have to change your system. But putting into place shared spectrum regimes that have an expectation of ongoing coordination as you work these spectrum issues and these new technologies that can make more efficient use of spectrum, I think that's a good thing.

So obviously you're going to need the certainty, but I think also some of these innovative sharing regimes are great for spectrum policy and for new entrants who are trying to bring competition.

SCOTT PATRICK: I'm going to go out of order here a little bit, just to warn you all. Since you mentioned that great point about spectrum sharing and innovation, NTIA has been, or we think we're at the forefront of that with this incumbent informing capability, or IIC as we call it sometimes, trying to have a world where we're not all always reinventing the wheel. I know folks have mentioned already it seems like every band has their own unique sets of circumstances, but maybe there are tools we can develop that would expedite things, facilitate things if we can apply it across each band, and so forth.

So I'll throw it out to the group. Things like IIC, these kind of spectrum-sharing innovations, it seems like it has to be part of the future as demand increases and we all want to use the same spectrum, but I'll let you all talk; what do you think?

HAROLD FELD: Yes. I mean, the fact is, we need more of an ability to share and to share these different uses, in part because if you look at what's going on in CBRS, one of the things that I've now started to talk about is, we talk about flexible use, but in reality we end up, when we do spectrum bands with command-and-control, but it's through technology. So we have folks who want to raise the power levels on CBRS because that way it'll be better suited for 5G and LTE. Well, okay, we need bands where you can have more kinds of innovations.

The LA Port Authority is not looking to do LTE; they are looking to do their own kind of IoT network that can track all of these millions and millions of containers that come in on a regular basis, and that needed to be shifted to flatbeds, to trucks, to different trains. And that's not an LTE use. Sure, you could do that, you could make LTE to a lot of different things, but when we say flexible use, that means, great, match the use to the technology. There's a low power general access technology there that lets folks do that more. We don't need to boost power; in fact, we should not be boosting power in that band to make it more like every other band.

That's one important element of flexibility. The others are the technologies and the governance regimes that we are talking about. There are a lot of different ways we could be doing spectrum access and spectrum sharing. There are a lot of different ways we could be doing exclusive licensing. There was mention at an earlier panel about the propagation characteristics that we're looking at. If you look at technology like Starry or some of the fixed wireless broadbandware, we're taking these very high frequencies and bouncing them off buildings and having sophisticated antennas to take advantage of what had previously been thought of as a defect of the fact that they don't penetrate solid objects in the way that low-band spectrum does.

So that potentially opens the door to a different set of governance, which is not necessarily unlicensed, but it's not first in time, first in right. We could do mixed regimes. We're looking potentially in the 12-gigahertz band where – the lower 12, I guess I'll call it – where most people think of it as a dispute between Dish and SpaceX, but the reality is we have pushed for different rules for urban or rural, depending upon the nature of the environment, different types of governance regimes that would preserve certain types of shared use while potentially opening up to different types of exclusive use.

There's a lot of creativity that we now have. The technology has grown at an exponential basis. And our regulatory creativity has not kept up. And we need to start thinking in ways that are not exclusive licensing, first in time, first in right, unlicensed. We need to start thinking about new ways of opening up spectrum access.

HANK HULTQUIST: I think those good points. I want to react a little bit to say, as far as I can tell, for the last, I don't know, as long as we've been doing spectrum, we've been talking about other ways of accessing spectrum than exclusive licensing. So I don't think that's anything new. And I think it is important on the front end; I think we should definitely be doing R&D and investment in a lot of the capabilities of technology to promote more efficient use of spectrum, to allow greater sharing of spectrumware. There aren't alternatives to clear spectrum, which, as everybody knows, are increasingly the case.

But I also think on the back end, it's important to then do a review and say, okay, we put this out there. How does it work? Is it achieving the goals that we set for it? And I think in the case of CBRS, I don't know the answer to that question. I know that when CBRS was established, there were expectations of what it could achieve and I think it's important in retrospect to say, Okay, how are we doing? Is it functioning as it's intended to? What are the metrics we would use to compare it to other ways of allocating spectrum?

And I think we need to do both the front end and the back end.

COLLEEN KING: I'll just jump in and say, we think CBRS is a great success so far and continues to grow. We're big fans of sharing. We think CBRS is a great model in mid-band. I think, as Harold mentioned, there's other options in millimeter wave spectrum. But CBRS, first of all, the diversity of users and use cases has been very impressive – 228 bidders compared to the 3/4/5 and C-band, which I think there were 23 and 21 winning bidders.

So if you look at all the different use cases that are coming out of sharing, it's not just– there's the broad spectrum. There's the biggest users. Charter will use CBRS spectrum for 5G service. And then there's down to the schools who are providing private networks for students. There's telemedicine. Smart cities. It's being used everywhere. And it's growing. It was the first big, dynamic sharing regime, and we're really just building on that.

And we think it's a great model to look at other mid-band spectrum and consider how that type of the lessons learned from CBRS and what we're doing there can be expanded into other spectrum bands.

HAROLD FELD: And let me use this as an example of where I think we see the intersection of different technologies. We talk about O-RAN, for example. And people think of O-RAN as being a cellular play. Well, CBRS opens up the potential that it'll be an enterprise wireless play, where there is greater need for self-configuring networks to provide for different types of flexible uses from different sets of customers.

I agree with Hank that one of the problems is we don't have really good metrics on how we look at this. It's easy to measure the success of cellular mobile because everybody's got one and we have a relatively small number of companies, and you can look at their annual income. We've gotten a little more creative about how we measure the success of unlicensed spectrum,

specifically wifi, in how many products are being put out, how many annual sales are we getting of different types of products that use it.

We're not very good at qualitative metrics. So if we say, okay, what's going to be the measure of CBRS, and the fact that it may enable a wide range of different uses, no one of which is going to be super huge, but the fact that people use it – the ports use it, the petroleum companies use it for a different set of uses, the cable folks use it for a different set of uses – these make it somewhat harder to measure. But the fact that there are so many different use cases is what is the success of the flexibility.

So we have to be aware of, one, the changes in technologies that we're not thinking of as wireless technologies that are going to influence how we innovate and what it makes possible. And at the same time, we also have to be creative in our choice of metrics and how we're going to assess the success or failure of these new spectrum access regimes.

SCOTT PATRICK: I'll make one point here. We at NTIA thank you for these glowing reports about CBRS. I paid no money for those advertisements. I'm glad to hear that it's going prosperously.

And I'd also say that I think the panelists were unanimous in saying that we need more money from Congress to do research on spectrum sharing. So I want to get that message out there.

HAROLD FELD: I'll add one other place where we need more money from Congress. We need money from Congress to upgrade federal users in the absence of an auction. The problem that we have right now with our funding for federal users, it is entirely linked to auctions. We don't see investment from Congress saying, Yeah, we could invest without an auction to create greater efficiency for federal users. And we need to instill that mentality because the linkage to auctions feeds in to this spectrum auction addiction[?] that Congress has and links improvements in

federal use and upgrades to federal use with taking federal spectrum for auction and limiting who can benefit from whose spectrum gets taken and forcing them to become more efficient.

I don't think we should force federal users to become more efficient by– there's the old story of the farmer who kept trying to train his donkey by cutting back his hay every day to get him to work for less hay until he finally starved to death. And the farmer was like, Wow, I almost had him able to go plow with nothing. And you can't keep doing this to the federal users. We have to invest in upgrading federal networks without having it tied to an auction.

SCOTT PATRICK: Harold, that's a great point. I think that's a great segue to where I was going next. One way or the other, we've been talking about what we refer to is repurposing or taking spectrum use for one thing, providing it in large part to a new use, likely commercial use. I want to start with Zach. Harold's already pointed out what sounds like a lesson learned, like, year, we could do this better if we did this. Do you have other lessons that might help repurposing in the future?

ZACH GOLDSTEIN: I mentioned one earlier that got back to my argument, especially the decoupling from auctions that you're talking about, where right now in the current scheme you're not going to get the resources for the more expensive operation that is more efficient out of the auction. You could, but that shouldn't be the only way.

So I agree with what Harold said. And I think that there are other lessons learned, or technology lessons learned. One of the things we did in AWS-3 was we created something called – as part of our transition plan back when we put it in in 2011, but now we've got it in operation – the radio frequency interference monitoring system. And the objective is to identify interference before it becomes destructive and mission-impairing.

And one of the things that I'm thinking about as I'm listening to my colleagues here is that we actually have a lot of sharing experience and lessons learned from what the federal government's doing because, for us, the flexible use world is here in terms of 5300, 5400. And all of a sudden, somebody's planning an auction. Where'd that come from, right?

And so, that's become our reality. And we're doing things, like RFNs and other technologies, timesharing and so on. And what I'm hearing everybody saying is that, it's not just about envisioning the future, which is fun and expensive, but it's also about actually doing that evaluation. How many times do we establish a metric, because we're all doing the PM thing. So we have a cost baseline and a performance baseline. We've got to measure these metrics. And then we don't; we don't develop the baseline before we start. We don't compare it to what's afterward.

And the things that we want to learn may have absolutely nothing to do with what we thought we were going to measure in the first place, is, how hard was it? What risks did we accept? What worked and what didn't work?

And so, I'd like to make a plea, building completely on what I'm hearing in this panel, for us to be rigorous in our thought processes and be reflective. We're learning lessons. We have the opportunity to learn lessons every day. And just like we're doing some great research; I know NIST, Charlie Burrough[?] is doing a lot of research and sharing. I know that the lab that NTIA has that has the same letters in a different sequence, I think–

SCOTT PATRICK: ITS.

ZACH GOLDSTEIN: One missing. Is all work being done looking forward. Maybe some of the allocation of the work – and maybe they need more money for this, too – is to look back and say, okay, we've shared here. Well, everybody's saying CBRS, a great success. Well, what didn't

work? It's not a PR exercise, not that I'm accusing anybody of that. We all want to feel good about success; otherwise we won't keep moving forward. So we've got to celebrate success. But let's talk a little bit of time to also formalize what we're saying here and look backwards.

HAROLD FELD: One caveat to that. We need to distinguish between what didn't work and what didn't come out the way we expected. Because sometimes things come out in ways that we– nobody, when we did unlicensed in the late '80s, did anybody think that was going to create wifi. Maybe one or two visionary folks did, but mostly it was about garage door openers. The fact that we have a lot fewer garage door openers and a lot more wifi is not a failure of the unlicensed regime.

So we just have to be careful when we talk about what worked and what didn't work, versus what we expected and what we didn't expect.

ZACH GOLDSTEIN: I just read an online thing about words one shouldn't use. Here is a recommendation, I forget where it came from, because language matters. Here's the question: what did we learn? That's what I want to know, is what did we learn.

SCOTT PATRICK: I hope the panelists will forgive me. I told them we probably wouldn't have questions from the audience, but I think we want to maybe do one, if we have time for one question from the audience. I see the microphone there, so maybe one question from the audience before we break.

All right, then I think I'll go ahead and close the panel. Thank you to the panelists. I appreciate your time and wise thoughts, and appreciate everyone. [applause]

CHARLES COOPER: Thank you, Scott, and all the panelists. That concludes that this morning's session. We'll be reconvening in about an hour, approximately. Mr. Scott Harris, who

is Senior Spectrum Policy Advisor to Alan will be reconvening us herein about an hour. We've got plenty more to go, two more panel discussions. We're going to hear from a couple Senators, a Congressman as well, Congressman Doyle, along with two more keynotes. So a lot more information to come.

Thank you very much, and thank you again.

[break for lunch]

END MORNING SESSION