

**President's Council of Advisors on Science and Technology (PCAST)
Public Meeting Transcript
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Welcome from PCAST Co-Chairs

>> JOHN HOLDREN: Good morning everybody. It is my pleasure to welcome you all to the bimonthly public meeting of President Obama's Council of Advisors on Science and Technology. We have as usual a full and very interesting agenda for this meeting. Before we launch into it, though, I have the particular pleasure of announcing, which has also been announced on a National Academy's Web site today, a wonderful award to one of our PCAST members, Dr. Chad Mirkin, who couldn't be at this meeting, will be receiving the Raymond and Beverly Sackler Prize in Convergence Research. This is the inaugural award of that prize, and he is receiving it in the amount of \$400,000 for pioneering work on spherical nucleic acids and their application in medicine. This is an amazing achievement for our friend and colleague Chad Mirkin. And so we congratulate Chad even though he's not here. [Applause]

>> JOHN HOLDREN: So let me now turn the microphone over to my co-chair of PCAST, Eric Lander, who will preside over the next couple of components of our agenda, Eric.

>> ERIC LANDER: I would like to extend my welcome to all of the members of PCAST who are here, and members of the public who have joined us here at the National Academy and those who are or will be watching on the web either live or sometime in the future because these are all archived and available. It has remained a very active time for PCAST. There are many studies still ongoing. I think we are expecting to work diligently for the next 16 months of this administration. Lots to do in terms of these new studies. Lots to do in terms of follow-up on previous reports of this PCAST. And so, it's an exciting time. And I'm just grateful to the whole Council for everyone's tremendous work and continued commitment.

PCAST Technology and the Future of Cities Study Update:

>> ERIC LANDER: We have two topics before we'll take a break this morning. And the first is a study we have been engaged in about cities. Asking the question about how cities can best take advantage of the opportunities offered by new technologies to improve life for all residents.

There are so many different opportunities for technologies in cities. But it's not easy for municipalities to figure out how to take advantage of them, how to ensure that the benefits are shared broadly across the city. How they can transform lives of the elderly, of young people, of people on fixed incomes, on limited incomes. And so PCAST has been engaged in this very wide ranging study of the potential impacts of technologies and what's needed to make that most accessible. What kind of demonstration projects might be needed. And of course because we're advisors to the President, what the Federal Government can do to assist in this case. So I'm going to turn first to PCAST member Mark Gorenberg who has been very active in this study. And Mark and Craig Mundie are going to give us an update on where this project on cities is going. Mark?

>> MARK GORENBERG: Eric, thank you. Ten years ago no one was talking about smart cities, but this week there was a city summit conference here in Washington D.C. and the White House announced -- oh, okay. Sure. This week there was a city summit conference in Washington D.C. and the White House announced it's Smart City Initiative, announced 160 million in funding, 25 collaborations, and perhaps most importantly brought together 20 city CIOs together with their sister research universities to look at how to create the Metro Labs Network and tackle some key local challenges. In February this year in parallel with these efforts, PCAST also began a study as Eric said to look at how combining policy and science and technology together can improve the future of U.S. cities. Specifically we're looking beyond the smart cities initiatives to integrate together all of these various technologies, and help cities become more green, low carbon, energy efficient, sustainable use of resources going beyond buildings to districts, more fluid, improving the mobility of people, resources and goods, and that -- and make them much more walkable, and enabling cities making them fairer, more inclusive, just environments, more creative, and enabling individuals and organizations and businesses to focus and invest in innovation. And also, of course, to make these cities more resilient. This morning we're here to give you a preview of our direction and solicit new ideas from our colleagues and also from the public that may be listening in, before completing our work and making a set of policy recommendations. Sorry. A number of members from PCAST has been have been involved because there's so many different disciplines that this study touches on. And as Eric said, Craig Mundie, who actually first pioneered the idea that we should be studying this in PCAST will make some comments after these slides. There's been tireless work from the PCAST staff starting with our Director Marjory Blumenthal. And also in February we invited a dozen urban and urban science experts to join us with some tremendous backgrounds and practitioners in industry, academia, Think Tanks, and even city Government and they are listed here and they have been invaluable in putting together and guiding this report. Our Mission Statement, as Eric said, is how the Federal Government can support science and technology opportunities to

improve America's cities, particularly for all of its residents, especially for those less fortunate who will otherwise be left behind in this technology wave. We focused at looking at the Federal Government role, knowing that the key players are actually in the private sector, academia, civic groups, individuals and local Government leaders. But what can the Federal Government do to help make these cities more nimble? To motivate them to take on these technology changes for good? Over the past nine months, we've spoken to a number of technology innovators, technology integrators, and policymakers in both the local and in the Federal Government to bounce some of these ideas off. Our observations are, first of all, that we're at the dawn of a historic era for cities. Cities are adding 65 million people a year, an unprecedented rate of growing concentration, where interconnection and interdependence is going to become the norm. There are many new infrastructure technologies relevant for cities. And you see some listed here, beyond the Information and Communication Technologies that are aided by fast and inexpensive distributed computing and new and expensive flexible sensors, they are revolutionizing what can be measured about cities in urban life, but there's also disruptive changes happening in transportation including electric and autonomous vehicles, energy including distributed renewable sources and energy storage, new localized water and recycling strategies are also coming into the mainstream and in parallel with these technology changes or perhaps as a consequence of them, we are also witnessing a significant change in norms of behavior. People in organizations are increasingly exploring new modes of interaction. Exchanging change facilitated by this information, and there's an emphasis on the sharing economy models that we hear of every day. More mixed land uses. Activities in urban spaces, like manufacturing and farming that are coming back to the city. And this while there's a growing sense that for a variety of structural and resource related issues, we still have a number of challenges. And challenges that will come because of this. Environmental challenges, health challenges, equity challenges, and frankly, cost challenges of people living in cities. But the potential benefits of urban living have never been more apparent or hopeful than they are today. There are many stakeholders, as we talked about listed here, the private sector, local and Federal Government, city residents. But a key opportunity is getting these stakeholders to work together to form a single version of the truth. The critical element will be their successful integration into using larger, more finely controlled systems. This integration which we will call in our report the integrated cities platform does not currently exist, but components are starting to emerge as a result of the convergence of many efforts from the Federal Government, cities and many other private organizations. A lot of it is Open Source collaborations. It is the key mechanism to interface traditionally slow changes in urban services and local governments with faster models of innovation and technology. So we're recommending the development of a system of technologies that feels more like open and distributed Internet operating system. Just as the Internet transformed computing, the Internet of Things is transforming our industrial sector. We believe the Internet of Cities that integrates

all of these data and technologies and norms of behavior together can create an open - a rapid experimentation vehicle for new applications for cities. You see some of the components that we'll be talking about in our report listed here. The notion of open data and making data more open. The idea of facilitating technology and data exchange with application program interfaces to more easily get at this. The data analytics we hear so much about in terms of both prediction and also optimization. And also a number of integrated models for decision support and scenario evaluation that can be shared between cities. And the sharing of both large and small cities together in this will help to elevate this forward. The success of the applications that are built on this platform is going to require a lot of experimentation. And it's very difficult to experiment across an entire metropolitan area. So the first wave that started to happen in districts was the idea of innovation districts. Really clusters for technology development. And they have already been starting to move into cities to create more entrepreneurial centers for new startups. And we believe this concept can be extended to other aspects of urban living, including living and playing to form sort of creative density that will require the urban development districts as we are going to coin them, as we said to be more fluid, more green, more enabling. These districts can be economically viable. But they will have higher initial costs. And they will have return on investments as their operating costs are recouped. So part of what we'll be doing is fostering experiments in these urban development districts to accelerate this maturity and make these break-even periods faster. And we think these shorter payback periods will also greatly increase the environmental and health benefits of cities. We think that best practices can be judged and learned by other districts of metropolitan areas, and this will certainly lead to metrics, fine grain analytics and a plethora of APIs and available data to review and anonymize across to be able to optimize in this Internet of Cities. Long term, these Internet of Cities can create vehicles maybe 50 to 100 years from now such as all electric cities, or perhaps carbon positive cities. Or cities that are certainly less gentrified, and certainly cities that have certainly a lot less urban sprawl. This is sort of a preview of some of the areas we'll be going down in terms of talking about how the Federal Government can be involved. Certainly one of them has been leveraging the place based programs. There are a dozen or so place based programs that have been very fundamental to this administration that can be extended with this technology as an underpinning. We also believe there's a need for the empowerment of HUD where HUD today is more about housing, but could be extended from much more housing to districts to be much more involved in urban development. And we look at the need for them to work with a number of other agencies which they do today, such as Department of Transportation, Department of Energy, EPA, Commerce and Agriculture on these concepts that are moving back to the city with new technologies. We believe this combined group can create incentives can create competitions that can recognize the game changers that are happening in districts in these cities, and also to help experimenting districts look at the work of each other. One important aspect of the Federal Government is it can help facilitate scientific research, so

many of the announcements this week were the Metro Labs about some urban science ideas that are being done in the agencies such as NSF. We believe that the time has come for a new urban science technology initiative that can help coordinate Federal research. That can take basic research, translational deployment, promotes urban science, and accelerates the components of this integrated cities platform. We think that this group should start with research inventory but over time can solicit new ideas and also propose grand challenges for urban science. So we also believe that there have been a number of great works done in the open Government data initiatives here. And they can be extended to cities for open data and data sharing and look at data sharing policy. So we're in the process of translating these broad ideas into Federal Government recommendations. And with that, I'm going to turn the microphone over to Craig.

>> CRAIG MUNDIE: Thank you Mark. Mark did a great job serving all of these things, and I want to reinforce a couple of points and maybe give a few examples of the things that are driving us to this somewhat different approach. We all live in an environment today where we see very rapid technological change. Especially in the Information Technology domain. But if you look carefully, there are also fundamental changes coming in other areas around energy and transportation. And when we look at cities, we realize there's really two challenges that we face, certainly if you look at it on a planetary scale as opposed to only a domestic scale. One is that a lot of people already live in cities. And that's especially true in developed countries. And you can say the preponderance of Americans already live in cities, and some of these cities are quite old. On the other hand, on a worldwide basis, the majority of people don't yet live in cities. But we can reliably predict that they ultimately will. So there's a huge business opportunity for the country in this globalizing environment. If in fact we could perfect what we thought these important changes were likely to be. In order to do that in the face of competition, we have to be able to look a little farther out. There's often a tendency to live with what we have. But if we look back over the longer arc of time with respect to cities, we find there were in fact in the day technological changes that radically transformed the city. Electrification was a fundamental one. The arrival of the automobile and the replacement of horse and buggy basically fundamentally altered the nature of cities. So today in a funny way we can look at each of these things that transformed cities before. Running water. The ability to distribute gas. Electrification. And say each of these infrastructures are fundamental to the society now. But each of them is essentially ready for another one of these big shifts. And so there's no reason to believe that it won't be quite natural to see that shift. But this time we have to do it recognizing the hysteresis we have in the very large infrastructures that we have investment in already. So we have looked at a number of these ideas. Today you can see people talking about, for example, autonomous cars. Most of the discussion is, well, will we get

the insurance right or the regulation right. But as scientists, we can look at the evidence and say, it seems inevitable now that eventually we'll have autonomous vehicles. And so then it requires that you look a little farther out and say, well, if that was going to happen, then how could we project that the city should change, what could we do to encourage that change? And these are the kind of activities that we're looking at in this report. The other big idea we've seen now, particularly in the Information Technology domain, is the importance of bringing things together. Integrating across different aspects of the problem. And so we also seek to bring some of this notion of integration to the different technological revolutions that are likely to come in these classily disjoint infrastructures and that is in part possible because we also recognize that Information Technology itself is diffusing itself into virtually every one of these things as a critical element of their design and operation. And we think there's substantial benefits that accrue from that kind of integration. So this idea of focusing on the evolution of a platform that would promote the same kind of radical development and accelerated development that we see happening around us every day in the Information Technology space. But applied to this broader array of technological shifts we think would be quite beneficial. So that's just a little color on top of the details that Mark provided. And I think both of us are happy to take your questions.

>> JOHN HOLDREN: Well, thank you both for the summary and for all of the work you've been leading on PCAST and the meetings you've been organizing. The floor is open to questions from the PCAST we'll follow our usual pattern of turning our flags up, and James Gates I recognize.

>> JAMES GATES: Thank you Eric and both Mark and Craig for that review. You have both talked about transformation and of course we all know the important element of the city is the people, so is there going to be some attention paid to some sociological factors about how people might be living differently, and what impact that has as we think about these new platforms.

>> MARK GORENBERG: Yes and there are different parts of society where they will be able to access this. And actually it will benefit them tremendously. If you look at for example the aging population. And I know Chris Cassel can speak much more eloquently about this than we. Cities have an increasing population over 65. Their mobility is limited by physical and medical conditions. And they can really use these shared economies transportation services for example, to go beyond the mass transit ideas that are there today. Autonomous vehicles can be a huge boom to that part of society. And frankly if you look at the elderly, the quality time they

can spend in fact with their grandchildren, in taking them to school is just one aspect of many things that could happen. And the other side of that coin is that there are a lot of new technologies in what we would call aging in place where they can be monitored, where they can live much more productive sort of independent lives. So with that access being sent back to family members, caregivers, et cetera, so that's just one example of things we'll be looking at. There's some areas I wanted to say there were some areas of the country that have extremely benefitted already that were sort of areas left behind by these new technologies. Solar farms have become really interesting in low income areas right now, particularly there are projects in both Chicago and Indianapolis that have been done in concert with the local housing authorities and the local utilities and the private sector that have re- made areas like Laurelwood in Indianapolis where they funded a pilot project and that is lowering the electricity bills of housing. And they are also selling back into the grid to get money for that housing. Or it's converted in Chicago, the Excellent Corporation converted abandoned industrial space into a solar farm large enough to power 1200 to 1500 homes. Energy storage can also be tremendously beneficial for resilient cities that are more vulnerable so those are just some examples.

>> ERIC LANDER: Great. Chris Cassel?

>> CHRIS CASSEL: Thank you, Eric and Mark, since you mentioned the issue of aging and cities, I just wanted to highlight and related to Jim's point, two additional things. One is we tend to think of the generations as benefiting separately from the kinds of advances that you're describing. But in fact, one of the big advantages of urban settings in places for people to grow old and aging in place is the density allows for the kinds of service availability so that you don't have to go to an old person's community. But there's a lot more opportunity for intergenerational interaction of all kinds, which can benefit both younger and older people. And there's a lot of good data on that. The second point I want to make is related to the density of cities has many advantages but also can be a real challenge in the event of natural and other kinds of disasters. We have seen that with Katrina and Superstorm Sandy as two big examples that we have examined and looked at in terms of preparedness and resilience. So that's another opportunity for technology to anticipate the more vulnerable of that population, many of whom are older people. So I just wanted to add that dimension, as well.

>> ERIC LANDER: That's great. Other questions? Well if there are no other questions now I want to thank Mark and Craig and their colleagues for all the work that's ongoing on cities. I know

we're a little bit over time but it was very good to hear the whole -- the breadth of what's getting discussed and it's really pretty exciting so thank you very much.

PCAST Technology to Help People as They Age: Hearing Technologies Discussion

>> ERIC LANDER: Another update is from Chris Cassel on work that PCAST has been doing asking about how technologies can help Americans age in place, age with independence, age with productivity, and that's a broad topic that Chris has been leading a study group through. And then within the course of that it's been identified a very specific topic where there seems to be tremendous opportunities for, I think short-term progress. And that has to do with the question of the normal mild to moderate hearing loss that's associated with aging. And the question of hearing aids to help with that. So Chris is going to give us a bit of an update on the broad work that she's been leading on aging. And then particularly on hearing technologies.

>> CHRIS CASSEL: Thank you, Eric. Well, first let me just say that in terms of the broader study, the group is focusing on ways that technology can help people as they age with issues of cognitive function and cognitive impairment. With issues of mobility enhancement. With issues of social connectedness and engagement as well as with this important area of hearing. So PCAST will hear more about the broader focus in subsequent meetings. So I'm not going to spend a lot of time since our time is limited today. I did want to update the group on our findings to date and the direction of our thinking with the hearing report. So let's see if we can. . . So as Mark did, I want to thank and be very grateful to, what you see here is a very hard-working list of Working Group members for the whole report, many of the PCAST members from many different disciplines and perspectives have joined this group, as well as experts in all of the other fields that I mentioned. You see their names up there. I particularly want to thank Ashley Predith and Diana Pankevich who really worked very hard to staff all of the subcommittees and various groups that are working in this area, and also our science writer, Robert Saunders. So let me just give a little background about why this has taken sort of the forefront of our work over the recent last couple of months. The first is that there's not only an urgent need to improve hearing, but a great opportunity right now. This is a major health and social problem, if you think about it, if you have trouble hearing, it leads to social isolation, it leads to an inability to keep working if that's what you want or need to do. It can lead to depression. There's some demonstrated association with higher risk of falls, falls with injury. And even dementia. And of course all of this is made more important by the good news that people are living longer in our country and that a vast majority of people with hearing

impairment have hearing impairment because of age related hearing loss or what's called presbycusis. So our focus is on that group. There's a lot of people in this country who have hearing loss from congenital problems, who have serious hearing impairment from injuries and other kinds of disorders that are much less common, so I do want to emphasize that our report is really only focusing on the presbycusis related hearing loss. But if you think about how many people actually use hearing aids. There is technology that can be extremely helpful for this problem, and yet of the people who suffer from these problems, so let me give you some numbers. 1 out of 4 people between the ages of 65 to 69, One-half, 50% of people between the ages of 70 and 79, and almost 80% of people over the age of 80 have some degree of hearing impairment. So that's huge. Roughly we think 30 million people now. And that number is likely to grow, and yet very few of them actually seek help and get hearing aids. It's hard to know because a lot of this is self reported. But somewhere between probably 15 to 30% of people actually use available technologies. This is a big problem, and as I'm going to say in a moment, the Institute of Medicine is just launched a big study in this area of the whole broad area of hearing loss, both age related and other kinds, but as we look at the data to what the barriers are on the adoption of available technology, the No. 1 issue that people report over and over again is the cost of technology. Averaging about \$2400 per hearing aid, and since with presbycusis it's mostly a bilateral condition, most people need two of these. And it's not uncommon to have them cost even more, \$4,000 to \$8,000 is not an uncommon cost. Added to that insurance, Medicare does not cover the cost of hearing aids. And most other insurance doesn't. It doesn't consider it a medical condition, interestingly enough. In addition to that, the access is very complex. Often you have to seek out an audiologist in a specific kind of arrangement with one or more hearing aid companies. The choices are somewhat limited. By and large these are not available online or in other kinds of consumer venues the way people are increasingly accessing many aspects of health care. There is a requirement that people see a physician to rule out other medical causes of hearing loss. And so while a large majority of people actually waive that requirement it's somehow also seen as a barrier because you also have to get a doctor's appointment with a doctor who knows something about this. There are some innovators in the market in terms of marketing organizations like Costco and others who have begun to find ways to make the cost a little bit lower and make access a little bit easier. There's also a market in devices that are not hearing aids, called personal sound amplification products, that can amplify sounds. But that aren't marketed to people who are hard of hearing. So they have not been widely used for that purpose. There's also kind of a social stigma. It's kind of interesting to me as a geriatrician that people are wearing eyeglasses for example, and we have age-related condition of people needing reading glasses it's called presbyopia, and you know people nowadays think that there are different fashionable glasses that they wear, and certainly don't hide the fact that you need eyeglasses. And yet, I think because it's so difficult and because the large number of people who need them don't actually use them that we just

haven't gotten to that tipping point in terms of social attitude. So there's still a reluctance to admit that people need help. And this is important. Because there are risks to waiting too long. And this is very well demonstrated that if you begin to notice you're having trouble hearing, and you say well I don't need this quite yet and you wait six or eight years until it gets worse, then when you do seek help it's harder to get back to baseline. Sometimes impossible. Because changes to how the brain processes auditory signals decline, and so here is another situation as in many places in health care where it's better to seek help early rather than wait. And then another factor that I mentioned earlier is that by and large, most primary care physicians don't consider this part of their business. They rarely include it in a review of systems with a patient. And if a patient is hard of hearing, it may be tough to communicate with them. But they don't consider that they should try to get you help for that as part of your medical workup. So all of this creates a kind of a situation that we think is actually ripe for a technology solution that could be helped along by Federal action. Now, there is this big study that the National Academies of Medicine has just launched and we have talked to many of the same people. We have attended their public meetings. They are not likely to issue a report before probably a year from now. So we are thinking, and what they are looking at is a much broader scope of this whole problem. Our focus is people who have age mild to moderate hearing loss associated with age and what technology could do. And what Federal actions might make that technology both more available and more widely used. So the goals of our report are the following. To reduce the costs number one. And we think that the market forces are quite ripe for doing that. And also if the cost went down significantly, the likelihood of insurance coverage would be increased so we could have a salutary effect in both of those ways and would increase the number of people who use this technology I mentioned the 30 million figure. There will be more people, as more of us are living longer and as the baby boomers are now beginning to enter in greater numbers, that cohort. So this benefits people in terms of their own lives. But it also benefits families. So if you think about it, it's a lot more than 30 million people who would benefit from a spouse or a parent or a grandparent being able to hear better. And then finally, there is enormous productivity and innovation in acoustic technology and signal processing. People are wearing noise canceling headphones on the airplanes, and there's all kinds of interesting things that people in the music industry and in the sports arena use. And we live in a new world where there's much more rapid advances in that kind of technology. Also aging baby boomers are much more comfortable with things like trying things out at home, ordering things on the Internet, programming devices on their cell phone, things need to be interoperable with other devices, all of your tablets and music devices with loop technologies in theaters and other public places. So the technology is out there. And innovation I think is happening. But it hasn't really been made available to this important market I think. So if you look at a couple of observations, one is that in every other aspect of electronics, technical advances in general reduce costs. Not increase costs. And actually reduce costs quite dramatically. And that in the

traditional hearing aid market, it's actually the opposite. If you add features like programmable to your cell phone and other kinds of things, it costs more, not less. So we think there needs to be a way to open the market up to more competition in that area. Secondly, the technologies itself is not that costly. And several groups are actually selling the very same hearing aids at lower costs. I mentioned the Costco example, but the Veterans Administration covers first dollar coverage for hearing aids for Veterans who need it and have told us that it costs them about \$500 per patient, or that's what they spend on that condition. Lots of European countries cover hearing aids as part of their health insurance programs. And buy them from the same companies and spend much, much less. So we think that there is a disconnect between the cost of these things and what's available in the market. And these electronic solutions consumer products, these electronic sound amplification products. are available at a much, much lower cost and some of those companies actually make traditional hearing aids as well as the PSAPs. They have many of the same features. And could in fact be very helpful in people who don't need a lot of fancy features, who have a simple need for amplification and perhaps some personalization that could be accomplished in a much easier way. So what we really need is consumer shopping. That's the challenge here. We need to allow consumers to shop for the best value to maybe take a test online that evaluates their hearing. and have a much more wide availability of trying things out and finding what works for them at a price point that works for them. So that includes Internet shopping. and would allow more new entrants into the field. So let me then turn to this one concern that keeps coming up over and over again about well, what if you had some other medical condition that was causing your hearing loss that went without treatment. And we have examined this in some detail and find that there's the actual risk of this is actually quite small. Especially if you focus on this issue of age related mild to moderate hearing loss. The main concern in most of the literature is acoustic neuroma, which is a quite rare condition, .001% according to NIH data. It's a benign tumor, it's not a malignant tumor. Very slow growing. Most common in people between the ages of 30 to 60. So not really in the demographic that we're talking about here. And you know, there can be very unusual conditions that would lead to a sudden hearing loss or a hearing loss just on one ear. But think about the way that eyeglasses are treated. Glaucoma for example, is much, much more common than acoustic neuroma, 3.5% of the population. People have disorders of their retinal arteries or veins. And if you have a sudden problem with your eye or it's painful, you go to the doctor. And we trust consumers to make those decisions. So I think we need some comparison here about the risk of, the relative risk of millions of people going without treating their hearing loss with the relatively smaller risk of missing a serious treatable condition. So I think the, we have heard from many people about this comparison with the reading class situation. I think there are some lessons there. And I think we also have ways of alerting people to seek help if they have certain red flag conditions. And those lists are out there. They are available. So in conclusion, I think our path forward is that we think there are some technology-based changes

in Federal regulations that could make this technology more available and begin to promote more innovation in the market. And that as these consumer products became more acceptable, we think it could also lower the barriers and increase access and acceptance among a much broader number of people. So let me stop there and see if we have any questions.

>> ERIC LANDER: Wow, that's great overview of the entire situation. Let's me throw it open to PCAST for questions. Mario?

>>MARIO MOLINA: I think one of the common problems with this age related hearing loss is noisy environments. So my question is are there any technology advances there, or is it something that only the human brain can do, mainly, discriminate human voice from background noise.

>> CHRIS CASSEL: There are actually advances Mario in that area where there's selective amplification of certain kinds of sounds like human voices as well as dampening of ambient noise of various kinds. And some of the products in this PSAP market will do that, too, where you can put microphones, selective microphones on the restaurant table in a noisy restaurant for example and then wear a special kind of gadget in your ear that helps to get both of those things. One of the concerns we have is that in general the current regulatory framework doesn't allow those kinds of things to be easily available to people. You know if you have a mild hearing loss, you may not need to wear a hearing aid in normal places where it's reasonably quiet like this room for example, with good amplification. But I think probably everyone in this room has been to a noisy restaurant where it's hard to hear a conversation. And that kind of technology ought to be available and more widely.

>> ERIC LANDER: Great, Michael McQuade.

>> MICHAEL MCQUADE: This was a really fascinating overview and presentation. Really good work. You mentioned in passing a number of places outside the U.S. where these things are more uniformly covered under insurance. Do we know about where the model you're talking about is being implemented outside of the U.S., the more commercial driven easy access model? Do we have any evidence of success one way or the other?

>> CHRIS CASSEL: By and large, the answer is I don't know in great detail about whether this kind of open consumer market, if there's examples of that. I do know that the barriers are much lower in many of those countries. But also there's an issue of what -- in any insurance situation, what the insurance will cover versus what consumers might want to buy. They might want to buy up to a different model, or might want to try a different model. But it's a good question. We should probably look into that more.

>> WILLIAM PRESS: I was interested in your mentioning that Medicare in the original legislation today doesn't consider hearing loss a medical condition in the other things that it handles I wonder if you have any thoughts on how do we decide what kinds of things we consider medicalized. For example, I can't run as far as I could when I was ten years younger, but we don't have a Latin word for inability to run as far. We haven't medicalized that. So is that completely a question of social policy, or is there a medical basis for deciding when something is a condition.

>> CHRIS CASSEL: Well, Bill, that's a really big almost philosophical question. There was a time for example, when we used to think senility was a normal part of aging, then we began diagnosing Alzheimer's disease and other causes of dementing illness and we have created a National Institute on Aging that has led the study of that. It was interesting similarly there was a lot of stigma associated with that in previous decades. Similarly things like osteoarthritis which, is an age-related condition is treatable. It isn't reversible or curable in the same sense that a lot of other conditions are. So I think we are evolving in our understanding of the biology of aging and where things are treatable or not. Whether they are considered medical conditions to my mind as a physician is if something has a medical treatment, then that treatment ought to be available. And so I don't find that terminology, I think it's becoming less useful as we look at ways to enhance functions with aging. And so you know that Medicare legislation dates from 1966.

>> ERIC LANDER: Interesting.

>> CHRIS CASSEL: Yeah. That was a long time ago.

>> ERIC LANDER: So I was struck by your numbers. I'll just, I know we're a trifle over but we'll stop in second but if I've got your numbers right, buying hearing aids for both ears is like 10 times more than buying a sophisticated SmartPhone or iPad or something like that. And yet the technology is dramatically less sophisticated. So a factor of 10 more than consumer electronics. Then the other number I was struck by was 30 million people who have mild to moderate age related hearing loss, versus maybe the couple of cases we're worrying about rare conditions of acoustic neuroma and such that if I counted correctly might be out of those 30 million people 150 cases. And balancing the possibility that 150 cases might not be picked up for what you said was a benign tumor anyway, versus 30 million people either not having access at all or having vastly expensive devices available. So I think those two numbers were really striking to me. was the cost relative to any other consumer device. And the balancing of risks one way, that is under treating the age related hearing loss, versus the very handful of conditions that might be missed in a medical inspection, especially when people can waive and often do waive any medical examination when they buy a hearing device.

>> CHRIS CASSEL: I don't want to under appreciate that acoustic neuroma is a real condition and people who have it, if you require a surgery, sometimes it's so slow growing, particularly in older people, that the doctor advises usually just watching it and if it grows more quickly so that it can impair your hearing, then recommends either radiation or surgery. But the surgery often ends up damaging the hearing in that ear anyway. So it is an important condition to recognize. So two points about that. One is that if you have hearing loss in only one ear, then you should go to the doctor. I mean

>> ERIC LANDER: If it's not bilateral, so that's an easy rule.

>> CHRIS CASSEL: Right. And the second is that the numbers of people that are affected, well, let me put it this way, since so few people are seeking help for their hearing anyway, picking up people with acoustic neuroma isn't working anyway if only 1 out of 5 people are seven seeking help.

>> ERIC LANDER: I should be quiet, I don't mean in any way to understate the importance of those cases. I'm just balancing numbers here and thinking about leaving 30 million people undertreated in some way is also a very serious thing given the comments you've made.

>> CHRIS CASSEL: It's a major public health issue.

>> ERIC LANDER: It's a major public health issue. And all regulatory decisions are about balances. But it's great. I think you have assembled a great collection of facts, I think your pointing us toward, somehow a market that is out of whack and that could be in a situation that we can better serve Americans and we look forward very much to getting your report with recommendations. My understanding is you're hoping to be able to produce such a report relatively soon. And it may even be perhaps before the next PCAST meeting in which case we'll schedule a public phone call or whatever, but we're very eager to hear the recommendations.

>> CHRIS CASSEL: I wanted to signal to my colleagues that I hope you'll be hearing from us within the next few weeks to set up a phone call.

>> ERIC LANDER: That would be great. Excellent and I would also like to thank Ed Penhoet for his leadership on this general aging and specifically the hearing technology, as well. So we're now going to go to a break until 11:00 o'clock when we are going to hear from Willie May, the Director of the National Institute of Standards and Technology and the Under Secretary of Commerce for Standards and Technology. During the break, members of PCAST will be free to try to develop a Latin name for Bill's age-related inability to run as fast as he used to. We're on break.

News from NIST

>> JOHN HOLDREN: It is a real personal pleasure for me to welcome Dr. Willie May, the Under Secretary of Commerce for Standards and Technology, and the Director of the National Institute of Standards and Technology, NIST. Dr. May has a long and distinguished career with NIST. For many years he led their research and measurement programs in chemistry related

areas. Personal research has focused on trace organic analytical chemistry and physical chemical properties of organic compounds. A large pile of refereed peer reviewed publications, a variety of other leadership responsibilities, the folks on PCAST can see his bio in your packages so I won't read it all. But Willie has been a great collaborator for me in the many areas where NIST's interests and OSTP's overlap. And so again, Willie, thank you so much for being with us today. And we look forward to hearing your thoughts on what NIST is up to.

>> WILLIE MAY: Well, thank you, everyone. Good morning. And I really appreciate this opportunity to discuss what NIST is, what we do. And why you should care both the scientific community, as well as the general public. During the time that we have, I would like to talk about the NIST mission and give you an overview of NIST, who we are, how we are structured, talk about how, when I get to our mission, you can see you can drive a few Mack Trucks through that. So how our programs at NIST evolved over the years in support of that mission. And more importantly, share with you some current examples of our activities in basic science, if you will. And also some of the things that we are doing using that expertise to address contemporary societal problems and issues. The next slide we can go through. I've been around a long time. I think I've seen a lot of this evolution. I'll take credit for the good stuff. And won't take any of the blame. I won't volunteer for any of the blame anyway. Here is the NIST mission that I talked about. Promote U.S. innovation and industrial competitiveness by advancing measurement science standards and technology in ways that enhance economic security and quality of life. It's a very clear mission. It gives us the opportunity to work in lots and lots of areas. So again the challenge for us is determining what things we absolutely should do. Versus all of the things that we could do with that very, very broad mission. Certainly our main reason for existing was the development, maintenance, and dissemination of the National Standards for Measurement. Our Director back in the '50s said very clearly that the standards work must keep abreast with the expansions of the frontiers of science. So that's a license to have a world class research program and certainly this deep research expertise not only allows us to expand our standards program to address contemporary needs, it's sort of facilitates innovation in a number of areas like new materials, advanced local diagnostics, advanced communications, and the like. We're also a non-regulatory agency and sometimes I say that we are here to help and people actually believe us, but this actually gives us the ability to serve as a convener between the academic sector and Government because we often don't have a stake in the game. Our job is to provide the absolute measurement truth to the extent that we can. So how do we carry out that mission? We have four program areas. We have our laboratory program. I say world leading, but certainly world class program in measurement science and among national institutes I would say unconditionally, we are the world's leading institute, we plan to stay that way. We also have a manufacturing extension partnership that's a nationwide

network of manufacturing, at least extension centers, we have one in each state. There are 60 in total. And they are they essentially interact with small and mid size manufacturers in each state, providing them whatever they need to be competitive. They exist by grants from NIST to each of the states. And we complete those on a five year basis now. We have a program in performance excellence that sort of determines the metrics if you will for performance excellence in a number of areas, health care, the broadest program has been wildly accepted there. Education. Nonprofit. Manufacturing. And soon to come we are now working with Tony Scott, the CIO, to establish a Baldrige-like award in cyber security, if you will, to award those companies who are embracing cyber security in a very, very robust way to use them as an exemplar for others in their areas. And we also have stood up in advance the National Advanced Manufacturing Program Office. And this office is responsible for coordinating the activities among this network of manufacturing innovation institutes that the President envisions. Right now they are 9 of those spoken for. The vision was initially 45. I think by the end of this administration we're looking for 15. And this office sort of coordinates the reporting, communications among the network, and try to make the total greater than the sum of its parts in this area. Well, this is my vanity slide, sort of supports us being a world class scientific institute. Work on our campus has gone up 5 Nobel prizes or 4 plus 1 since 1997. 4 for NIST employees. One has retired. But for those who haven't retired, well even the one that has retired are still essentially NIST employees, and working with NIST. The fifth, Danny Schectman actually got his Nobel prize for work, he did doing two sabbaticals working with John Cahn who is adjacent to him who poetically received the Kyoto prize that same year in material science. So two MacArthur fellowship winners, a number of, two national medal of science. Well you can read the slide. This is sort of a vanity slide, if you will. NIST at a glance, we have two campuses, one in Gaithersburg, Maryland and one in Boulder, Colorado. We have an appropriated budget of around \$864 million. About 675 million of that is for our laboratory programs. Additionally each year we get about \$120 million for services that we provide for other Government agencies on a cost reimbursable basis, and roughly around \$50 million for the standards that we sell, the standard reference materials and calibration we perform and not as much now for the standard reference data because we are giving away more of our data these days. We have partnerships in every state. Primarily through the manufacturing extension partnership. In terms of employees, we have 3,000 employees. In 1971 when I came to NIST, we had 3300 employees so it looks like we are sort of shrinking but we are not. The big difference is we have a number of associates and guest workers. We have 300 to 500 now. We may have had 300 then. And those, I guess it's not there. Those associates come from, it's in the wrong place. Here we are. Of 3500, about two-thirds are domestic. Primarily from academia. But often the ones from industry it's interesting we have about three times those from small businesses as from larger businesses. Which means we're really tapping into the innovation. We're driving innovation through working with small businesses. We have a number of foreign

guest scientists that's increasingly become, actually at the academic institution we need this, but there are some other issues there that I won't discuss with you as much. Our laboratory program. Two metrology laboratories, this is so the old remnant of the old National Bureau of Standards if you will. We have two technology laboratories, an engineering laboratory, and an information technology laboratory, and we have two organizations that serve as national user of facilities to provide the best neutron, the best neutron source for materials characterization that we can. Among the top in the world. And in our nano center, I will say, it's probably the nano fab part of that maintains the best facilities that money can buy to make them available to the public on a competitive basis. We have a number of joint institutes and Centers of Excellence. Our joint institutes were established for opportunistic reasons. Over the years some of our people got to get with some of their people at several places. And University of Colorado to establish unquestionably the world's foremost, atomic, molecular and optical physics institution in the world. We have the Hollings Marine Laboratory in Charleston, South Carolina, the Joint Quantum institute. I guess you can read them there. And these are all established to assist us in our science mission. And putting these together, we didn't really consider their lifetime. So they are essentially -- they are ongoing relationships. For these new Centers of Excellence that we have, they are to help us to solve short-term problems and assist us with assignments that we have. They are grants, at least cooperative agreements, with clusters of universities for a five-year period of time. And they can be renewed for five years. And I'll give you some context for that. So I'll go forward. Here are the three that we have done. The first one was to assist us with our responsibilities on the materials genome. Again, this is a nationwide competition. The winners were the University of Chicago, Northwestern, Argonne National Laboratory. And it's to work with us to in our program in materials by design. We have one to assist us in our program in community resilience. You can see the partners. And the final one is to assist us in our program in forensic science. Now, when we were established, we were established for many of the problems that we have to date, manufacturing, commerce and trade, work with the private sector, work with the academic sector. Again, our primary mission was to provide custody and the dissemination of our national standards, compare those with other countries, if you will. We still are very active in this area. We have recently developed the world's most precise atomic clock. It's a tick rate accuracy of 1 second in the life of the universe. (Chuckles).

>> WILLIE MAY: For the time being. We are also leading an international effort to redetermine the kilogram. Why would you do that? That's so esoteric. One is, it's necessary because the kilogram, for better or worse, what's defined is the mass of a block of platinum meridium that's kept in the basement of the International Bureau of Weights and Measures in Paris. If that thing drops and chips, the kilogram - the unit of mass has been defined. Because it's defined as

the block of platinum meridium, so there's a worldwide effort to try to define the kilogram based on a physical constant, and that is Planck's constant. There are two ways to do it. One is the so-called watt balance where we null out mass and power and from that you can extract Planck's constant. The other way to do that is through redetermine Avogadro's number by counting the number of silicon atoms in the mole of silicon, and from that you can determine Avogadro's constant and when the results of those two experiments conducted by a number of laboratories around the world in 2018, we'll redefine the kilogram. So this is sort of the old mission that we're still involved in. But since our inception as the National Bureau of Standards in 1901, we have recognized in addition to maintaining the basic standards, as the initial mission was, we have to be involved and provide support to address contemporary societal problems. So in 1901 we were in the midst of the Industrial Revolution so we were looking at interoperability issues. That was the fire in Baltimore. Half of the city burned down because when the fire engines came from cities all around, they couldn't connect to the hose. So we did that. Light standards, standardizing irons and steels for buildings, we were building lots of buildings then and working with the Interstate Commerce Commission to reduce railway accidents. Fast forward to 2015, these are the things we're looking at, advanced communications, advanced manufacturing, advanced materials, biosciences, cyber physical systems, cyber security, disaster resilience, forensic science, and quantum science. And a lot of that is supported, thank you, John, by OSTP to help us get resources to work in these areas. So quickly, in advanced manufacturing I mentioned that the President's vision is this National Network for manufacturing innovation. It is taking form. Supported by the Department of Defense and the Department of Energy, and the reason we have the vision but not the money, so the Department of Defense and Energy have used essentially a playbook, we developed in NIST to identify areas that might be dual use, so I think nine of these have been stood up, and there are two in the works. The NIST is to host this advanced manufacturing program office that I talked about. To coordinate the collaborations among institutes. Provide annual reporting to Congress, to share best practices among the institutes. And for commerce to establish two institutes when we get the money to focus somewhat on the white space, we are not necessarily focused on defense or energy needs, but focused on private sector needs. We are providing resources to the existing institutes to conduct measurement, science research, so sort of conduct NIST mission in that space, if you will and we provide laboratory experts to support activities in those areas. And also we are on the advisory boards for all of the existing institutes. We also have a very active laboratory research program. You can see that on the areas listed to the right which just happened to match very well with the existing institutes that have been stood up. Forensic science. I think the Academy issued a report in 2009 that said in essence that we needed to improve the science that underpin the forensic evidence used in the courts on a regular basis to make guilty or innocence decisions. So we have worked in three areas. One, we have worked with the Department of Justice to stand up the National Commission on

Forensic Science, co-chaired by DOJ and NIST but actually this is a DOJ, this is the Commission is in the Department of Justice and we are assisting them in that regard. The Commission consists of forensic science practitioners, academic researchers like Professor James Gates. Thank you, Jim. He says I twisted his arm to do this. But he really enjoys it. He loves it. So the Commission is to sort of look at the issues surrounding forensic science and make recommendations to the Attorney General. NIST has taken the lead on setting up an Organization of Scientific Area Committees to basically identify the documentary standards needs, and put those standards in place, if you will. And then we've also, based on input we are getting from the Commission and from the OSACs have focused in on a very active scientific research program in the areas that you see on the slides. And you can see some of the recent accomplishments that we've had over the last couple of years in this area. We have also established one of these Centers of Excellence. And the idea is to improve the statistics so that you can provide probabilistic evidence in court. For example, we can say in the DNA based human identification area, you can say to one part in several tens of millions that that was Willie May's blood left at that crime scene. Based on the science. And we can say this with definition. We can't say this about other pattern evidence areas like fingerprints, firearms, tool marks, and so forth. So the idea is to have this consortium of universities work with us to provide that type of scientific rigor to evidence that's used in court. So that you don't have the situation where you have one piece of evidence and you have the defense team and the prosecuting team come in and have someone say in my 20, my 50 years of experience or whatever the number might be, I can say definitively that this is that and they are saying just the opposite about the same piece of information, so that's what we are trying to eradicate in this area through this Center of Excellence that we're establishing. Advanced communications. This is our newest technical laboratory at NIST. We have marshaled resources to support advanced communication in one area and also doing a lot of hiring in this area. There are three focus areas, one is public safety communications research. Working to support a FirstNet, which is a private company that operates within the National Telecommunications and Information Agency, NTIA. And we are to provide technical support of the build out of a nationwide LTE network for first responders. That was, that is being funded by the Spectrum Option. The Spectrum Option was very successful. And this will get \$300 million to support this activity in addition to our appropriated funds, and this money can be spent from this year to 2022 I think. The other is to work with NTIA on developing the science to support more effective sharing of spectrum. And finally, to develop an active research program. And the endpoint of that would be sort of to leading U.S. Government's efforts for defining 5G. We are actually well behind Europe and some of the Asian countries so we are trying to pull together the resources to become active in this area. Quantum research obviously, countries around the world are very, very active in this area for obvious reasons. A large part of the NIST effort we have activities on our Boulder campus, on Gaithersburg campus, and a large portion of that

is in a collaboration we have with the University of Maryland and the NSA. And now Lockheed at the University of Maryland and the Joint Quantum Institute, which is a world class institute in quantum science, and we're all in this race to develop the world's really first functioning quantum computer. It's a major driver for us. Also both in our quantum program, research program, and our cyber security program, we're working on the tools to provide quantum resistance cryptography, so we can develop the crypts and key management capabilities to defend against attacks once we are living in the quantum world. We have major responsibilities to improve cyber security infrastructure. Supporting national priorities and stakeholders. Active research program. And we have a responsibility through our national initiative on cyber security education in this area. So quantum cyber security is the fastest growing research area at NIST over the last ten years. One of the things I would like to highlight is that the National Cyber Security Center of Excellence that was established in 2012 that's actually NIST and about 22 technology companies. And in this case, rather than just develop the standards, we were off campus, take our standards and work with companies in baking those into practice in a way so they can participate in this so that no one has a strategic advantage, and we are able to leverage their resources with our resources to provide practical standards in this area. Obviously we can't develop new standardization in this area like we do in others. Things are moving too rapidly. We are very active in the global cities area and we are primarily using our convening role here. Last year we had global cities competition, 64 teams from 50 governments from around the world, from the picture you can see me there standing and smiling with the King and Queen of the Netherlands. They attended, the Netherlands is very, very active in this role and they actually dropped by the expo after having lunch with the President. And we are in the process now of working with a consortium, with a team to begin to launch the next round of global cities team challenge. Community resilience. We were engaged because of, in response to the President's climate action plan, we were to develop a community resilience framework. We've completed that. The framework has two volumes that's out for public review. One sort of talks about the methodology we use and actually how that methodology can be used in a hypothetical small town, so you actually you take this methodology and use it and then the second volume has all of the metadata and all of the raw data that supports the original one. And finally, bio. NIST has historically been a physical sciences and engineering laboratory. Back in the late '80s, we established the Center for Advanced Research in Biotechnology between NIST and the University of Maryland College Park. We were supposed to teach the folks at College Park about measurement science. And they were supposed to teach us about biology because we had two biologists on the staff and they really weren't practicing biology at the time. Over the years we sort of played with this. And in the mid well the early 2000s, our Director sort of challenged me with putting together a Strategic Plan for our bio program. To either get real about it or get out. And part of that was to develop a plan, but also an elevator speech that was able to distinguish our role from that of NIH, and from

FDA. As I recall the elevator speech went something like, NIH is responsible for providing the basic, the research. And supporting research. Conducting and supporting research to address the prevention, diagnosis and treatment of disease. Our role is to provide the underpinning measurement science to allow them to carry out that mission. And with the directors support, we began getting resources to build our program. And we've gone from maybe two biologists in the late 1980s to probably, I would say we have at least 75 to 100 PhD biologists on our staff now. But that's not enough. We're never going to develop a precedent of biology that we have developed in physical sciences, there's just not the resources, so strategically we have decided to build that program, also, by very aggressive partnerships. The Center for Advanced Research in Biotechnology CARB, was started in the mid '80s, has grown to, and I know this is a mouthful, Institute for Bioscience and Biotechnological Research. IBBR and we are probably going to change that but that's a partnership between NIST, the University of Maryland, College Park and the University of Maryland med school. It focuses on advanced therapeutics. Biologic drugs and vaccines, and we have started a joint initiative on metrology and biology to address this biological irreproducibility issue, we have 50 faculty, and it's between the med school and the School of Engineering at Stanford. NIST has about 12 staff embedded there. Plan to grow that by 10 over the next several years. And again the focus there would there would be genomics and synthetic biology. So again finding the right partnerships to leverage our areas is the direction we have decided to go to really be able to deliver the standards and the measurement science needed in this area. This is just a quote from, at least an excerpt from a note we got from a member of our evaluation panel for our material measurement laboratory. That's our laboratory that deals with the chemistry of biology and material science function at NIST. And basically most folks - NIST doesn't do biology, and there's no way it can have an impact. This is just typical of the feedback that we got. The NIST labs reminded me of one of my favorite places in a hardware store where you can go in and get the stuff you need. The greatest news for us is that NIST has decided to help in the area of designing standards for biology, and really the efforts we started are really beginning to make a difference for that community. So thank you for your attention and I'll entertain any questions.

>> JOHN HOLDREN: Thank you, Willie for that great overview of the terrain, It is now, there's topics now open for comments by PCAST members. Wanda, I see your sign up. You're first.

>> WANDA AUSTIN: Thank you. I had a question about spectrum sharing and recognize the value of establishing standards at a time when everybody wants access to spectrum. I mean we all are walking around trying to get a few bars. My question to you is how are we going about

testing the effectiveness of those standards with respect to potential for interference with existing systems.

>> WILLIE MAY: I'm sorry I'm not an expert in this area but we have actually set up a test bed in our Boulder laboratory and we are working with, we formed a consortium called Neston where the military is involved, NTIA is involved and we are involved and we are developing a test bed so as we develop these technologies we actually perform simulations at that facility, at other facilities in the country, a lot out in the Midwest where we can actually test these to make sure that the theory actually does perform in the real world.

>> SUSAN GRAHAM: So struck by the remarks you made at the beginning that virtually all of the growth in NIST has been from including people from outside of the two centers. You said that you had 3,000 people, 3300 in 1901. You have 3,000 now. And yet you have roughly doubled because of the people that come from outside. So my question is how do you figure out what you do in-house and what you do with the larger community, especially when it comes to new area.

>> WILLIE MAY: I guess that growth in that manner, Susan, was by design, not a mistake. In order for us to be as agile as we need to do, well those of you who have worked in the Government realizes that it's not easy, the personnel rules don't allow you to be as agile as maybe you should be so we have tried to minimize the growth of our permanent Fed staff and bring people in. I think the fact we have 3500 people who work with us on problems of mutual interest on their nickel as being an exemplar. The fact that people, means that we are working on the right types of things. So most of that work, -- those numbers where people work on our campus, these were not contractors offsite, these are people who work on our campus on an ongoing basis so we have actually doubled staff. What I didn't include, and there's sort of a way we count the numbers, we also have about 100 new post docs that come each year. And 100 minus 30 to 40% leave. So we are growing. So we have folks, having someone work at NIST for, if you get past the three years, you're usually there for 30 or longer. The way we make sure that we have fresh ideas, energetic people is this post doc program. 100 new people at least every year. And we sort of cherry pick those based obviously on our perception of their competence. But also match to a need either retirement or an area we're moving into. For example we have heavily invested in nine post docs in bio and advanced communications and growing in the quantum area and cryptography.

>> ROSINA BIERBAUM: Thank you, Dr. May for such a rich and broad description of so many topics near and dear to us perhaps like Wanda it's unfair for me to focus in on one of the issues that you brought up but PCAST has been thinking for a long time about climate change and resilience and you mentioned in response to the Task Force how you have your now two volume report out and I want to commend you because in our work we have found that it's really the small communities that have no resources to win their way through the datasets and tools and all of that so I think that's a very valuable addition and will really be helpful. My question is in that same vein, are you thinking, are you working on areas that would help the private sector consider resilience? Obviously you focus on infrastructure and there's infrastructure in the private sector as well, but the issues are different when you think about supply chains and just wondered, and just wondered if you're working in that arena.

>> WILLIE MAY: Obviously when you say resilience, it means different things to different people and there are very few agencies that don't have programs in resilience. Just in the Department of Commerce, I pulled together a meeting about a year and a half ago just so that we and the Department of Commerce understood what each was saying by resilience, and we were meaning different things. So we have a very broad narrow mandate, and it is to look at at least critical infrastructure and in particular the built environment is where we are focusing. But obviously if there is a disruption in the built environment, it impacts the private sector, so this isn't for Government. This is for community resilience, and communities are composed of people, Government activities, private sector. So it's how do we measure the, how do we provide tools that will allow the built environment to recover from things that we can't control. So we can't control the climate shift. And you mention climate, we have another activity that I didn't say. We have a major program in greenhouse gas measurements where we are providing the measurement science that will allow that to be done very, very robustly. And just next week, I'm signing an agreement with the Chinese too since we are the two larger for actually they are the equivalent of NIST to work together on the measurement technology and standards and use those as tools for the decision makers to use in this area. The other area that we're going to work on with them is standards that support personalized or precision medicine by the way and that will be signed on the 22nd.

>> JAMES GATES: Like my colleagues I would like to thank Dr. May for the briefing. I also in response to your comment about the enjoyable experience I've had on the National Commission, I have a basically I would like to invite you to give, to do one of two things. To

either give your perspective to PCAST about the operation of the National Commission on Forensic Science. And the second part of that is what ask might you make of PCAST in that particular domain?

>> WILLIE MAY: Well, progress. We got off to a slow start because we're starting from zero and obviously with some of the advice given in the Catamere report it wasn't taken as well as it could be by some people, so part of it was bringing together this group and us getting to trust each other. And that took place over the first few meetings as you're aware, Jim, and I'm sure Tonya is over there. Also, I think that there is, I've seen a true commitment from the Department of Justice to invest in this. Sally Yates is a pleasure to work with. We are both committed to making this work. So the only ask I would have of PCAST is your continued support through OSTP and individually and Jim, certainly we want you to stay on the Commission.

>> JOHN HOLDREN: Eric Lander.

>> ERIC LANDER: If I can follow up just very briefly, with regard to that kind of work, forensics involves comparisons of patterns. And asking are they the same against some larger database. I'm curious if you could point to areas outside of forensics where NIST does similar things. What are the best analogies to the rigorous comparisons of patterns? You know, it could be, well, it could be forensic identification of chemical materials or nuclear explosions, or maybe it's some other place. But this whole pattern matching business is different maybe than kilograms and seconds. And what could you tell us about the many corners of NIST that have insight into that.

>> WILLIE MAY: Well you asked me a difficult question and I'm getting more senior I can't bring stuff back as quickly as I used to. Certainly you mentioned one the area of chemical identification. We have been doing this for years. We maintain the mass spectral database that's used probably in more than 90% of the mass spectrometers that are sold in the world. That's essentially a pattern recognition. So we do this in, we have a major program in reference data. And this data in many ways is used for pattern recognition to some extent. So that's been a whole hallmark of our measurement services programs for, well for years. For a long time.

>> ERIC LANDER: That's great maybe offline we can learn more about these programs on reference data.

>> WILLIE MAY: Sure.

>> ERIC LANDER: Thank you.

>> WILLIE MAY: Okay.

>> JOHN HOLDREN: Well, very good with no more flags up we have come virtually exactly to the end of the allotted time. So let me again thank Dr. May for a terrific presentation. And a good Q&A. We are now going to move into the part of our agenda. (Applause).

Public Comment

>> JOHN HOLDREN: We are now going to move into the part of our agenda that is reserved for public comment. And presiding over the public comment session will be our Vice Chair, Bill Press.

>> BILL PRESS: Thank you, John. We have three public comments presented today in the open meeting. I want to mention that the presentations are only the tip of the iceberg of the way PCAST gets input from the public. It's also possible to send written input to PCAST before a meeting. And this is all described in the Federal Register and that's the PCAST. As PCAST members all know, we received more than 50 pages of public comment prior to this meeting. And that was distributed to all of you. In the presentations here, we customarily allow each speaker two minutes to make a presentation. And I'll give a 30-second, I'll give a warning when there's 30 seconds left. The first speaker will be Thomas Powers, who represents the Hearing Industries Association. Tom, are you here, maybe take a seat right at the front. And when you feel like starting, I'll start my clock.

>> BILL PRESS: Please.

>> THOMAS POWERS: Thank you for the opportunity to speak to you today on behalf of the Hearing Industries Association we just completed a White Paper on hearing loss, which we will be sending to PCAST in the next few days. I'm currently employed by Sivantos, which is formerly Siemens Audiology and today I am speaking on behalf of the Hearing Industries Association. As was stated this morning hearing loss is a critical aspect of public health. Untreated hearing loss can have a significant impact on peoples' lives, their communication abilities, and their families. So for many of these folks, about 95% of them, hearing aids are the way that they find a solution to this hearing loss problem. FDA has made it clear that there's a clear distinction between hearing aids and PSAPs based on performance claims, and I think this is an important distinction between those two devices. The sale of PSAPs over the counter would allow basically patients to self diagnose and self treat some degrees of hearing loss. We have also had some test results that were just presented at the IOM that showed that many of these devices do have outputs that are in excess of allowable limits currently allowed by the FDA which is 132 dB by taking these from mild hearing loss you may be creating more hearing loss which is contrary to the original solution. And also the analogy between eyeglasses and hearing loss may be a little simplistic in the fact if you use readers it may solve one particular problem, but maybe not the extent of the rest of them. Hearing aids are dispensed by dispensed by professionals at various locations for the accessibility part of this. Hearing aids can cost between \$500 and \$3,000 as mentioned earlier but there are a number of devices at the low end of the spectrum which include the professional fitting fees, which is a major component of the total cost of buying hearing aids in the market today. Red flags are also an important part of this. And while the detection of acoustic neuroma is one of them, you see the rest of them here, ear wax is a treatable condition which a lot of people have. Two large chains just reported for --

>> BILL PRESS: Could you finish up now.

>> THOMAS POWERS: 250,000 people that came to large chains, about 4 to 5% of them demonstrated one or more of these red flags which accounts for about 4 to 5% of their referral base. So in summary, hearing aids are affordable devices they are available at many locations which were mentioned earlier, Costco and others which again provides accessibility as well as

low cost from 500 up to about \$3,000. More details will be in our White Paper which will be provided to PCAST shortly. Thank you for your time.

>> BILL PRESS: Thank you very much. The next comment on a related subject is by Lise Hamlin who represents the Hearing Loss Association of America. Lise.

>> LISE HAMLIN: Thank you. I am the Director of public policy at Hearing Loss Association of America. I depend on technology. I wear a cochlear implant and a hearing aid. So the fact is, though, that many people with hearing loss do not know about the technology or they can't afford it. So as Dr. Cassel was saying, there are many people who could benefit from hearing aids that just don't have them. Now, I also distributed, we have provided a number of papers that will be posted and one has been passed out. I'm just going to focus on the recommendation in my very brief two minutes here. What we think would be really helpful to people with hearing loss like myself, is for the Federal Government to launch a campaign that highlights hearing loss as a public health issue. We also think that the statutory, that the Federal Government should support the removal of the statutory denial of services under Medicare. We think that it should be amended, it should include hearing aids, examinations for hearing aids, all rehabilitation. And not only that, assistive listening devices which we didn't discuss but a hearing aid doesn't work well on its own, it needs other devices and those aren't covered, either. We support CMS and other third party pairs reimbursing primary care providers to include standardized hearing screenings. Doctors do not screen for hearing loss. You go to your primary care and you don't know. And people do respond when their doctor tells them as opposed to their spouse. We thought, we put this in before showing up today but we think that NIST or other Federal agency should start looking at standards for things like PSAPs so that we have -- we know what the good standards are and they come up to standards when you're making new products that are not quite hearing aids, but something that could help people getting hearing aids, or who have hearing loss and need it. We also think that data should be gathered too across the disability spectrum. CDC has gathered data recently and they did not include people with hearing loss. Data should be -- whenever data is collected it should include people with hearing loss. And we should promote hearing friendly environments in Federal buildings in the built environment so that they are installed hearing assistive devices such as loops or other devices that will help people with hearing loss, and I see I've run out of time so thank you very much for allowing me to speak today.

>> BILL PRESS: Thank you very much. Our third and last comment today is on a different subject. And it's by Anthony Nunez who is the CEO of Infamous Robotics LLC.

>> ANTHONY NUÑEZ: Thank you very much. My name is Anthony, and I'm the CEO and also an instructor at Infamous Robotics based in Arlington, Virginia. We have developed a unique curriculum and approach to teaching children about the robotics field. Our curriculum incorporates many aspects from design, engineering, art, and also entrepreneurship. Graduates of our core programs go into an eight month long process known as the robotics inventors club. At Infamous Robotics, students are engaged by innovative and unique curriculum designed to challenge students by increasing rigor in the classroom, and produce high levels of achievement not only in critical need areas of STEM subjects, but also core content areas of English, language arts, and social studies. This ambitious approach is accomplished by delivery of the curriculum we have developed. We recently conducted a study for a period of four months that evaluated 110 of our students before and after participating in our curriculum. The results showed prior to the instruction of the curriculum the average score of all the students was 5 out of 100. And this is on subject matter related to robotics and engineering. Following the assessment of our curriculum, students scored an average of 99 out of 100. These students came from all different types of backgrounds, students with no exposure to robotics, students from magnet schools in the area, and also students who have taken all enrichment style robotics programs. The future jobs for this country will be in high tech, engineering, and robotics. As a nation we must do a better job of preparing the children for global competition for robotics jobs. PCAST made many strides in this area. We ask that we, Infamous Robotics, be involved in these discussions so we can bring our expertise and experience to the table to help assist in this national effort. Thank you. Infamous Robotics looks forward to working with the administration to ensure children of our nation will be at the forefront in the line of robotics jobs and robotics innovation.

>> BILL PRESS: Thank you very much. And John, this concludes our public comments.

>> JOHN HOLDREN: Terrific. Well, the public session of this bimonthly PCAST meeting has run its course. I thank the PCAST members for their attention. The presenters for their content. The audience for their interest. And senior OSTP staff here for their continued engagement and support of PCAST activities. And of course I thank the PCAST Executive Secretariat in particular for the work that they always do at these meetings, before these meetings, and in between

these meetings. We look forward to seeing you all next time. And again, thanks to the audience both in the room and on the web. Eric. Do you have any closing thoughts.

>> ERIC LANDER: Just again my thanks to the PCAST for their continued energies and efforts. Thanks.

>> JOHN HOLDREN: We are now adjourned.