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Transcript

Welcome from PCAST Co-Chairs

>> JOHN HOLDREN: Well, good morning, everybody. We are pretty much right on time. My pleasure to welcome you to our bimonthly PCAST meeting the members of the PCAST, the members of the scientific and engineering and mathematics technology communities who have joined us both in person and following us on the web. As usual we have a full schedule for this morning. We'll be discussing, and I trust approving recommendations from two PCAST studies. We will be hearing from a very interesting panel on forensic science issues. A very interesting presentation on global issues around spectrum. And I'm looking forward to it all. Without any further ado, let me ask my Co-Chair Eric Lander if he has any words of welcome, provocation, or encouragement.

>> ERIC LANDER: Mostly words of thanks. I want to thank everyone who has joined us here today in the room and on the web. I also really want to extend my thanks to all of the PCAST. We have two major reports coming to this PCAST meeting today for discussion and potential approval, and it represents a huge amount of work on the part of everybody. There are still many more reports underway at PCAST so I think although this is the last full year of the Administration, as with every place else in the Administration, I think the energy is not lacking at all, and I want to thank everybody in PCAST for their energies and commitments, thank you.

>> JOHN HOLDREN: Yeah, let me just riff off of Eric's theme for one further moment. Anyone who saw the State of the Union address on Tuesday night knows that the President is not letting up in the last year of his presidency in his pursuit of initiatives and accomplishments that will improve the lives of the American people and help address the challenges that we face as a world. And the same is true of PCAST. PCAST is not letting up, as those of you around the table who have been doing this work can testify personally. We still have a lot more to get done, but this has without question been the most productive PCAST in history with almost 30 reports to the credit of this group. So let us turn to the first of the reports and sets of recommendations that we'll be considering this morning, and that is on the future of cities. And I will turn to our PCAST member Mark Gorenberg, who has led this effort for PCAST with strong support from Craig Mundie, and of course from the staff. So Mark, the floor is yours.

The Future of Cities

>> MARK GORENBERG: It's an honor to present the findings and recommendations of our study on how the Federal Government can support science and technology opportunities to improve America's cities. There have been a number of members from PCAST that have been involved. This has truly been a team effort. I especially want to call out Craig Mundie who came up with

the idea for PCAST to originally study this topic has had many brilliant suggestions for things along the day and hope he will make comments after this presentation. There's been tireless work from the PCAST staff, particularly our director Marjory Blumenthal has worked day and night on this and special contributions from Diana Pankevich and from Ashley Predith and our interns and we can't thank them enough. Last year we also added a dozen experts on the topic who joined us in a very intense Working Group. They are listed here. They have been invaluable in guiding this report. The topic is getting a lot of attention because this is a 100-year change in cities not just here but around the world in terms of being a new historic era for cities. If you put in context from 1920 to 2010, metropolitan areas have increased, but primarily around the idea of central cores that frankly have been starting to hollow out as people have moved to the suburbs, and this has been much more of an automobile society for most cities. But in 2011, that actually started reversing itself as Millennials and Baby Boomers started returning to the city and that's transformed the city form these central cores first of all to unique districts and so we have a number of observations associated with that that are really helping to push that forward. One of them is there have been very fast advances in many technologies that are relevant for cities, and particularly technologies being retransformed to work at the district level. Information and Communication Technologies are really aided by chief distributed computing, new inexpensive flexible sensors and they are revolutionizing what we can measure about our urban life, and they are actually opening the door for a brand-new field, the evolution from urban planning to urban science. And there have been disruptive changes in technology and transportation, in electric and now coming autonomous vehicles and energy, especially those competitively priced around distributed renewable sources and storage, new localized water concepts as the whole water system is in position now to undergo change, recycling strategies, and frankly this is starting to become mainstream. In parallel with these technological and demographic changes and perhaps partly as a consequence of them, we're also witnessing changes in norms of behavior, so people are now using digital technologies to be able to connect to their services. There's an emphasis on the sharing economy that we hear about, mixed land uses, more emphasis on walking and biking, matching what's happening really in the rest of the world. Not as much core car ownership as frankly we're starting to move more towards the concepts of mobility as a service as well as other concepts as a service. We have also seen large city CTOs are starting to use real-time data analytics to improve their services in areas like health and public safety, so we list many examples in our upcoming report. But for example, one that's interesting is in Chicago, they are starting to use sensors to track how water is accumulating. And from that they can get a better idea of what's moving forward in the rodent population. And from that they can correlate all of that to asthma cases that are happening in Chicago, and that's actually tracking to very specific districts, and particularly low income districts where they are particularly susceptible to children who are there. And we've also observed through talking to many people that this is actually a very complicated subject of a combination of stakeholders to bring together. The private sector, governments, city residents of all kinds that need to share their information, discuss the results with each other to move their cities forward. The Federal Government has already implemented a lot of helpful early programs from many agencies, and this is a slide. It's very difficult to read because there's so many listed here, but starting point, what's been happening, particularly in the Administration being very sensitive to place based programs and 18 large place based programs

went into place starting with the Administration, but really in the last year a lot of them have started to look towards technology. So for example, the White House in September pushed forward their Smart Cities Initiative, and it was quite a boom of many people coming back to Washington. They introduced new R&D funding, created the MetroLab Networks, which brought 20 universities paired together with their city CTOs to look at some of the R&D problems that are happening there. So what is needed? First of all, experimentation. Experimentation really at the district level. And to test technologies and learn from that. Districts frankly have proven to be large enough to learn from, but small enough to actually do good experiments. And we can add technologies to districts that can make them more energy efficient and we can optimize on that essentially being green. We can look at convenience. To make them more mobile. We can look at them to be in the word that we use connected, to be much more inclusive for people to be able to use technologies like broadband. This helps improve health, lowers pollution, reduces energy use, better water management, creates safer neighborhoods, decreases congestion, and offers these technologies for a level playing field. McKenzie did a report looking at green districts where they saw a path to them not only being easily more affordable, but they used 20 to 40% less energy consumption, 60 to 65% less fresh water consumption, 25% less waste was created, and 30 to 50% reduction in emissions, and found a payback of the districts because of costs involved in the beginning, were typically three to five years. We also feel we need a breath of knowledge platform, where different from the start of the Smart Cities Initiative we really top down where single large vendors were involved working with cities, this is very much, this era is very much being characterized as bottom up from many different parts of the stakeholder community, but also startups that are creating ideas, bringing those forward and just like the worldwide web, the best ideas are being adopted and being brought forward. So we believe that we need something like a city web that is sort of equivalent the way the worldwide web has been for corporations, multi-stakeholder, shared data, APIs to connect to programs and data, predictive analytics and optimization algorithms that people can look at and learn from their results, their models their best practices, and frankly the idea of moving from these one-off implementations that city CTOs are doing today to try to create real application at that can then be shared across cities and also alone then smaller cities that don't have technology capacity to be able to adopt these ideas. And most importantly we think we need this in an integrated approach. If you think about the simple examples of how these technologies may work together, 25% of the space in districts and cities or more is being used just for parked vehicles. So if you can reduce that through the use of autonomous vehicle, that will open up that space that can then be used to enable pedestrian paths, bike lanes, new denser affordable housing, and that new denser affordable housing can allow us to start relooking at our energy systems we put in place to more district energy systems, so that lowered housing utility and transportation cost will also allow residents to be able to afford to be in cities and be closer to their jobs. And this freed up space will also then allow us to look at some of the concepts coming back to cities like urban agriculture and cleaner manufacturing, and that will produce local supply chains that will be much better than large supply chains of today shipping goods thousands of miles to their destinations. We also feel what is needed is a new workforce. A workforce that's basically educated and train to be able to implement all of these different technologies, and frankly the concept of having them have credentials and accreditation so they can export their skills to other parts of the country. So

what is needed from the Federal Government to do all of this? We think we need to start to move, the agencies are doing their job in terms of silos today but we really think we need much more of a cross agency effort to put these pilots together. We need the Government to work on helping the private sector to create this workforce of tomorrow. Clearly we need more Federal funding if we're going to compete with the rest of the world. We need the Government to help us in terms of creating this city web platform that many people in many parts, stakeholders in the private sector, are talking about the need to create, particularly around standards and interoperability We need to have international collaboration because frankly the ISO standards coming together are going to be very important for us and for our vendors in the United States to be able to work with a lot of the problem overseas where there's even more acute view of people moving from rural areas to cities. We also need coordinated R&D across the various Government agencies, where today there really isn't even an inventory of projects that touch onto this city effort. This is a multi-trillion dollar business opportunity that the U.S. cannot afford to lose. There's significant efforts underway in the UK and Singapore, countries like Germany, Spain, Sweden, Netherlands, India, China. Our counterparts in the UK Science Advisory Council have now written 13 reports on this topic of all various types, and the UK has even created a Minister of Cities in their Cabinet so they are looking very closely at what is happening in this area to lead the next wave. As a result, these are some of our recommendations. And our recommendations really fall as it turns out four main recommendations sorry; what happened, did I hit a button? Go ahead, maybe you can figure that out. In any event, let me talk to it. Okay. Yeah. Are you going to advance it? Okay, great, thank you. So these recommendations really fall into four main categories, being around organization, technology capacity, legislative financing, and R&D. I think I'm just going to keep going and we'll let the slides catch up.

>> JOHN HOLDREN: Please keep going. They will do their best to get it back up. I don't know what's happening. It came back up but it gave up when they got to the recommendations.

>> MARK GORENBERG: Hopefully that's not a sign.

>> MARK GORENBERG: The first recommendation on organization is we need an integrated agency approach. Each of the agencies have technology capacity for cities of different levels. Frankly we have talked to most of them, but the Department of Commerce has as many areas that are particularly applicable to the next era of city efforts through NIST, economic development census, NTIA, NOAA, many other parts of the organization, and for that reason, we believe the Secretary of Commerce working with the secretaries of HUD, Transportation and Energy should establish an interagency initiative, to support the efforts for models for technology enhanced cities. And there are multiple parts to this recommendation. The first is that we're going to, we would like to ask them to create, we believe they should create a multi-agency blueprint this year to be able to move this forward for frankly for the next 100 years. We need to immediately, you're going to run it from there? Okay great. We need to immediately create an integrated technology competition program, so model after the Department of Transportation Smart City Challenge which was announced in December, that's currently underway and it's gathering proposals to award $40 million to a single city for a living

lab transportation experiment. It's created a real buzz around the country. We have seen the start of the workgroups and the deadlines they are under. They have been able to use this to bring all of the stakeholders together in a way that very few things can bring together, to talk about how to move their city districts forward We need to have this group explore the training programs that connect urban technology innovation to jobs development, particularly around certification programs, and help the private sector to move that forward. We need to work with Federal agencies such as DOD to evolve urban districts. Like military bases, with these new technologies to learn how we can take that knowledge to the evolution of urban districts in cities. We need to have a convening process, have them initiate a convening process using NIST and NSF, help spawn the standards efforts that will be needed for many stakeholders of the city web. And then turn it over to the private sector, much the same way that the worldwide web started with the creation of the W3C. And we also need to have the agencies work together with the U.S. Chief Data Scientist to identify types of data that can help city services, and then work with the private sector to come up with those incentives to allow them to think about data sharing, and particularly to put in place the privacy and security concerns that folks like that may have. Second in terms of technology capacity, we believe that HUD plays a very crucial role for low income communities. And should have technology tools like CTO, like innovation labs, so that technology can empower these communities for better health, better education, better employment, with an emphasis to make sure these city districts are affordable to a wide number of people. Third, in terms of legislative financing, we have two recommendations.

A large level of funding will be required to change our cities to this new era. Other parts of the world recognize this. The Asian Development Bank, for example, is spending $18 billion a year as they expect 1.1 billion people to move into Asian cities over the next decade, so we will need to spend some real money to compete The first and probably the easiest is the idea of approving what's called QPIBs, qualified public infrastructure bonds, that's already been brought by the Administration to Congress this past year as a new type of municipal bond that allows public-private partnerships to be funded by bond holders, which is especially needed for re-platforming our cities although it came up initially for general infrastructure. The second is we believe treasury should create an advanced technology infrastructure incubator loan facility to loan dollars for re-platforming these cities. And fourth, in terms of our recommendation is in the organization of R&D and the Federal Government. We propose that there be National Science and Technology Council subcommittee, we call it the Urban Science Technology Initiative to coordinate Federally funded R&D starting with an inventory, then having these teams work together. And even look at the concept of grand challenges for how our cities can move forward. So with that, I'm going to turn this over to Craig for comments.

>> CRAIG MUNDIE: Thanks, Mark, and let me also thank Mark for his leadership on this project. It's been quite an effort and he's done a fantastic job. He mentioned many things. But I just would like to reinforce a couple of them. One is that if you look back far enough, well, more than 100 years, it's always been a technological change that has driven really structural change in the nature of cities. We created running water. Then plumbing. Distribution of gas. Electricity. Then automobiles for example. Each of these changed the nature of cities, the scale of cities, and the way people lived and worked in them. In my mind it's quite natural to find, particularly with information technologies being added to this list of critical capabilities, and

also looking at the aging of many of those now almost 100 year old systems, that it's come a time where we should naturally expect cities to evolve one more time. And I think that this report is showing a direction that will help the country and world move in this direction. Second is that we now see that many of these things that have evolved in separate ways now will be much better if we can integrate them. You can't integrate them as you're inventing them one at a time, historically, but now that we know that we need all of these infrastructures, and we can add Information technology on top of them, it provides a way of gaining advantage from that integration which we think is important both in operational capability and economically. Third, there's a lot of talk today about smart cities but smart up to this point has been about optimizing the performance of the cities as we have known them. But we now have an opportunity to really re-platform the city, and this is a significant shift, so while we embrace all that's been achieved in the smart cities activities to date, and certainly would want them integrated in a natural way, this is a much more profound shift than just adding a level of instrumentation and optimization to the cities we now have. It's also important to recognize that this is not an incremental thing, that this is really a replacement in many ways of the investments we've made over time and that we necessarily have to continue to make in order to sustain the infrastructures we already have. I think it's important to recognize that it's not all at the margin incremental spend. However, as any business would know, when you have to re-platform your business, there's a period of time where you have to have an overlapping investment in order to bootstrap that change. So the recommendations and the focus on the need to provide these economic mechanisms for the bootstrap, I think are absolutely essential recognizing it's not an incremental tweak we're making to the cities we have now. Then I think it's also important, and Mark mentioned this, to recognize it and you can look to some other work and other PCAST reports where we have pointed out that technological change is largely going to displace most of the jobs in the world in the United States especially over the next 20-year period. And we have an imperative to find a way to move our workforce up to a more technologically advanced capability. And I think this provides at scale opportunity around the United States and ultimately around the world to create a new class of jobs and a new way of training people for those jobs. And that as this technological re-platforming takes hold it can bring along with it a huge opportunity to deal with what would otherwise be a growing problem of unemployment. So I think this is a very profound thing. I'm appreciative that PCAST leadership and my colleagues and so many people chose to participate in this program. I'm enthused about what I think will come about as a result. Thank you.

>> JOHN HOLDREN: Great. The floor is now open for discussions, comments and questions by PCAST members. Jim Gates is the first flag up, Jim.

>> JIM GATES: Thank you, and I would like to pay tribute to first Mark and Craig for their leadership on this project. It was inspiring to be part of the team to put it together. My question has to do with something that a lot of us are concerned about and Craig touched on it at the end of his comments. Namely are we envisioning a city where all Americans have a chance to have the kind of middle class existence that our citizens have become accustomed to over the last 100 years, so could you speak to that just a bit.

>> MARK GORENBERG: Yes Jim it's a really great question, and one certainly on the front and center on the mind of everyone in the Federal Government, and on the minds of all of us versus what we're starting to see in some cities in parts of the world where they are wrestling with cities not being affordable to a wide range of people that live there. So technology is the way that we can start to move from just the notion of affordable housing to affordable living, basically within cities. You can do this, as we talk about, by changing land use, by construction costs which newer technologies will let you do. Land use will get back by moving the technologies around so you can create denser cities, but you can also with this have lower operating costs in terms of energy, in terms of transportation, and bring jobs back to the city so people can live close to where they work. If you can lower the basic cost of housing, energy, transportation, and at the same time increase the number of jobs that are in cities and things like agriculture and manufacturing and other areas, you have the opportunity to have cities remain affordable to a large range of people. And a lot of the early projects have gone on really around the idea of low income. Solar technologies in particular, HUD has worked with both the DOE and EPA. They have a Renew 300 program today. So they are particularly bringing solar technology to low income areas so people can afford to remain there, lower their costs, and frankly have the ability to put costs back into the system, to get dollars back with their money. So this is front and center to this, and will be very, very important to the initiative

>> JOHN HOLDREN: Thank you, William Press.

>> WILLIAM PRESS: Thanks, John. Mark, this is a wonderful report, and I think it's recommendations are going to have a big impact. There are recommendations across a wide range of cabinet departments. You've suggested that Commerce should take the lead. But clearly Energy, Labor, HUD are all involved. I recognize that you can't commit cabinet departments to do certain things, but I wonder in the course of this report do you have a sense of whether there is interest in those departments for moving out in this direction?

>> MARK GORENBERG: Absolutely. We talked to, and I give Marjory a lot of credit for helping us set up and get through to a number of folks who are here. We talked to a number of people we call the inventors, the integrators, and frankly the policy people, and a lot of people in the Federal Government across these agencies we find they are trying to create integrated approaches on their own in an informal way so we are seeing HUD work with DOE and EPA. We are already seeing Commerce start to work with some of the other parts of the organization. We're seeing transportation that's moving forward. We have talked at high levels in these agencies and there's definitely an interest in working together on these points and to be able to share their technology capacity with each other to create these integrated city districts.

>> JOHN HOLDREN: Michael McQuade.

>> MICHAEL McQUADE: Again, I think a terrific team effort to take a very, very large subject and come down to a set of recommendations that really capture the essence of where we are. So Mark, one of the key elements in here, there's the city initiative and then there's the City Web.

Can you talk just a little bit about the City Web. So what, maybe give a few words on how expansive that is, what the rationale is, et cetera.

>> MARK GORENBERG: I'm going to say a couple of words but I want to hand it over to Craig who has helped pioneer the idea and headed the committee. I want to talk about it more from the aspect of sitting with a number of disparate private sector groups, sitting out there working on proposals they keep looking at the idea of trying to create this themselves and know it's very difficult one-off, but there are many plans around the idea of having to have sort of on open environment where people can share things. Whether it's code or data but even more so their insights that they learn. So with that as a starting point, Craig, why don't you go ahead.

>> CRAIG MUNDIE: Yeah, we were motivated to propose the City Web by looking at how the Internet grew. It started out as just basic connectivity. Then people had files and they were all around. But you had to know where they were. You couldn't, you had to move them with some difficulty. And two things fundamentally changed that. We added HTML and HTTP so people could all describe a web page in a uniform way, and with metadata there a lot of emergence of the search engines, which is the ubiquitous way of finding what you need. The question is how do you take and create in analogous terms a way for all people in this huge growing community of urban science to go to this same point of evolution. How can they share what they have in some unified way? How can you discover something that's being done in the department in a Chicago environment and find it in a small city? We found in our work that many of the biggest cities in the country of course have people that are invested in doing some of these things. But even they don't know about each other and don't have a good way to share. Of course if you look at the smaller cities, they just don't have the capacity to do this thing. So if you don't want this to become something that just affects a few elites, if you want the same ubiquity we see on the web, we have to create some standards to allow this type of exchange and discovery to happen and allow collaborative development to take place the way we see now in so many other areas. So the belief is we could add a few protocols and description mechanisms that are specific to both the discovery, collaboration, and operational elements of an interconnected smart new platform city environment. And get the kind of leverage we have in so many other areas applied to the people who work in this space, so that can be assembled standing completely on the shoulders all the success the world has had on the Internet and the worldwide web, but give it the kind of specificity that's going to be necessary to bootstrap this new area of urban science.

>> JOHN HOLDREN: Good. Thank you. I see no other flags up, so I would like to ask if the members of PCAST are ready to approve these recommendations and the underlying report, subject as usual to final edits. All those in favor, please raise their hands. Opposed? Seeing none, the recommendations are unanimously embraced. The report is approved subject to final edits. And again, I can only add my heartfelt thanks to Mark, to Craig, to Marjory and Diana and Ashley, who did so much work and also to the other PCAST members who contributed and the experts who were consulted. This was a big, big team effort. And it's terrific to see it come to such productive and potentially influential conclusions.

Technology and Aging

>>JOHN HOLDREN: We will now move on to the second of the reports for our consideration this morning, the Technology and Aging report. And there I believe Christine Cassel will tee this up for us with Ed Penhoet probably adding some comments after Chris' presentation. So Chris, the floor is yours.

>> CHRISTINE CASSEL: Thank you, John. And I do want to thank Ed, the Co-Chair on this report. And I also can't help but comment that there are many similarities between the cities report and the aging report. Two major ones that both of them really involve a broad span of Government agencies. And public and private players. And the second is that older people are a major component of our city's population and a growing one. And all of the recommendations that Mark and Craig told us about dramatically add to the ability of older people to live and flourish in cities. So keep that in mind. So our report was focused on a very specific question of how can technology help people as they get older to remain independent one way and productive and improve their quality of life. And one way to think about that is delaying and maybe avoiding altogether the need for people to move out of their homes, to move into more dependent situations such as nursing homes. So I'm going to go through a brief overview. A number of cross cutting recommendations. Because we did find a number of recommendations really span a whole range of applications. And then three specific applications of technology, if you will. One about social connectivity and health. Another about cognitive ability and ways that technology can help in situations of declining cognitive ability and similarly with physical ability declines. So this is the picture that we all should be keeping in mind about the population. If you look at between 2010 and 2020, roughly where we are now, 2016, you can see that that number of people over the age of 65 is rising, and the number of 85 is very dramatically rising. So it's no longer the case that we can talk about the elderly as a unified coherent concept. It really is a large part of our population. And not only is it very relevant to Federal policy and policy at every level, but as many people have pointed out, it's also an enormous market for products and services that really can help people and provide services. So the basic context, though, with aging, even though I would point out that the majority of people over the age of 65 are quite healthy and independent and active, that with age comes higher risk for complex health problems, for functional declines, and for the risk of a number of serious medical conditions. So our study focused on, as I side, helping older adults remain independent and have higher quality of life with a special consideration for disparities of various sorts. So cultural differences and how families live and interact, socioeconomic differences, and particularly access to products and services by people who have lower ability to purchase those on their own behalf. And ways that collective efforts in cities and communities can help people. Then the last point is really important for PCAST members and others to understand that there is an enormous range of innovation going on out there related to new technologies and potentially ways in which technology can help people as they age. We decided to really focus on the short-term impact, the low hanging fruit, if you will, where the technologies are most immediately able to help people within the next few years and where Federal policy changes could have the greatest and quickest impact. So here is our group, Ed and I were privileged to serve as Co-Chairs and we have a number of PCAST members as you

can see there as well as experts from a number of different perspectives from academia, industry, and others. And I particularly want to thank Ashley Predith, the Assistant Executive Director of PCAST who really shepherded this and helped not only organize all of the meetings, but bring coherence and important organization to the text of the report. Also Diana Pankevich played a major role, particularly with our cognitive aging subgroup. And Rob Saunders who helped us with the writing. So the cross cutting recommendations are important. Because what we discovered is if you look at each of the special needs, mobility, cognitive function, social engagement, there are a number of themes that run across these. And so some of these are that there's a great heterogeneity in the population, I mentioned that already. But what that also means is that there's a great, there's a breadth of policies needed from many different aspects of Government. When we think about aging policy, we tend to think about HHS and about health and medical issues. But in fact, housing, transportation, communications, emergency services, education, a whole range of other policy areas, are extremely relevant to helping people stay independent. Second point was the foundation of Internet connectivity. Internet, I'm starting to think of Internet as a basic health resource, as well as a basic communication and social resource. Monitoring technologies have now become with big data and data analytics and predictive modeling very sophisticated. And can be used to great beneficial impact. In aging, there are a lot of issues there which we'll get into. But that's a consistent theme throughout the report. And then interface and interoperability standards for technology and for information are very important. And then finally, the need for more research. So recommendation number one has to do with this issue of the breadth of agency and policy impact. So we really recognize that we need more coordinated action rather than we were tempted to recommend a Department of Aging but we thought rather than do that, all of these people are working in existing agencies on relevant areas that instead, they should be coordinated. So we asked OSTP to create a one-year Task Force of the National Science and Technology Council to identify the technologies vital to an aging population, and focus their recommendations on how best to enhance the work between these agencies. And then within the health area, most immediately, that HHS should bring the private sector into a public and private council with people from industry, academia, and advocacy organizations, to advise on ways to advance technology in the same service. I imagine that the findings of that group can directly then impact what the interagency discussion would be. Recommendation number two about engagement and social connectivity. I'm going to point out that access to Internet communications really underlies a whole range of ability, if you think about it, of older people, as well as everybody, to access the kind of information that they need. And reach out and engage in the communication that they need. Many people have this attitude that older people don't use the Internet. That actually is not true. And it's increasingly not true with the aging of the baby boomers. So not only do you have people entering the over 65 age group who have basic skills and familiarity with technology, but it's also been demonstrated that older people, even in the 85 and plus group, can learn and are able to learn, particularly if the learning is oriented towards their learning styles and educational styles. So we have recommendations related to both of those. So the first thing is to have access to broadband. And we've had other PCAST reports that address this. But what we're asking here is that HHS through the Agency for Community Living and Commerce through NTIA to work together to create a national plan to ensure that older people have access to broadband. And then at the same time, FCC should

review and consider in all of its negotiated agreements about federal communications approvals that older people are included. There's been a lot of attention to making sure schoolchildren have access. But less explicit attention to older people. And then finally FCC and NTIA should create a plan that includes a matching program with private support to support training centers. There are a few of these in some cities that have been very successful in reaching out and making training available to older people. But there aren't enough of them. And they certainly aren't accessible to all of the people who could benefit from them. The third recommendation is about training monitoring technology for frail and vulnerable elders in particular. So I mentioned the promise of that. We tend to be concerned first and foremost about privacy and the sort of potentially intrusive nature of monitoring. But in fact the benefits far outweigh those risks. So what we want to do is ask the Federal agencies to find ways to further strengthen and enhance the benefits and reduce the risks of monitoring. And so if you think about it, this monitoring can help us predict problems with mobility, with neurological function, changes in daily patterns of behaviors so if you just can have some signals that go to a family member or a medical professional if there are major changes like not getting up out of bed or not eating for a day or something like that, and people could continue to live longer in their own homes, some of these very basic functions could be supported in that way. And then finally there's major benefits in financial security that I'll get to in a minute. So we're asking NIST to collaborate as it always does with the private sector to develop marketing and instructional materials so consumers understand the operational requirements, the benefits of monitoring, and also are able to appropriately calculate the risks And then also to develop guidance to identify privacy and security safeguards in a way that doesn't impose undue barriers to innovation and adoption. Recommendation number 4 is about research. And there's of course needs for research. But particularly urgent in some of these areas that are just ripe for applicability but haven't quite reached that tipping point yet. So here is a place where all of the Federal research agencies and in particular NIH, AHRQ, NSF, the VA, DOD and DARPA, should get together and really develop a plan to accelerate research in robotics, other advanced mobility technologies, communications, special emphasis on emergency situations, cognitive training, and home monitoring. So getting to the specific areas, we talked a lot about facilitating social engagement, and both information gathering and communication for these purposes. One is social participation. It's not just a nice thing to have. There's very good data that people who are isolated and don't engage in their communities are more likely to have dementia, for cognitive impairment to accelerate, to suffer from depression, which leads to a number of exacerbated medical conditions, and other kinds of problems. Plus, they are not able to keep working, if they want or need to have to do that. And they are not able to take advantage of volunteering activities. They also can access information and resources more easily. And be more likely to be secure and safe in various kinds of emergencies. So the first recommendation in this area, recommendation 5 overall, is that the Administration should support education and training in online technologies. So this happens in a major way through continuing reauthorization of the Older Americans Act. And in particular, Section 415 that specifically focus on access to online services and protection from scams and fraud. We also would ask the CNCS, the Corporation for National and Community Services, which already has support for a senior volunteer corps, to expand this to include people who already have technology skills who can help other people gain these skills. Recommendation number six is about emergency response

and communications. Here is a place where you think about it where older people, much of the attention in disasters have been to people in nursing homes, rightly so. But also isolated people in their own homes who may also have impaired sight, hearing, not getting the messages everybody else is getting. And even if they do, impaired mobility that makes it harder for them to leave or evacuate. So we're recommending that FEMA should advance strategies to create effective communication systems to reach people in those various circumstances. The Assistant Secretary for Preparedness and Response work with the Office of the National Coordinator and CMS to promote more rapid interoperability of medical information. So that whenever and wherever an older person is in need, the relevant information about that person's condition can be accessed. Also, to identify people at risk in advance of known emergencies, such as tropical storms or tornadoes, where you could identify people who, for example, are dependent on technology such as dialysis, various infusion pumps, ventilators, et cetera. And get help to them in advance of a predicted emergency problem. And then the last recommendation that FEMA, ASPR, and CMS work together to make medical device interfaces more consistent and interoperable. So this has to do with charging, signaling between devices and various backup strategies, all of which now each different device and each different maker of each different device has a different approach to. So it makes it very hard to have a systemic approach to making help available to people in those situations. Cognitive ability is something people often think about when they think about problems with aging. There is a high risk for neurodegenerative diseases such as Alzheimer's disease. But there's also even with normal aging a decline in certain kinds of executive functions in the ability to identify risks, perhaps to analyze particularly financial situations, putting people at greater risk for fraud and financial mismanagement and endangering financial security for older people who are on fixed income or limited savings in particular. So the recommendations here are about financial services and also about cognitive training. The first one about financial services is that the Federal Government should encourage the banking and financial industries to offer monitoring to protect assets from fraud and exploitation So here I want people to think about your credit card companies, that has very good monitoring. They understand your patterns of how you use your credit card. And if they see something out of the ordinary, they will decline the use of the card and they will send you a message. Did you really, is this you making this purchase? And then it's very easy to just signal that it is. And then they will authorize the card. That takes enormous risk out of the loss of a credit card or the theft of a credit card. Very similar things could happen in banking. People do have patterns of how they spend their money through various banking services. And dramatic or unusual changes in those patterns could be identified. And people could simply be warned or asked, or an authorized family member warned or asked, do you really want to go through with this set of transactions. So there already are some banks that are doing this. And there are many of the big banks who are exploring it. And understanding that this is going to be an important need going forward. So we're asking the signatories to the 2013 interagency guidance on privacy laws and reporting of financial abuse to accelerate this expectation of banks, and within their regulatory capacities, to help banks to get these services available to older people. We're also asking the Executive Office of the President to convene state governors to ensure there's an appropriate and effective link between these type of reports and adult protective services, particularly for older people who are on their own or isolated where there's not a family member engaged in this kind of oversight, or if there's some

risk of the family member themselves may be involved in the exploitation. And then, cognitive training. Because of the concern that everyone has about cognitive decline with aging, there's been a booming market in games and online training products to help people that ostensibly help people strengthen aspects of brain function. It turns out that there's relatively little evidence that these things are effective in any broad way. And so we encourage, and the FCC has actually gone to reach out and regulate the claims of these products, many of which are unjustified. And so we encourage the FCC to continue to do that on behalf of consumers. Then finally, changes in physical ability. This can happen at many different levels. Some of it is just limited activity due to arthritis and other kinds of conditions, some of it is real, post stroke or other kinds of situations which leave people dependent on wheelchairs for transportation and mobility, and in all of these areas there's great technological advances. Much of it led by DOD and DARPA on behalf of veterans and injured veterans but it could be applied to great benefit to the older population more broadly. But there are barriers to that happening. So let me go first then to recommendation nine, which is about tele-health. So people, tele-health is another promising way not only to get health services over the Internet, over Skype in various kinds of virtual communication techniques, between health care providers and people who need advice or monitoring for their health, the full promise of tele-health, I would say, and our committee identified has been limited by two things. One is the fact that medical licenses are done by states, and the states don't have consistent standards. So doctors in one state can't advise somebody in another state. Even if they have greater expertise. So the Federation of State Medical Boards, that's FSMB, has already begun a project of beginning to get agreements between the states on reciprocal recognition of licensure, and we urge them to continue to do that. And we are suggesting that HHS convene the FSMB with the National Governors Association to find ways to accelerate this reciprocity. The second point that limits the acceleration of tele-health is CMS policies, which for understandable reasons, have required that the patient actually see the doctor if you're going to send a bill to Medicare. They are worried of course about fraud, about ways in which people could game the system. And that's understandable. We think there's technology solutions to that, as well. But we think that CMS should, within the Innovation Center, which was started by the Affordable Care Act, to find ways to advance payment policies that support innovation, which moving away fee for service to outcome based payments where if you get the right outcome you shouldn't have to depend on actually showing up at the doctor's office, what should happen is the person gets what they need through whatever mechanism, and is the more patient centered. Recommendation number ten is about home design, so here we're talking about the impact of HUD and home design uniform policies in all kinds of accessibility standards that allow people to have services and products that come into the home and not have to be retrofitted for every different product and service that comes in. There's been a lot of designs in this area in other aspects of housing. And this is particularly important for retirement communities. The last two recommendations are about product designs. The first one is just general product design to make senior-friendly packaging more ubiquitous. This has already occurred within the pharmaceutical industry because for a while, if you recall, there were all of these childproof bottles of medications that actually were adult proof, as well, so it made it hard for people to open them. They have now figured out how to do that with these simple pressure caps. But all the other products in our world, and ironically, particularly technology products, are encased in

these hard plastic containers that make it hard, even for somebody who is not mobility impaired to access them, but if we really want older people to have access to goods and services that they need, we really need to get the Consumer Product Safety Commission to work with the private sector, AARP, and other relevant groups, to design better guidelines for packaging. And then Recommendation number 12 is about assistive and robotic technologies, and in particular mobility necessary technologies such as wheelchairs. There's also been a lot of work that DARPA has done with exoskeletons for people who have paralysis and other kinds of conditions that can get you out of a wheelchair and get you moving. All of those things ought to be much more quickly made available to older people, either in clinical trials or actually in services. Medicare payment policies, again, are intended to limit the potential for fraud, which is, again, understandable. But we think that examining Medicare payment policies to find ways that they can reduce the barriers to access, and particularly to market innovation. Some of this has to do with payment policies that limit the amount Medicare pays for a wheelchair. And that, therefore, have led the industry to kind of limit the products that are offered just to that amount. So I think making payment policies more like reference pricing and other kinds of ways that Medicare could offer a certain reimbursement. But then allow the consumer to go and find what works best for that person, and if they chose to pay above and beyond what Medicare would pay. So there's ways of thinking about working within that system. And then finally, that a multi-agency and industry Task Force led by the Veterans Administration, DoD, DARPA, NHHS, should really look at where we are with these mobility technologies and how to accelerate over the next five to ten years much greater progress. There has been a lot of innovation. But somehow it just hasn't made it to the marketplace. So we think that it's a really ripe opportunity. So in summary, these are very specific recommendations focused on the fact that the aging of our population is not only a challenge from the policy perspective, but also a huge opportunity to make a vital and contributing and productive part of our population even more so. We focus on near-term actions with broad application, and very targeted Federal action. So let me stop there and turn this over to Ed.

>> ED PENHOET: Thank you, Chris. And let me add my thanks, Chris, to the thanks that you have already indicated for all the participants in this study, especially Ashley Predith and Rob Saunders. But especially to you, Chris, I can't imagine a better partner on a project than Christine Cassel, so you've done a great job on this project. I simply want to emphasize two points that Chris has already mentioned. First of all, the overlap with the Cities Project which I think will become more and more evident as we move forward in this space. And second of all, in reading these recommendations, you could walk away from this assuming that this is a lot of stuff being done for older people. But it's being done for I think a very good reason which is to have them remain productive members of society. Their continued employment is likely to be an important factor in our workforce in the future. Their ability to mentor young people or middle aged people for that matter in a whole variety of areas where experience matters will be an important aspect of their lives. And I think in an area of overlap with the Cities Project, community leadership. They may have the time actually to spend on these district problems and creating communities within the broader context of the cities. So the reason that many of these things actually are being provided for seniors is to empower them actually to continue to contribute to society's goals going forward and it's clear many of them will live in cities. And

they can be an important force in actually driving some of the change that we heard about earlier in the cities discussion. So don't come away from this discussion thinking this is simply a program designed to help older people. It's to help older people remain productive in our society and contributing in a variety of different ways. And so I think with that, we'll look forward to any questions anybody has. And hopefully to the approval of our report.

>> JOHN HOLDREN: Yes, indeed, do any PCAST members have questions or comments on this report. William Press?

>> WILLIAM PRESS: Thanks, John. Thanks, Chris and Ed. That's really a wonderful report. Several of your recommendations involve changes in policy at CMS. And it's never clear to me, maybe you can help me, which of those changes require legislative action, which can CMS do as a matter of policy, or which could they do only within their experimental areas and not easily do across the board?

>> CHRISTINE CASSEL: That's a very good question, Bill. And I think that we have actually talked with a number of experts within CMS, and on the Hill. And the answer is, it depends. So, it depends on a whole range of things. So there are things that definitely require legislation and we talked about that in our hearing report, for example, because there is specific legislation right now that says Medicare will not cover hearing aids. So if there's something like that, that's very concrete. Often there is some discretion within the overall range, for example, in the wheelchair area. A lot of it has to do with precedent and where it's come from. It's always, just as we heard within, with the FCC, though, it's always better to have input from and support from Congress if you're going to make major changes in these Federally funded and Congressional oversight areas. So that's why in some of the recommendations we ask HHS and CMS to examine the possibilities of how to reduce barriers related to payment. In tele-health, for example, and in the wheelchair area. The last thing I would say is that the experimental area that you mentioned, the Affordable Care Act created the Center for Medicare and Medicaid Innovation, CMMI, which actually has enormous authority to try out new models of payment, new models of health care delivery. And within that venue, they can try out a lot of these things. And within the legislation, it specifies that if a program is successful at reducing costs and maintaining or improving quality, that then it can be expanded to Medicare without going back to Congress. So the Innovation Center actually has enormous potential in this area. And I think within some of these areas, that's the avenue to actually getting a broader spread.

>> JOHN HOLDREN: Good. Jim Gates.

>> JIM GATES: Well, again, thank you to my colleagues for doing this. And my question actually is prompted by your comment, Ed, of a few minutes ago, that many of these recommendations are there to empower our maturing population to continue to contribute to society productively. And so I remember at some stage, it was in one of your subgroups on this, I remember at one stage hearing about some programs that I don't remember the formal titles but I thought of them as kind of senior corps, where you have mature people getting together in organized groups and making contributions, and I'm curious in the final formal report, did we

find a trend of this a senior core of talented, mature individuals who want to be empowered to contribute?

>> CHRISTINE CASSEL: There are both Federally supported programs and privately supported programs, Jim, that are like that. They are remarkably effective. There just need to be more of them and they need to be more visible and widely known. There was one calls Experience Corps in Baltimore that you may be familiar with, but now it's national in which older people volunteer in inner city schools and underserved school districts as mentors, as teachers sometimes, just as people to help out with children of all ages. It's been hugely successful not only at helping the children, but demonstrated better quality of life, better cognitive function, better mood, better sleep for all of these older people who are doing it. So it turns out to be a win-win.

>> JOHN HOLDREN: Maxine Savitz.

>> MAXINE SAVITZ; again, I want to thank Chris, Ed, and Ashley for a really comprehensive report. Going back to 2011, the PCAST reports regarding health IT and the system have all talked about interoperability. Your recommendation six talks about interoperability of Electronic Health Records. How much progress has been made and you know is this going to be enough to really sort of get us there as it becomes more and more important and also important regarding the cities?

>> CHRISTINE CASSEL: Here I would ask both Bill Press and Craig Mundie, both of whom have been involved in this same issue, I would just say some progress. Certainly in the sense that everybody now I think really realizes that we aren't where we need to be in this area. The progress towards getting there is still in I think more, is slower than we would like the Office of the National Coordinator put out a roadmap of interoperability, it's a ten-year roadmap, so I think a lot of people are trying to figure out ways to accelerate that.

>> JOHN HOLDREN: We are running a little behind so I don't want to get too deeply into the Electronic Health Record business, but Craig do you want to make a quick comment.

>> CRAIG MUNDIE: I'll just stand down then.

>> JOHN HOLDREN: Seeing no further flags, I ask the usual question, are the members of PCAST prepared to approve these recommendations? And the underlying report subject to final edits, all those in favor, please raise your hand Opposed? Seeing none, it is unanimous. Again, I can only add my thanks to Chris Cassel, to Ed Penhoet, and to Ashley Predith and everyone who contributed to this project. It is a great pleasure to have two reports approved this morning at this PCAST meeting, and I will be conveying those recommendations to the President very promptly.

Forensics

>> JOHN HOLDREN: We now turn to a session on forensics. And for that purpose, I'm going to turn the chair over to PCAST Co-Chair Dr. Eric Lander.

>> ERIC LANDER: Great, thank you very much, John, and I'll invite our speakers to make their way up to the front. We are very lucky to have today a remarkable panel of six individuals who bring great expertise in forensic science to speak with us. As PCAST already knows, and as those who have been following PCAST on the web know, PCAST has been trying to educate itself about forensic science. It's a large, important, complex area, and I think it's fair to say we have probably engaged in more public information gathering and education on this topic than on any other topic. And that in addition to inviting groups of speakers to open PCAST meetings, to subcommittee meetings that have been held where we have tried to educate ourselves, we have also put out a request on the web for the first time asking for a whole bunch of specific questions and for people to supply information to PCAST about those questions. And we've been just gratified by the response we have gotten on the web. I don't know the count at the moment, but it's a very large number of long and thoughtful comments. We asked for pointers to the literature. And we're really grateful for that. So we're in the midst of sifting through all of that information that we have received. So I think it's fair to say we're still at an early stage of digesting all of it, but today there's no substitute for having individuals who are deeply active in the field here to share their expertise. We have, according to our schedule, oh, about an hour, hour and five minutes to do this. We've got six speakers, and I think the speakers have all agreed that they would confine their remarks to five minutes and that would allow time for PCAST to actually ask questions and perhaps even have some dialogue within the panel there. I think we're just going to go in order. I think that's the best way to do it. And I will introduce each speaker in turn. And we're going to start with Alice Isenberg, Deputy Assistant Director of the FBI laboratory. Thank you so much for being here

>> ALICE ISENBERG: Good morning and thank you for the invitation to speak to you about opportunities and challenges that face the forensic science community as we continue to advance this discipline which lives at the intersection of science and law. I wish to focus my remarks this morning on ways to enhance forensic science first with the development of consensus standards that can assist in making the application of forensic science more uniform and secondly, by ensuring that research performs to improve our laboratory procedures is sound. Most forensic science disciplines are founded on historical and ongoing research which has established not only the basis for the interpretation of results, but also the limitations that are associated with these examinations. In addition, these disciplines have been subjected at various frequencies to admissibility hearings in court under Federal and state legal standards. To date, there is no scientific research that exists to question the validity of the basis of these disciplines so long as the meaning of the results and the limitations associated with those results are communicated in a manner that is clear and understandable to the audience. While the forensic science community has benefited from the activities of several robust working groups to develop best practices for appropriate interpretation and communication of results,

there has not been a coordinated effort across all disciplines and all laboratories to set best practices for the community until very recently with the creation of the Organization of Scientific Area Committees or OSAC, managed by the National Association of Standards and Technology. The FBI has recently developed internal standards for scientific reports and testimony to mitigate the risk associated with a lack of such standards in the general forensic science community. These standards were developed and reviewed by both scientists and attorneys to set internal FBI policy for acceptable and unacceptable statements, as well as to document limitations associated with the forensic examinations we perform These standards not only provide a template for reviewing an analyst testimony, but also document the state of the science for each discipline so that historical reviews of cases can be informed by these records in light of, for example, technological advancements or a better understanding of the distribution of characteristics across larger sample sizes. Thus, one short-term recommendation that I would make to advance forensic science is to encourage the development of standards for report and testimony language across the entire forensic science community. The OSAC would be an excellent organization to take on this challenge given their mission to coordinate development of standards and guidelines for the forensic science community to improve quality and consistency of work. With respect to the long-term needs of the forensic science community, continued improvement in providing context and meaning to the results obtained in forensic examinations is an overarching requirement. The FBI has recently supported research that studies the decision making process in latent current examination. These studies have been performed in collaboration with the international forensic science community in order to obtain a wealth of data surrounding the process used by analysts in reaching decisions. Due to the success of this research project, the FBI established a research portfolio for the five areas of research that we predict will drive the forensic science community into the next generation technology and methodology. Others in the forensic science community have also initiated several projects to develop a research agenda or research priorities, and would benefit from the support of PCAST in advancing these projects. However, in order for the forensic science community to be able to carry out these research agendas efficiently, we also need the support of PCAST to augment the hiring and availability of statisticians to perform the required data analysis in these research efforts. While the forensic science community has a robust body of subject matter experts in the fields of biology, chemistry and physics, for example, it often lacks the statistical expertise needed to ensure that research and validation efforts are thoroughly and critically vetted. Whether this expertise comes in the form of postdoctoral fellowships, funded positions, or other incentives, the assistance would be tremendous in furthering research agendas across the forensic science community. In conclusion, the forensic science community must build on the concept of continuous improvement that is so important in our accreditation programs and quality systems to further our understanding of the context and meaning of our results and the communication of those results. Improving the statistical analyses associated with our highest priority research projects, and creating consensus standards for the communication of our results are essential opportunities to advance our field in order to meet the challenges we face in the future. Thank you.

>> ERIC LANDER: Well, thank you very much. We're not going to take questions after each one. I think we'll go down and do it. But I do want to just especially compliment the FBI on one thing.

You only alluded to it briefly and did not take credit for it, but the FBI showed a remarkable openness in reviewing its own testimony in these hair analysis cases. And I don't know many agencies that would have felt comfortable making a public statement that in more than 90% of the cases, the testimony that had been given was not supported by the scientific evidence below it, and you're taking it on board. It's not to say those cases came to the wrong result, but it's just a microscopic look saying those things should not have been said and you should be proud to do that. A real hallmark of science is to hold the mirror up and say, we got it wrong in places. And you know, agencies don't do it that often, so I want to compliment you on that. Thank you very much.

>> ALICE ISENBERG: Thank you.

>> ERIC LANDER: We'll turn to Jeff Salyards, the Executive Director of the Defense Forensic Science Center.

>> JEFF SALYARDS: Thank you, if I can just take a few seconds for some housekeeping items, I'm very honored to be here before you today, and very humbled to be part of this panel with five very esteemed colleagues. I also need to point out I'm not making Department of Defense or Army policy here today, although I'm very proud to serve with those folks on a different venue I can tell you very exciting stories of how we push forensics into the battlefield and expeditionary space. I think we all share the same goal here today, which is how do we make forensic science testimony more reliable, more accurate, more scientific, more rigorous. And so in the short time I have remaining, I would like to offer you two ideas to pique your imagination. The first is you'll hear a lot today about the OSAC structure at NIST, and I was probably among many a little apprehensive at first was this unwieldy or was the structure right, but I think all of us have become very impressed by what is a very professional franchise. Many of us have subordinates who attend and have participated in this process. And they are really down to business. They are really tackling some good issues and not wasting any time this whole effort, though, is really relying on a spirit of volunteerism. And that results in a real potential for a game of pickup basketball, and so I think that we need to consider taking some steps to stabilize the leadership of that organization, so I would throw out just one thing for your consideration. NSF in particular has done a very nice job with the Intergovernmental Personnel Act and their Visiting Science and Engineers Educators Program other government agencies have done the same thing. And the OSAC hierarchy there's five SACs, if you will, three resource committees and an FSB. If we created nine IPA positions, a drop in the bucket of a large Federal Government, it would have a profound effect of stabilizing the leadership of that organization. I understand we've, our recommendations are not supposed to propose new funding. I think a salami slice of all of the agencies that are interested in forensic science could probably handle that or maybe a reprioritization within the NIJ budget can support something like that. The second idea I would throw out for your consideration is as we think about how to show that these forensic science disciplines are valid and rigorous and have been properly researched, it's been a real journey and it's been very retrospective. We're looking at this vast library of research. And it's hard to piece it all together. Some of it is rigorous work. Some of it is argumentative essays. And I wonder if we're going about it the wrong way. I wonder if we should propose something much

more forward looking, a clinical trial similar to something that the FDA would use for a new screening test or diagnostic test. We have even tried to increase funding for validation studies. But when you do that, you put out a broad agency announcement that gets proposals from principle investigators. The strength of those proposals, they are very clever and original. The weakness of those proposals is they are very clever and original. And what you need is a protocol that's very standard of what before we practice this forensic science discipline, before we testify to these types of conclusions in court, have we reached a certain bar, I think the FDA has already plowed some of that ground and we could probably borrow from their expertise. And finally, I would tell you that I have many more ideas, but I only have five minutes. And so I look forward to your questions and an opportunity to answer them. Thank you.

>> ERIC LANDER: Great and while you only have five minutes for the introductory remarks, PCAST is really very interested in hearing about these ideas. So following up on things like trials that would let us know, as you said, whether something is really ready for use in a courtroom, if you wish to elaborate on that we're just at the stage we would like to hear more detail around that. I notice that Alice Isenberg had prepared remarks, while we're recording all of this, if those of you who do have prepared remarks would be willing to share it with us, that would be great. And if you wish at the end of this to send us further things based on the discussion we're very, very eager to hear particularly about proposals like what you're saying. Great. We're going to turn next to Jill Spriggs, Laboratory Director of the Laboratory of Forensic Sciences at the Sacramento County District Attorney's Office. Thanks so much.

>> JILL SPRIGGS: Members of the Council, thank you for asking me to discuss before you matters regarding forensic science. My name is Jill Spriggs and I'm the current Crime Laboratory Director for the Office of the District Attorney, Sacramento County Laboratory of Forensic Sciences. I'm also the past president of the American Society of Crime lab directors, I'm the current president of the California Association of Crime Lab Directors and current secretary of the American Congress of Forensic Science Laboratories. In my career, I have overseen the daily operations of both the state, the California Department of Justice Lab System, and local crime laboratory. I'll first address an actionable recommendation the Federal Government can do in the near term or within one year. In order for forensic testimony to be supported by reliable principles, all forensic disciplines should be accredited including digital evidence and multimedia. Digital evidence and multimedia evidence is considered a forensic discipline, not only by the OSAC but also by such accrediting bodies as ASCLAD/LAB, in fact OSAC which is an initiative by NIST and the Department of Justice to strengthen forensic science has within it a committee called Digital Multimedia with subcommittees comprised of digital evidence, facial identification, speaker recognition and video imaging technology and analysis. In March 2013, Attorney General Holder signed the charter for the National Commission on Forensic Science. The charter spelled out the Commission was to develop or recommend guidance for the forensic sciences except for one discipline which was digital evidence. In April of 2013, Attorney Holder signed an updated charter for the National Commission on Forensic Science, only this time there wasn't a clause exempting digital evidence, instead the charter talks of strengthening disciplines only. Also in 2015, the commission and a policy recommendation document on universal accreditation to the general attorney recommended all forensic science

providers, including those with the function of digital and multimedia examinations be accredited. Of concern recently was a memo issued by the current Attorney General in November of 2015, directing the departments to take several steps to strengthen forensic science based on the Commission's recommendation that digital multimedia evidence was specifically excused from obtaining or maintaining departmental accreditation. Although the Attorney General did ask for a recommendation from the Commission of the digital evidence which should be included as a service provider or not at the very end of this document. If digital evidence multimedia is not considered a forensic discipline, I can assure you we will be sitting here ten years from now discussing how evidence was handled improperly. Information was retrieved and lost and reports were not written or reviewed Even the retail company Target's digital laboratory is accredited at this time. It is encouraged of the Department of Justice change their recommendation to include digital evidence and multimedia evidence as a forensic discipline. Second, voluntary accreditation of crime labs over the last few years have increased dramatically, which helps to ensure that forensic testimony is supported by reliable principles and methods. With ISO accreditation cradle to grave documentation exists in crime labs where it doesn't exist before as labs adhere to now over 400 standards. The ultimate goal of accreditation is to ensure the standards are adhered to and a quality product is produced. Accreditation should no longer be considered voluntary, but a necessity and should be enforced for the entire forensic community, even to include law enforcement agencies with small units performing analysis such as latent print analysis or crime scene investigation. After all, crime labs receive the evidence we analyze from them. Part of the accreditation is testimony monitoring which is a very important part. But in order to assure that testimony monitoring is including the correct conclusions in court, one of the things that needs to change is the technical reviews of cases. Currently the laboratory has the ability to determine the sample size or percentage of completed case records to technically review. For example, a laboratory may deem it only necessary to technically review 10 out of 100 cases or 10%. Instead, all test reports must be technically reviewed to ensure an adequate test report with the proper supporting documentation in order to aid in forensic testimony that is supported by reliable principles and methods. The technical review of examination reports, and examination records and test reports should be mandatory in an accredited laboratory within the next three to five years to ensure the validity of scientific results and conclusions. Some crime labs will need to address work related issues such as procurement of additional staff and training of staff in order to aid in the process. Testimony is an important part of forensic scientist's job. Testimony must be clear to the jury and based upon sound principles and methods with attention paid to an excellent product in the form of a test report. The public deserves the best a crime laboratory has to offer and assurance that work coming out of the crime laboratory is of the highest quality. Thank you for allowing me to address you today.

>> ERIC LANDER: Thank you very much. We'll turn next to Matthew Gamette.

>> MATTHEW GAMETTE: Gamette.

>> ERIC LANDER: Matthew Gamette who is the Laboratory System Director of the Idaho State Police Forensic Services. Thank you for coming here.

>> MATTHEW GAMETTE: Members of the Council, I'm Matt Gamette. I'm the Laboratory System Director for the Idaho State Police Forensic Services labs. I'm also a current Board Member for the American Society of Crime Laboratory Directors and I chair the Consortium of Forensic Science Organizations which represents over 21,000 forensic practitioner memberships. I have several suggestions for immediate improvement. First, laboratories should have an internal validation study for each method they employ in the laboratory. This should be a requirement for all forensic service providers regardless of accreditation status. However, since the majority of all full service laboratory systems are accredited to ISO standards, and because I support accreditation of all forensic science providers, I'll focus my comments today on how we can improve this criteria in accredited laboratories validation studies for scientific methods are a requirement under the ISO program. Even though validation studies are a requirement, there's variability lab to lab and even discipline to discipline on how each lab performs a validation study, and what's contained within it. While the ISO standards states that written validation shall be as extensive as necessary to meet the needs of the given application or field, the laboratory must independently develop and execute a validation plan. To further complicate the issue, many laboratory methods were established long before any current validation requirements were in place. Additionally the application of this validation standard is a better fit for instrumental based disciplines than it is for pattern focused disciplines. PCAST can assist by helping the community develop minimal standards for developmental and internal validation studies in each forensic discipline, and providing recommended criteria for publication. Simply requiring validations to contain more supporting peer reviewed publications would be beneficial to our nation's courts. This effort may also standardize the validation publication format making interlap comparisons and peer review scrutiny more feasible. An example of how important this standardization is to the forensic science community is the quality assurance standards for DNA laboratories, which provides very clear direction regarding validation requirements. Highlights include the necessity of written validation studies, peer reviewed publications underlying the scientific principles, and most importantly, competency testing of each analyst on the new method. Second, PCAST and the Federal Government could be helpful to the forensic community in making Federal researchers, scientists, and statisticians more available to state and local laboratories for peer review of validation work. There's a precedent for this type of validation collaboration at NHTSA among other federal agencies. In my own laboratory we asked NHTSA to evaluate our internal validation of breath alcohol instruments. And in one case, while this is outside of their normal scope, NHTSA performed a review and provided us with excellent feedback. Having the ability to collaborate with researchers at Federal agencies on all phases of validation has several positive effects. First it encourages labs to publish their data outside of their laboratory system. Second, it produces more standardized and robust studies and third, it speeds up the validation work. My lab recently completed two substantial validation studies using external vendors. Like my lab, most small labs do not have staff statisticians, technical writers, or the ability to free up casework staff. Our vendor strategy produced a well planned scientific and defensible validation studies in a fraction of the time, but it was also very costly. Giving state and local labs with limited resource access to Federal Government validation experts, and Federal lab validation plans and studies would be a huge benefit. While the forensic labs are getting better at publishing data

every lab in the country has a treasure trove of validation data that's not published in scientific journals. While most of the current forensic journals wouldn't be interested in publish state and local lab internal validations, the community would benefit if such a peer reviewed publication existed. It would allow labs to share findings and access more data to support their own validation studies. PCAST could lead in the publication of research presented at forensic science conferences. There are perhaps close to 100 or more of these conferences held each year, and very few of these have published proceedings. PCAST could offer mechanisms and incentives for research presentations to be converted into peer reviewed publications. Finally, PCAST should address a critical need for forensic practitioner access to scientific literature. Most forensic science providers don't have a budget for wide access to scientific journals, and most using interlibrary loans or colleagues to get journal articles they desperately need. Access to published research is absolutely essential in the continuous improvement of the forensic science industry. Forensic practitioners must be accessing, discussing, and implementing the most current scientific literature in their field. Perhaps a simple starting point is getting state and local labs set up under the Federal EBSCO contract for library services. A PCAST longer term plan would be a more robust plan for library services including development of a forensic science literature search tool. In conclusion I would like to thank PCAST for the invitation to address this very important issue. Only through continued dialogue and collaboration with practitioners we will realize the fruition of these goals.

>> ERIC LANDER: Thank you very much. We'll next turn David Senn, a clinical Assistant Professor at the University of Texas Health Science Center in San Antonio. Thank you for being here.

>> DAVID SENN: Thank you very much for the invitation. Actually I was a little surprised to be invited and I want to thank Dr. Pankevich for being patient with my skepticism and for explaining to me that this Council of Advisors truly is interested in objective information from a broad range of stakeholders in forensic science. I don't want to say that I doubted that objectivity, but it was shaken a little bit when Dr. Jo Handelsman made a statement back in July of 2015 that she thought that she called for the eradication of bite marks from forensic science. And she did that without checking with me or with anybody else in the American Board of Forensic Odontology and we thought that showed a little bit of a lack of objectivity. I really thought I should have been invited to the October 22nd meeting that you had here that where someone spoke on the strengths and limitations of bite mark evidence and testimony. That's a topic that I know something about. But instead you invited known bite mark opponents Dr. Mary Bush from the State University of New York in Buffalo and her husband Peter Bush to speak. And neither of them actually has ever done a bite mark case or neither of them are bite mark specialists, and their research bears no resemblance to true bite mark cases Nevertheless, I'm honored to be here today. And back in this building where I spoke to the National Academy of Sciences in 2007 on the issue of bite marks. And in that presentation, interestingly I discussed the strengths and limitations of bite mark evidence, or at least that's what I thought I discussed when I read the 2009 report, I discovered I must have forgotten to speak anything about the strengths of bite mark evidence, so I wanted to maybe show you some of that today.

>> ERIC LANDER: Don't make that mistake this time then.

>> DAVID SENN: Thank you. You told me to focus my remarks on these near term and long-term answers, but to not include anything about money or research. You guys don't make it very easy for us to make recommendations. So my succinct near term recommendation is you review and truly understand the Federal Rules of Evidence, especially rule 702 and 703, and I know you already know that plus the state Rules of Evidence for each state I know that you already know that because and you understand the role of judges as gatekeepers for this type of evidence and you have even included one of the four parts of Rule 702, reliable principles and methods for your questions here. So I know I'm preaching to the choir about this. My long-term recommendation, and I'm going to violate the money rules of engagement that you made, there has to be training for judges to be better gatekeepers and I think that's one of the problems. And perhaps a mechanism for doing that would be to provide training in science and technology and statistics for judges who are really pretty smart people. Maybe this could be done at the new Forensic Science Center of Excellence at Iowa State University that's been developed, that's been recently developed. And hopefully they will let some forensic odontologists come to Iowa State and learn some of this material, too, which we think would be helpful. But what it occurred to me on the airplane coming in that you, this committee, or this Council may not have ever actually seen how bite mark cases are done. So I wanted to show you the way that they are used both in the investigation of some of these cases and in the testimony that's given for them. I think where, these are some bite mark cases that I wanted to show you. This happens in Christmas of 2011. It's an injury to a young child. This is the way it happens. I get calls from emergency rooms or other agencies like child protective agencies and they say there's an injured child, could this be a bite mark and they send me some pictures, and I say yes it may be it could be a bite mark, send me some more pictures and let's see what we come up with so they send, and these are all on the same child, by the way, they send me these multiple pictures of these patterned injuries. And we get more information. And if it's justified, I go to the emergency room and take my own photography or have someone take some photography for me. These are multiple injuries to the same child. I'm going to go through this because I don't have a lot of time. We select the injury that has the best evidence. And this was the one we selected for this particular case. It's on the, actually on the back of the calf of the left calf of this young person. And then we enhance that image to the best so we can see all of the features of the bite mark, and this is a bite mark. We rotate it so we think the mark is made by the upper teeth are at the top, the marks made by the lower teeth are at the bottom and there's, I can count them there's eight marks for upper teeth and eight marks for lower teeth in this image, so pretty good evidence. So how do we use this evidence? If I took the evidence on the injured party, I don't take the evidence on the suspected biters. I have someone else do that and they present the evidence to me as blinded evidence, and all I know is that the suspected biters are A, B, C and D. And we get images of the teeth of the suspected biter along with models of the teeth of the suspected biters to make our various tests that we're going to do in this case. So we have Suspect A, Suspect B, Suspect C, Suspect D. And then we will go to various tests, one of them which is an overlay test, we make hollow volume overlays and lay them over the injury, same scale, same size and see if we can make any judgments, this is Suspect A, Suspect B, Suspect C, Suspect D. I can run back through those and explain to you how we make those comparisons but in my opinion Suspect D was the most likely suspect. In

this case, a live-in boyfriend was one of the suspects. There was the mother, the babysitter, the live-in boyfriend of the baby sitter, and the baby sitter's five year old son. In my opinion the five year old son made the mark, and the baby sitter's live-in boyfriend who was in jail was released. That is an investigative use of bite marks something that tends to show innocence. We also can profile biters. I get pictures sent to me from agencies and they say here is an injury to a child, could it be a bite mark, perhaps, let's analyze it. We do a profile, I say there's some lower teeth that are rotated in the same direction, some upper teeth that are rotated in opposite directions, look for someone who has those features. And about an hour later, the child protective agency person sends me a cell phone photograph and says what about this guy? Yeah, that could be a guy who could have made that mark. And even though these are cell phone photos that are not quality evidence, it's enough to say we think that this is the person who is most likely to have made that mark, the person that you have in jail can be released. There a lot of terrific and horrific cases of bite mark cases. Here is a case that was used in court in Texas. These are models of teeth that were used to make some comparisons. This is not my case. This is someone else's case. This is a horrible case. I apologize for the graphic nature of the pictures, but these are the kind of cases that we see. Multiple bite marks on a dead child in a morgue. On both sides, we look for the best evidence. In this case this, the dentist who did this case chose the bite mark on the neck. I hope that you can see that clearly. There's marks made by the upper teeth here and marks made by the lower teeth here. He uses a different system of comparison. He takes the actual cutouts of the dental models themselves and lays them over the marks and makes his comparisons and in his opinion, in this case, there were three suspects at trial, he testified his opinion that he could exclude two of the suspects, but that he could not exclude another of the suspects. He didn't make any wild claims about statistics, no 1 in a million and I know you've heard about yesterday. Just the opinion that some people could be excluded and some people could not be excluded. So my opinion is that if the use of bite mark evidence is prevented in some way, there's going to be a great backlash from the defense bar because their clients were not protected by doing these kinds of analyses.

>> ERIC LANDER: We're going to have to wrap up I think.

>> DAVID SENN: Thank you.

>> ERIC LANDER: Actually if you're done, go back just a couple of slides I just want to make sure we looked at something because I do have a question that would make more sense to ask now. Go back another one, another one, another one, another one. Yeah, right about there. That's the one. Do you look at all of those marks and ask if they are consistent with each other? Because if I look on the chest, the upper right side of the chest, there appear to be two different size marks, so do you actually look for the consistency of all of those because you were referring to picking the best one.

>> DAVID SENN: We select the best evidence to demonstrate in court but we look at every mark.

>> ERIC LANDER: You then would report that every one of those are consistent with each other?

>> DAVID SENN: In the report.

>> ERIC LANDER: In that picture?

>> DAVID SENN: Or not.

>> ERIC LANDER: In that picture are they consistent

>> DAVID SENN: This is not my case.

>> ERIC LANDER: I'm trying to learn because you're trying to teach us.

>> DAVID SENN: If this were my case I would have analyzed every mark I would have told in the report and have said of features that were consistent and some, if some were inconsistent, then that would have been reported.

>> ERIC LANDER: Super, perfect. Very helpful to see these very disturbing pictures, but to help us understand your procedures. Thank you very much. Let's move on to our last speaker Norah Rudin, the Co-Chair of the Constitution Project Committee on DNA collection.

>> NORAH RUDIN: Thank you for inviting me to speak to you this morning. That is certainly one role. What I do day to day is I'm an independent forensic DNA consultant and I review cases, and of course I do a lot of teaching and training and writing, as well. I would like to speak to you today about, first of all, fundamental principles of forensic science. And then I will segue towards the end into some comments about probabilistic genotyping. We have also seen this image of the OSACs, it's always struck me as a little bit of a headless monster, no disrespect to the very hard working people on all of these committees. But I feel like it lacks some unifying principles. We have maybe a bit of an autonomic nervous system in the FSSB committees that interact with all of the OSACs, but I think it would be useful if we had an overarching head or brain, if you will, again, no disrespect intended, that would really help direct and unify all of the committees. So what I see really is an absence of guiding scientific principles and practices, which is a discussion for another day I feel that a consensus paradigm of forensic science principles would, number one, help to unify the disciplines, really provide an overarching structure. And such a structure would assist in articulating common problems and possible shared solutions. Forensic science has always been a bit of a bastard stepchild and has never really achieved acceptance in the greater scientific community, and I feel that that consensus paradigm as well as another issue I'll talk about in a moment, would really contribute to legitimizing the forensic sciences and help its true entry into the world of science. So for a little bit of historical context, over 50 years ago, Paul Kirk, professor of forensic science at University of California at Berkeley, wrote this famous paper on "Ontogeny of Criminalistics". In it he defined forensic science as the science of individualization, and that has defined our work and

our practice for a very long time. And in 2001, my colleague Keith Inman and I wrote a book, "Principles and Practices of Criminalistics: the Profession of Forensic Science". In creating our paradigm we bought into this aspect of individualization, and we have since come to realize that we really need to leave this behind. Individualization is not a scientific construct. It's an absolute and science really is more about estimating uncertainty, not about asserting certainty, and so I'll talk to you now about how we can leave this idea of individualization behind. This is our forensic science paradigm. I've written here six principles, if you will, divisible matter, transfer of matter and also of patterns, identification, which we talk about as categorization, individualization, which is now crossed out and I'll come back to that. Association of people and/or objects, and reconstruction, the ordering of time of events in space and time. So coming back to individualization, I will suggest that the better way to address it is to talk in statistical and probabilistic terms about the probability of the evidence such that it might support an inference of source. The first action I would like to suggest to the President, he should direct formation of a committee at or above the level of the FSSB to implement and administer guiding principles and practices, as you heard Alice Isenberg mention before of forensic science. I kind of like our paradigm but obviously that is a discussion that could take place. Next I would like to segue into talking about DNA as compared to the other disciplines in forensic science It has often been held that DNA is sort of the gold standard and different than the other disciplines, and I would like to suggest and in fact really at the heart of it, all forensic science is pattern comparison and DNA is really not much different or really at all different from the other disciplines. DNA does have the advantage that it has a strong academic foundation. The patterns are easy to digitize. And we enjoy stable and well characterized populations. Those ideas of patterns and how we characterize them in populations and how we define them really are at the heart of some of the challenges of the other disciplines. And while they do have challenges, those challenges are also not insurmountable It can be addressed by statistical and probabilistic approaches. And I won't go into the details here. But you have the slide and obviously we can chat later. I'll also note that DNA has made the mistake of basically repeating itself not learning from early mistakes. As the technology increased as we were able to detect much less, much lower amounts of DNA and we received more complex samples, the technology really exceeded our ability to interpret and weight such evidence, both the weight and as well as and the significance in the context of the case. And DNA is finally slowly making progress in implementing probabilistic genotyping approaches that can assist in this that and I would say that approach can be transferred to these other disciplines it might be more difficult but again the challenges aren't insurmountable and I've provided you with a couple of papers where people have performed research on these issues. Any approach or model requires software, you can't do it without software. Ideally software should be open source and it's nice if it's free of charge. Currently the probabilistic genotyping software that's quickly becoming in the standard in the U.S. is from New Zealand Institute of Environmental Services and Research, a private company that provides scientific services to the Government of New Zealand. It's commercial, it is proprietary and it is very expensive, and many of the laboratories that purchase this software purchase it through NIJ grants, in other words our Federal dollars are being exported to New Zealand. So in my opinion, the model should be open source for software. Free of charge, as I say, is nice. And an example that has been created by the Federal Government is OSIRIS, that should be all caps, which was created by the NCBI. It's a genetic

analysis program so obviously it's possible, sorry open source and free of charge software exists. Our group provides one such example, but small nonprofit groups cannot serve the national need of all of the laboratories in the U.S. So again, I would like to suggest an action that the President could take is to sponsor federally the creation of probabilistic genotyping programs, first for DNA and a model for disciplines that would eventually need such programs. Thank you for your attention.

>> ERIC LANDER: Thank you, thank you to the whole panel, it's great, we have such a diversity of opinions and perspectives. I pick up all, a variety of very, very interesting points and some range of opinions, and I think that's exactly what we have been trying to learn over the course of months now is the whole range of views and how to think about things. Several of you have offered ways to frame these questions. And I'm hoping we can now engage in a robust discussion with PCAST. Our practice is when PCAST members want to speak, they turn their flag vertically. And I shall invite Barbara Schaal as the first flag to go up, then Barbara and Bill and Craig.

>> BARBARA SCHAAL: First, thank you very much. This was really very interesting and engaging. One of the themes that have come out across the number of speakers is the need to have some very large widely accepted standards. In particular, both Alice Isenberg and Norah Rudin talked about statistics and probability of assigning genotypic data, and I'm particularly interested in how widespread the use of such kinds of software is beyond just DNA, and even within DNA you talked Norah Rudin about different kinds of software packages. Do they have different efficiencies? Are they all widely accepted as having the same standard? And how do we get to a point where we have accepted standards for evidence for validating techniques and for analyzing data that everyone agrees are appropriate techniques?

>> NORAH RUDIN: Yes, thank you. There are a number of different software packages. Actually there's quite a few of them from all over the world, there's probably four I would say that American labs consider. And they have quite different models and quite different approaches. And there has not been yet sufficient comparison to determine if there really is a fundamental difference in the inferences that might be made. Part of the problem of course we don't know especially with probabilistic approaches what the true answer is. Even if we start from known samples. So that work really has yet to be done. One of the things that impedes it is these commercial programs. And so for example, you have to have the program in order to perform the comparison. So there are some issues. And there's been some political issues with that. And so the answer is we don't know yet. I think they are all extremely useful and all a step forward. But in terms of comparing them, work yet to be done

>> WILLIAM PRESS: I guess my question is to Jeff Salyards. I wonder if you can elaborate a little bit more on the idea of clinical trials because in particular, in some of the forensic disciplines for example, some of the pattern matching ones, maybe it's bite marks, I guess there's the question that Norah just raised of you don't know the ground truth in the first place. In real clinical trials you know the outcomes, did the patient get better or not. And just if you could say

a little more on how you might try to bring some of the clinical trial methodology into these more complicated fields

>> JEFF SALYARDS: Absolutely. So if we take the hard case of bite marks or cartridge comparisons or fingerprints even, I think we could create ground truths. I can prepare sets of prints that these match and these don't match. So the FBI under JoAnn Buscaglia about five or six years ago did a wonderful black box kind of study of we'll let you off the hook of any rigorous measurements, but how successful are you at this. And then that could be expanded to what if I only give you a half of a print or a quarter of the print. Where does it break down? So there's lots of ideas. But that could just balloon into the thousands of experiments we could do that would be interesting, and so that's why I think we need some help from a policy point of view of what let's this be valid. And then we have to not shy away from the rigor of what is it that we're actually measuring? It might be very kind of intuitive. But there's actually something going on. And we could begin to get at what is the thing that, what's the real index of similarity. And then that would lead us to probabilistic statements a more baseum model, if you have this index of similarity, how likely is that evidence in the face of this hypothesis versus that hypothesis.

>> ERIC LANDER: Next up is Craig.

>> CRAIG MUNDIE: I have a question for Matthew. You talked about the idea of publications, both access to them and the idea of having a lot of these studies perhaps published in a peer reviewed environment. In my experience lately, even in fields that have many, many decades of established publications and peer review, more and more this is moving to be online. That before you ever get it to the peer reviewed environment, it's essentially published instantaneously like in the physics archive or other things. And everybody has access to that immediately. And so a lot of the science now is essentially being reviewed by peers, but not for the purposes of producing a peer reviewed publication. And the whole thing seems to be accelerating some of this. So similarly if you're looking in that environment, there's no costs associated with it, there's no subscription fees, et cetera. So I was curious why in your remarks you focused on what I'll call the yesterday's approach to publication, scientific publication. And at least to the exclusion of this idea that the community could itself bootstrap some of this more quickly just using Internet publication methods.

>> MATTHEW GAMETTE: Yes, I appreciate the question. I believe you're correct. There are a number of methodologies that could be used to accomplish this. Efforts have been made by different organizations to try to publish some of this data for whatever reason and there are a variety of reasons, laboratories are a little skittish about publishing their validation data out that hasn't been specifically reviewed by statisticians and others that they may not have resources to. And so I think some of those challenges need to be overcome before labs are willing to publish out that data.

>> CRAIG MUNDIE: What do you think their fear is?

>> MATTHEW GAMETTE: I think the fear is the unknown perhaps without having a statistician or other resources to review that data, they are not willing to publish out that data because then it could be challenged in court and other avenues and venues that are important. We don't want to be subject to legal challenges over things that we should have and could have reviewed before we published it.

>> JIM GATES: First of all, I want to thank the panel for these very lucid presentations, very deeply embedded in your mastery of the area. I also want to thank you for continuing this experience of having PCAST interact with the forensic science community. Something I've been enjoying for about two years myself. And the word enjoy is in quotes, I'll have you know.

>> JIM GATES: My question actually arises out of the recommendation that Alice made at the beginning, which was that we should think about having OSACs at least that's what I heard have the OSACs set a standards for testimony did I misunderstand you?

>> ALICE ISENBERG: No you didn't.

>> JIM GATES: Can you expand on that please?

>> ALICE ISENBERG: Certainly we have discovered underlying science supporting science disciplines is very valid. The problem arises when we are trying to communicate science to the layperson in an adversarial system or in a legal environment, and even in my own agency, lawyers talking to scientists is often difficult and until we really talk things through, words have meetings for both of those different groups of people and it helps if the testimony, the language that is used to describe a forensic science result in a courtroom, words like rare or unusual or unique, those sorts of words mean different things to different people. So there has to be a great deal of care in how someone describes their results, especially a class based evidence or other types of evidence where there is no probabilistic information that's conveyed in the results.

>> JIM GATES: If I may have a follow-up, but what intrigued me is you suggested that the OSACs but basically operate under NIST should undertake this, this is what I was puzzled about. One could imagine there are other organizations that might be better situated. So my question really is, did you, I agree with you on the interpretation of the problem. I've seen it as Jeff knows, I sit next to him often at the Forensics Commission and we hear these things, but my question was have you gone through a range of possibilities of organizations that might bring this expertise to the solution of the problem?

>> ALICE ISENBERG: I recommended the OSAC as a starting point because their goal is to attain public consensus through the creation of standards. So standards that will be created there will be vetted by anyone. They have, they will target interest groups in the law community, legal community, in the scientific community, commercial community, potentially, and then even the public. And all of the comments are very carefully read, reviewed, documented, and dealt with. So there's, it's a very transparent process and takes into account the opinions of everyone.

>> ERIC LANDER: Thank you, Michael McQuade is next up.

>> MICHAEL McQUADE: Thank you very much. It's a really terrific panel because there's, I wouldn't say this is sort of a wild diversity of detail. But a very big diversity of where you all come from in what is and I think Alice you said it in the beginning, sort of right at the crux of law and science. So Alice I want to ask you a question, first I want to make sure I got right what I think I heard in the very beginning. What I think I heard you say was there's no scientific studies that call into question the validity of these techniques as long as the applicability is properly communicated. Is that an accurate thing?

>> ALICE ISENBERG: As long as the limitations of the technique or the results are conveyed properly

>> MICHAEL McQUADE: Good. So let me ask you to give maybe an opinion on the opposite side of that question. So what scientific studies or other work would you think as a standard to actually assert the validity of the test? So it's one thing to say, I can't prove the tests are inaccurate. As a general theme, so not bite marks in particular or any other pattern matching or whatever, when you think about what would make you comfortable that these various techniques actually are proven to be valid within their limitations, what do you think about in those terms? What kinds of things would give you confidence that these are in fact valid techniques?

>> ALICE ISENBERG: I'll use the example of the firearms discipline. One type of research that is done to look at the validity of these, that discipline is to send out in a round robin fashion evidence or examples of evidence that people compare to various firearms to determine if a bullet was shot from a particular firearm. You look at the results of that round robin testing to see how often people get the result correct. Then you also add to that research where you, where would I expect to see the most similarity between two firearms? Well, that would be firearms that are manufactured subsequent to each other. And the way a firearm is manufactured is by taking a long piece of metal and cutting it into pieces and each of those goes into one firearm after the other. So if you can obtain firearms that are manufactured very close in time to each other, you would expect that they would be the most similar as compared to any random firearm from somewhere else. Studies have shown that you can differentiate a bullet shot from those different firearms that come from the closest period of time in manufacturing with each other. So studies like that where you do have also potentially ground truth information, latent prints or something like that where you know the source of those, those sorts of studies support the foundations of the various forensic disciplines.

>> MICHAEL McQUADE: Just to replay I heard sort of two different things. The second was there's some logical reason to believe there's a ground truth and there may be a way to get there and there may have to be a logical explanation. The first was essentially concurrence of a variety of experts, and presumably there are some limit in there where you say if I send this out

and 10% of the people all agree I have a problem and if 99%, maybe I have a different conclusion is that what I'm hearing.

>> ALICE ISENBERG: Correct and the more studies like that are done the more confidence one can have that the foundation of this discipline is appropriate. And the more you learn about the limitations of that discipline, though, as well. And as a discipline initially but when initially research is done, perhaps the results and interpretations need to be clarified and the limitations need to be very expressly given, but the more research that's done to show that you get the same results across various people performing the examination or various types of evidence where there can be slight differences in characteristics, the more confidence you can have the key is to put a number to that confidence as was suggested.

>> ERIC LANDER: Just very briefly on that point. So would you then say that's the guide to what it means to have reliable principles and methods, the principles and methods have been tested for reliability in one or more of the fashions you've said? And that we actually know the limitations on the error rates? This phrase reliable principles and methods isn't often defined. It gets used. But I hear you offering almost a definition of it.

>> ALICE ISENBERG: I would agree that's the way we gain more confidence that our results are correct. I don't agree that the limitations are associated with error rates. I think the limitations are in what, where we know we would see variation. And the extent, that's why we do validation studies is to determine the limits of what this test can, we're able to say about it. And the more different kinds of evidence or the different kinds of characteristics we see in evidence across huge sample sizes, the more confidence we can have in that. But if you don't have ground truth information, it's very difficult to calculate an error rate.

>> ERIC LANDER: So when you have ground truth information, though you can calculate it and then it's right to speak of it. When you don't know what the truth is, you can only talk about the correlation between examiners.

>> ALICE ISENBERG: Correct.

>> ERIC LANDER: But those are the kinds of things you would say constitute the threshold of reliable principles and methods basically.

>> ALICE ISENBERG: Yes.

>> ERIC LANDER: That's very helpful I'm going to ask does anybody in the panel have an alternative definition of what this is supposed to mean, because I just found that really insightful. Is there another way to think about what constitutes a reliable principle and method? Norah.

>> NORAH RUDIN: I like very much what Alice is saying about limitations. I tend to think of these validation studies in terms of capabilities in limitations, and what is very important is to

really stress the system so one can really reach the point where you can see what the limitations are, define them, and see how they are really defined their limitations. And then I would suggest that ideally we would like to quantitatively characterize both the variation and the limitations so we can say something quantitative about it. The other point I would make is error rates can be a little bit difficult. A rate implies a constant. And another way to characterize that is the risk of error. Either a false positive or false negative, so that's just a different way to think about it.

>> ERIC LANDER: Sure. Very helpful. I jumped in and I shouldn't have done that but in any case I'm going to turn back to Daniel Schrag as the next, then I have Ed Penhoet is your flag back down, Ed's flag is back down ,and and Susan Graham. And that might bring us to the end of our allotted time.

>> DANIEL SCHRAG: Thank you I want to follow up on the same line of questioning I do appreciate everybody's comments, I'm learning a lot. I want to talk, ask a question of David Senn, Dr. Senn, I really appreciate your testimony. I really thought it was very helpful to see how you go through this. And I was particularly impressed with the way you evaluate the bite marks in a blind fashion as an investigator. I'm actually curious about what fraction of bite mark analyses around the country are done in that fashion. But that's a minor question. My main question really follows up the other one, which is how do you know your error rate? How do you know both in terms of exclusion and inclusion? Especially given that bite marks, there's a spectrum of probably easy ones and more difficult ones. Ones that are blurry, ones that are very, very clear. And therefore, in that, when there's a whole spectrum of quality of bite marks, et cetera, and you can do the same thing with partial fingerprints, but how do you know? And specific for you, is it that there's an artificial test? Or is it based on comparison of specific cases with other data like DNA, or how do you actually know your error rate?

>> DAVID SENN: Thank you, that's an excellent question. And as others have already said, error rates are a very difficult area for us because we don't know the ground truth in a bite mark case. We only have opinions and we can only look at the data that's available to us and do the tests and examinations that we do. And to formulate that opinion. And we try to state that opinion, in the past we had standards and guidelines that were developed by the American Board of Forensic Odontology, and by the way are currently being co-developed or co-amended by both the American Board of Forensic Odontology and the Odontology sub-committee of the OSAC NIST structure since we don't know the ground truth, it's very difficult to say that the error rate for a bite mark analogy is this. It's a difficult problem.

>> DANIEL SCHRAG: Have you looked at cases where you've done your analysis and then there's additional evidence like DNA, and do you have a sense of what the error rate might be?

>> DAVID SENN: Yeah, I guess there's sort of an error rate, and I'm sure when the innocence project was here yesterday talking about cases in which bite mark testimony was later overturned by DNA testing, and so we can say if we take that number of cases, and there have been about 20 cases that have been of the exoneration cases that they list on their website,

about 20 cases that were bite mark testimony was given and DNA testing of some type later proved some other truth, and they attribute that to faulty bite mark testimony. But none of those cases that I've looked at was the bite mark testimony. The only physical evidence, there was much other evidence so there were multiple factors So if you take that as an error, you know, then 20 cases out of I don't know how many there are, hundreds or thousands, is not a real way to get the error rate.

>> ERIC LANDER: We're going to move on. I think the point Dan would make is of course there's no denominator to that calculation and so we would agree that's a meaningfulness.

>> DAVID SENN: Yes.

>> ERIC LANDER: It's not a helpful number.

>> DAVID SENN: The man has to know his limitations.

>> ERIC LANDER: Exactly, your first statement about we just can't know is a good one. Susan.

>> SUSAN GRAHAM: My question is for David, as well. And I, too, found it very helpful to your tutorial in a sense of how you do what you do. And the thing that surprises me is that you all still do this by hand. If I think about or hands, if I think about other areas of pattern recognition, we have developed computer based techniques to implement the strategies that human people use. But then to automate that. And in part that tends to mitigate the fact that some people are much better than others at doing human pattern recognition. Is that happening in your field? And how feasible do you think it is?

>> DAVID SENN: Thank you. I like the idea. You know, I would love to have a computer program where I could take the bite mark image and the image of the patterns of the teeth of the suspects and have it like on CSI they overlay and say match, match, match, match. That software does not exist. And for us. It may exist I think it exists in manufacturing where they make sure a bolt fits into a certain place or something, but we just don't have that available to us

>> ERIC LANDER: Would you recommend it? Many of us are sitting around the table thinking about software and pattern comparison saying, boy that's an easy piece of code to write if face recognition softwares that many of the companies that store your photos have can spot whether it's the same person in diverse photos, it doesn't sound, so hard would you recommend that be developed? Would that be helpful in increasing the standards in the field?

>> DAVID SENN: Any software program that would automate or help someone to make a decision about two things I think would be very helpful.

>> ERIC LANDER: Awesome. We have come to the end of our time and I really apologize because I think there are probably a lot more questions people would like to ask, but you have

stimulated us tremendously I think we've heard very interesting specific details I think we've heard some very general calls for clinical trials. We've heard, I think maybe the first person to give us a concrete suggestion as to what this reliable principles and methods might mean, which I think is probably a really important thing to nail down. I just can't thank you enough. I know you've come from quite considerable distances in many of these cases for this meeting about an hour 15 minutes so I know it's a lot of trouble, but it's really very much appreciated so thank you to the entire panel and we'll take a ten minute break

>> JOHN HOLDREN: Let me add my thanks I think this was terrific.

>> ERIC LANDER: Just great. (Applause).

World Radiocommunication Conference

>> JOHN HOLDREN: So we are going to come to order and moderating this session will be one of our two PCAST vice chairs, Dr. Bill Press.

>> WILLIAM PRESS: Thanks, John. This is a session on the World Radiocommunication Conference, but more generally on a subject that PCAST has been interested in for a long time, namely spectrum management, RF spectrum management. And we're very pleased to welcome Julie Zoller. PCAST members have her bio. And I think she must be used to this. It's the last one in your packet. So it's easy to find on the back page, alphabetically. Julie is with the Department of State's Bureau of Economic and Business Affairs and in particular, she's the Senior Deputy Coordinator and Director of Multi-lateral Affairs, International Communication and Information Policy. She has a long and distinguished history in spectrum management and related things. In particular she was with NTIA at the time that the PCAST report was, we like to think was so influential. But certainly well received by NTIA as well as FCC and other Federal agencies. So she has a lot of perspective on this field going all the way back to work early in her career at Lawrence Livermore Laboratory and with ITU, so let me just give you Julie Zoller.

>> JULIE ZOLLER: Thank you very much, Mr. Chairman. It's an honor to be here and to speak to your committee about the 2015 World Radiocommunication Conference. Or WRC-15 as it's commonly called. World Radiocommunication Conferences are convened by the International Telecommunication Union, the United Nations agency for Information and Communication Technology. To review and revise the radio regulations, the international treaty governing the use of the radio frequency spectrum. The regular three to four-year cycles of works allow the regulatory framework to keep pace with technology. Works provide international harmonization of spectrum policies which is essential for economies of scale, as well as efficiency and interoperability. More than 330 delegates from 162 countries in WRC-15 which took place in Geneva, Switzerland from the 2nd to the 27th of November. The nearly 170 member U.S. delegation included world class experts on every subject on the agenda and demonstrated how a delegation of public and private sector professionals can effectively work in partnership. Ambassador Decker Anstrom headed the U.S. delegation and I served as Deputy

Head of Delegation. The United States achieved all of its high-priority goals at WRC-15, advancing U.S. innovation and economic growth, preserving national security, and continuing U.S. leadership in spectrum policy. WRC-15's global decisions complimented domestic efforts under the President's wireless innovation and broadband policies to promote new technologies, spectrum allocations, and sharing techniques. Additionally half of the WRC-19 agenda is based on U.S. proposals, clearly reflecting continued U.S. leadership in mobile broadband, aviation and space applications. I will highlight several decisions WRC took concerning our key priorities for the conference. First spectrum for mobile broadband. Everything is mobile. The agenda, excuse me. The agenda to allocate spectrum to the mobile service and identify it for international mobile telecommunications or IMT, was our highest priority. As you recommend in your report on realizing the full potential of government-held spectrum to spur economic growth, we made international harmonization of spectrum allocations to wireless broadband, particularly in bands used or planned to be used in the United States. A key element of the U.S. position at WRC-15. Working closely with colleagues in the Americas, especially our neighbors Mexico and Canada, the United States was a leader in identifying new spectrum bands for the mobile industry. As a result of WRC-15 many countries around the world now have available up to 250 megahertz of additional spectrum from mobile wireless services. For the United States and North America, there's more than 500 megahertz of spectrum available as a result of this conference. The 470 to 698 megahertz band or UHF band is harmonized across North America and it's also allocated in select countries in South America, the Caribbean, and the Asia Pacific region. WRC-15 in the UHF band compliments the FCC's domestic incentive process to free up broadcast spectrum for wireless broadband. Countries in Europe, Africa, and the Middle East will consider introduction of mobile broadband in 2023. In the 1427 to 1518 megahertz band or L band, the United States supported the introduction of mobile broadband while safeguarding existing U.S flight testing systems. WRC-15 made 91 megahertz of spectrum available in the Americas, while 51 megahertz was identified in other regions. The 3400 to 3600 megahertz band or lower C band, is identified for mobile broadband in most countries and throughout the Americas, with the United States, Canada, Columbia, and Costa Rica extending this allocation up to 3700 megahertz, providing a total of 300 megahertz of spectrum in these countries. As was the case in the UHF band, WRC-15 action in the C band complements our domestic action, the new citizens band radio service in the 3550 to 3700 megahertz band. Meanwhile the conference acted decisively to continue protecting the upper C band above 3700 megahertz, recognizing the ongoing extensive use of this band by the fixed satellite service. In summary, the work to identify the lower C band, 3400 to 3600 megahertz for mobile broadband, begun at WRC-07 is nearly complete. Most significantly WRC-15 started what will be a decade long process to enable the use of the lower part of the UHF band for mobile broadband. As a sign of things to come, other countries such as India would have been included in the UHF allocation at WRC-15, were it not for the objections of some of their neighboring countries. The digital dividend reached in the upper in the UHF band 698 to 798 megahertz, will be extended to the lower part of the UHF band over time. Second, aviation. The issue of global flight tracking was added to the WRC-15 agenda following the tragic loss of the Malaysian aircraft in 2014. The conference acted swiftly and decisively to approve an allocation to the aeronautical satellite mobile route service in the L band to facilitate satellite reception of existing automatic dependent surveillance broadcasting transmissions. While there was

widespread consensus on global flight tracking, identifying bands for control and non-payload communications of unmanned aircraft was aircraft was one of the most challenging issues of the conference. Concerns over flight safety and the different applications for which UAS can be used affected the negotiations and ultimate outcome. Unmanned aircraft for civil and commercial uses is the next wave in aviation. These systems span to revolutionize the industry supporting functions ranging to disaster relief to meteorologic to agriculture. WRC-15 action on UAS will potentially pave the way for new applications that will add billions of dollars to the economies of the United States and other countries. The 2012 World Radio Conference allocated spectrum for the line of sight command and control of unmanned aircraft. WRC-15 continued this work by identifying existing fixed satellite service spectrums in the Ku and Ka-bands to enable control during long distance flight when the aircraft is beyond the horizon. The regulatory framework adopted at WRC-15 will now enable the International Civil Aviation Organization, ICAO, to proceed with the development of standards and recommended practices to provide a safe global communications infrastructure for UAS operations. Third, the future, the agenda of WRC-19. Each conference adopts a draft agenda for the subsequent conference. Half of the 16 items on the WRC-19 agenda were based on common proposals from the Americas, having their origins in U.S. proposals The WRC-19 agenda is rich with opportunity, and Member States at the conference preparatory meeting have already assigned the technical work to ITU study groups. All four U.S priorities are on the agenda for the next conference. While WRC-15 looked at spectrum below 6 gigahertz for mobile broadband, the agenda item for mobile broadband at WRC-19 identified more than 30 gigahertz of spectrum in the range from 24 to 86 gigahertz to enable applications such as 5G mobile service. This agenda item complements the FCC's spectrum frontiers proceeding to enable flexible use service rules in the 28, 37, 39 and 64 to 71 gigahertz bands. Other than the 28 gigahertz band, most of the spectrum the United States is exploring domestically is included in this WRC-19 agenda item. However, countries can't move forward in the 28 gigahertz band because this band is already allocated to the mobile service on a global basis. The agenda item for high altitude platform stations will consider spectrum that will enable lightweight solar powered aircraft operating in the stratosphere to provide broadband to developing nations and underserved areas. The agenda item for global aeronautical distress and safety systems will address aviation safety issues such as aircraft tracking under normal and abnormal conditions, autonomous distress tracking and automatic deployable flight recorders. And the agenda item for radio local area networks in the 5 gigahertz band will enable evaluation of the 5350 to 5470 megahertz band for our lands, complementing domestic studies already underway. There are also agenda items for advancing non-geostationary satellites in the V band, global maritime distress and safety modernization, meteorological satellites and for reviewing the orbital position limitations in the broadcasting satellite service plans. All of these were based on U.S. proposals. Looking beyond our own initiatives, many in the United States are pleased with the outcome on other agenda items. Earth stations on mobile platforms, communicating with geostationary satellites in the KA band, and intelligent transport systems applications to name two. There are other less prominent but important actions taken by WRC-15. While debate over mobile broadband, unmanned aircraft and global flight tracking captured most of the attention, the story of WRC-15 also included other actions that will make a difference in peoples' lives. The conference adopted a regulatory framework for public protection and disaster relief applications that will

pave the way for harmonized spectrums in the 7 to 800 megahertz range globally. WRC-15 approved an allocation for short-range radars in the 78 gigahertz band, enabling automotive and on-the-ground aviation uses that will protect people from injury and save untold millions of dollars by avoiding equipment damage. NASA and the world's other space agencies will benefit from new allocations for the earth exploration satellite service in the 7 and 9 gigahertz band and use to 410 to 420 megahertz band for operations near orbiting vehicles such as the International Space Station. In conclusion, WRC continues to play the key role in setting international spectrum policy and the Americas are leading the way. We achieved all of our objectives, expanding the spectrum available for mobile broadband, providing for global flight tracking and the control of unmanned aircraft and setting an agenda for the next conference that is ripe with opportunity for the United States and for all countries. A few trends are worth highlighting for the future: Incumbent services were well organized to protect the status quo at WRC-15, making the case against allowing new services into their bands. Nowhere was this more apparent than in the discussions on mobile broadband. This will continue to be a challenge. As we try and share more deeply the spectrum. Mobility is the future. Although not at the same pace as terrestrial services, satellite services are also going mobile. There's far less spectrum allocated to the mobile satellite service than can meet the demand. And recent attempts to identify more at WRC have not been successful. We have found ways to use the stationary fixed satellite service for earth stations in motion on ships, planes, and vehicles. But those successes often come with some penalties in terms of stringent sharing criteria. I believe we will need to rethink how we define radio services to enable such things as use of satellite links for communication and entertainment on the move as well as operations like controlling unmanned aircraft systems, which adds a safety dimension to the discussion We are approaching an upsurge in the deployment of non-geostationary satellites. Technology has involved and there's a real business case. Commercial constellations ranging in size from 400 to 700 satellites are being planned. The number of nano and pico satellites with price points so low that universities are now in space is also growing. This will present new challenges in terms of sharing spectrum, not to mention collision avoidance in space. The regular cycle of WRCs provides the only means to secure global frequency allocations and achieve international harmonization of the spectrum. WRCs enable the International Regulatory Framework to keep pace with technology development. And is essential for global business and global government applications, a high value proposition for the United States. Thank you, Mr. Chairman.

>> WILLIAM PRESS: Thank you very much. Let's see. As is our custom, PCAST members who wish to ask questions raise your flags and I already record two. Wanda, you were first.

>> WANDA AUSTIN: Thank you for your comments and for what you're doing with the work. That's terrific. My question is one of process. And I just want to make sure I understand how this works. So as you meet in the conference which meets -- doesn't meet all that often, it meets every four or five years, as you're making decisions about making more spectrum available, do we have a process for testing or really knowing who is using the spectrum today and being able to validate what the impact of releasing that spectrum will be?

>> JULIE ZOLLER: Thank you for your question. WRCs are occurring approximately every four years. As I mentioned the agenda for the 2019 conference was drafted by WRC-15. And it will be approved by the ITU Council this year. Already the agenda items have been assigned to technical study groups in the ITU, which will meet at least most of them twice a year and progress the technical studies to the extent that countries feel that those paper studies need to be backed up with actual testing back home, they will do that and bring those results into the ITU study process. Towards the end of the study period, the conclusions that are reached will be folded into something called a conference preparatory meeting report. And that will describe the studies conducted, the conclusions, and the options and advantages and disadvantages for satisfying that particular agenda item, and countries will meet at a conference preparatory meeting to discuss that and begin to exchange views on what their positions will be at the World Radio Conference. In parallel with that, each region has its own regional group that meets and develops preliminary views on the agenda items and over time preliminary and then final common proposals on issues about which they can agree. In the Americas that group is called the international telecommunications -- I've got to think of it in Spanish and go backwards: International Commission on Telecommunications. So we will start that process in the Americas in CTEL again this spring of looking at the agenda and deciding how as a regional group we're going to approach these issues. But testing comes into the process not in terms of the ITU itself conducting testing but the administrations which provide input to the process conducting their own domestic testing and then bringing those results into the conference.

>> WILLIAM PRESS: Mark Gorenberg

>> MARK GORENBERG: Bill, thank you, Julie, first of all thank you for being such an effective diplomat for the United States in these proceedings it's been extremely helpful for us. And particularly your work on sharing -- your work on getting international harmonization for the 3.4 to 3.7 band has been prolific for us because it's creating more chips basically by vendors in this band. And the band that came out of the PCAST study was the 3.5 to 3.7, which they now call officially the citizens broadband radio service. So as part of the PCAST report and what's gone forward through the FCC in sharing is the creation of the Spectrum Access System and the Spectrum Access System was approved by the FCC and now vendors are actually getting certified in the United States to do that. So what I'm wondering is how is sharing perceived by the rest of the world? Particularly sharing of this Administration, policy of broad spectrum sharing for this Administration, but also in terms of the Spectrum Access System, Canada is going to go through a similar set of proceedings now in sharing in this band. Is there any way to evangelize this technology to them and potentially get it adopted in Canada, as well?

>> JULIE ZOLLER: Thank you for your question. Sharing is the name of the game at World Radio Conferences. We do not clear spectrum bands or we haven't been clearing spectrum bands at WRCs. We've been adding new services to existing bands that are already occupied by other users. So sharing is how we get that done. And coming up with mitigation techniques, whether they be power flux density limits or separation in distance, we work out sharing techniques that are viable within the context of an international treaty. In satellite bands, particularly those use

by geostationary satellites, sharing is largely done through bilateral coordination between countries so that's an intensive process of negotiation which can take years to complete and is based on the registration of uses of spectrum with the International Telecommunication Union which keeps the Master International Frequency Register. In terms of actual operations, the ITU doesn't get involved in the details that would be required to do something like what we're doing domestically. So that would be strictly a domestic decision in terms of using those kinds of techniques. And certainly we have a regular dialogue with Canada. In fact, they are really one of our closest partners, Canada and Mexico, in the international scene, and then of course we have our cross border coordination, which is occurring on a near constant basis. So yes, I think there are opportunities to do this.

>> BILL PRESS: Thanks, Craig?

>> CRAIG MUNDIE: I want to pick up a little on Mark's question but also your answer, which in the PCAST report, we say look not just sharing is the name of the game. What you've had to do by I'll say classical means in the work up to this point. But we're saying with the advances in digital radio architectures and software, you don't have to share by just the classical means of separation by RF physics. And -- but the introduction of that, as a legitimate model, the Spectrum Access System, is a codification of that. But I guess the real question is: in the WRC-15 or in WRC-19 has the agenda moved to the question of saying that dynamic software mediated sharing is an equally legitimate model of sharing as opposed to that which the WRC has been confined to in the past where you had to find a physics based model of separation? And it wasn't clear to me whether or not - not just that sharing is the way forward. But our report was actually, went beyond that and what we're implementing both at the FCC and by the President's action across all the agencies is not just to say sharing is good. It's specifically to say dynamic sharing is good. So I'm curious, did that actually get projected into the WRC discussion? And if not, is it going to be in the '19 agenda?

>> JULIE ZOLLER: Thank you. Dynamic spectrum access and cognitive radio systems have been discussed in the ITU for I would venture probably five to seven years now. But in terms of predicting the type of sharing that will be needed under any item on the agenda, the agenda does not point towards that as a particular solution to prioritize. It leaves open what the technical studies might yield in terms of solutions at the end of day. But certainly that could be one mechanism evaluated in terms of options for satisfying the agenda.

>> CRAIG MUNDIE: To press a little harder to me the issue here is a policy question. Which you won't get out of the technical Working Group So how does the WRC address policy as opposed to just looking at the various recommended tradeoffs within any particular band?

>> JULIE ZOLLER: The WRC addresses policies based on the inputs of Member States. So if Member States are promoting a particular mechanism for sharing, that will be addressed at the WRC. And if we can form a consensus around a particular approach, which is what we do on all of the agenda items, and it's so important that we do that because the ITU has no authority in terms of enforcement like the FCC does. So it's important that we all agree that this is the way

to move forward. But if a Member State brings in a particular proposal on a policy basis, that will be considered and debated at the conference.

>> CRAIG MUNDIE: But given that the U.S. policy both at the FCC level and the White House level has said this is our top priority, as a Member State, have we actually brought it forward as such an issue?

>> JULIE ZOLLER: Not at the WRC level. I expect we have at the working level where the technical studies are undertaken.

>> CRAIG MUNDIE: But as you pointed out, the incumbent, you know, mobilize against this as a matter of policy. And so -- and since the incumbents pretty much dominate at the Working Group level, based on historical participation, that leaves us with a conundrum where we have made at the national leadership and independent agency of FCC a policy change that is pretty much guaranteed not to be implemented if left to that mechanism. In my opinion. So . . .

>> BILL PRESS: I guess I'll now declare that Craig is hectoring the witness. (Chuckles)

>> WILLIAM PRESS: But I'll call on myself now. I hope it's not quite more hectoring, but it's a related question. I think the whole question of the whole 24 to 86 gigahertz opening that up and in particular the low power applications on that, whether it's you know microcell, nano-cell, pico-cell, short range within buildings, because most of that doesn't go through walls and some of that doesn't go through the atmosphere, it seems to me there are enormous opportunities there for dynamic adaptive agile radios that are different -- different from fixed spectrum allocations in not quite the same way that Craig and Mark were discussing, but related ways. PCAST in our report, I think -- well, we're big fans of, you know, the original model is the WiFi model and I guess we think of that as unlicensed but it's called licensed by rule I guess is the technical term. In those bands that are very short range and very rarely would cross international borders, are the Member States free to do whatever they want? Could we declare rules for licensed by rule at low power across large swaths of the 24 to 86 gigahertz band? Or would we run afoul of the consensus of the ITU in doing something like that?

>> JULIE ZOLLER: We absolutely can do that, and all Member States have their sovereign right to decide what their national regulatory structure will be. The requirement is that in terms of transmitters, that you not cause harmful interference to a station operating in compliance with the radio regulations and authorized who have international recognition in order to be protected from harmful interference which means it's been registered with the ITU.

>> WILLIAM PRESS: I don't see any other flags from PCAST members. So with that, let's thank Julie Zoller for an interesting presentation. (Applause).

>> WILLIAM PRESS: Now John, back to you.

>> JOHN HOLDREN: Well, thank you very much it's my understanding that we do not have any public comments scheduled for today, is that correct? So I believe unless any other PCAST members have business arising, they would like to call our attention to? And seeing no flags to that effect, it is only left to us to again thank the PCAST members, the folks from the wider community in the audience and on the web, the staff, who have worked incredibly hard in support not just of these meetings but of the reports that we approve. We really appreciate everybody's engagement in this effort. And of course, we appreciate the engagement of the experts who agree to come and talk to us and be hectored by the --

>> ERIC LANDER: In a friendly way.

>> JOHN HOLDREN: In a friendly way by the PCAST members. Thank you to everybody. Eric any closing benediction?

>> ERIC LANDER: Just again thanks so much to everybody for all of their efforts. Still lots of work to go. We have a year's worth of work still to go. So looking forward to it. Thanks to everybody.

>> JOHN HOLDREN: We are adjourned.