THE BROOKINGS INSTITUTION
FALK AUDITORIUM

ENABLING OPPORTUNITIES:
5G, THE INTERNET OF THINGS, AND COMMUNITIES OF COLOR

Washington, D.C.
Wednesday, January 23, 2019

PARTICIPANTS:

Opening Remarks:

MARIE SYLLA-DIXON
Vice President, Federal Government and External Affairs
T-Mobile USA

Paper Presentation:

NICOL TURNER LEE
Fellow, Center for Technology Innovation
The Brookings Institution

Panelists:

NICOL TURNER LEE, Moderator
Fellow, Center for Technology Innovation
The Brookings Institution

DOUG BRAKE
Director, Broadband and Spectrum Policy
Information Technology and Innovation Foundation

DONALD CRAVINS, JR.
Senior Vice President for Policy and Executive
Director, Washington Bureau
National Urban League

MARK HUGO LOPEZ
Director, Global Migration and Demography
Pew Research Center

MICHAEL MANDEL
Chief Economic Strategist
Progressive Policy Institute

* * * * *

P R O C E E D I N G S

DR. TURNER LEE: Good morning. It is 11:00 o'clock and you all should be awake by now, so I'm going to say it again. (Laughter) Good morning. All right, that's more like it. Good morning, everybody. I was going to say good afternoon. I was just going to jump you into the next couple of hours. (Laughter) My name is Nicol Turner Lee; I'm a fellow here at Brookings in the Center for Technology Innovation. I'm glad to see so many familiar faces and new faces that are with us today. And I'm pretty excited about this morning because I get to talk about some of my own research that I've actually conducted to share with all of you.

So many of you know, but in case you don't, let me just share a little bit about my research portfolio as you explore the work I do if you don't know already. I actually focus on issues related to legislative and regulatory policy. I've been doing that for about 20 plus years. Anything related to telecommunications and high tech, I'm actually all in it. In addition to that I work on issues related to digital inclusion and artificial intelligence. One of the areas that I'm working on now is algorithmic bias. And we have a paper coming out in two weeks, so hopefully we'll see you again in the next month for that even that will address the discriminatory effects of on line bias.

I'll do a quick shameless plug. I do have a book coming out at the end of the year, hopefully, if not the first quarter of the year on digital inclusion and digital divide. The title is "Digital Invisibility: How the Internet is Creating the New Underclass". So I look forward to all of you buying it. (Laughter) It will be published by Brookings Press.

So enough of the shameless plugs. Let me go right into the paper that we're going to sort of frame our discussion around today. And I'm really excited about this conversation because how many of you in this room have continuously heard about the opportunities that are going to be available through something called 5G? Okay. It's out there. A couple of years ago many of us that were actually looking at next generation mobile technologies would not have imagined that we would have gone from a 1G world to a 5G

world. As I tell my mother, we went from analog to something highly more capable as we will see in the next few months, if not year, that will be able to do remarkable improvements in terms of digital access.

And for those of you that know me, my particular portfolio focuses on people of color and historically disadvantaged groups. For years, beginning my career here in DC as a Ph.D., I've been interested in the use of technology and this intersection of technology with low income communities, and particularly people of color, and how they leverage technologies and how they move from being on the wrong side of the digital divide onto the right side of the digital divide. There are lots of opportunities that technology has afforded. I started, just so you know, and the reason I'm qualified to talk about this, as a digital evangelist. I was actually in the field working on digital issues 20 years ago at a group called One Economy. And one of our areas was actually advancing technology access, flow, and (inaudible). And, today, as a researcher, I'm actually looking at this manifestation of where we are now and saying are we still being inclusive of communities where access to technology can change the narrative.

I think one of the major impetus for me to write this paper is to change the narrative about 5G. Yes, I want to be able to use 5G to download my Netflix movie at peak download speeds, but I also want to see 5G technologies be able to be applied in a way that it enhances and empowers and enables communities. And one of those areas that I actually propose in the paper is through the use of internet of things. Internet of things applications -- and we'll hear from my dear friend, Michael Mandel -- we've debated this over the years -- actually provides a suite of applications as well as devices that are in the verticals of healthcare, education, energy, transportation. Imagine a world that is coupled with new advanced 5G networks that have the high capacity, high speed, and lower latency, meaning that the transmission speeds will be at miraculous speeds where we won't even notice any kind of exchange, which is particularly relevant -- and again I'm qualified to talk about this -- to things like telehealth and telemedicine. We have a project on telehealth and telemedicine

that's coming out shortly. You know, and all these things matter to low income people who often not only sit on the wrong side of the divide, but they also tend to be on the wrong side of the economic and social mobility divide.

So this paper is about that narrative, it's about those folks that sit in the guise of underneath the radar of unemployment, of education opportunity, sort of dedicated to those experiences. And something that I actually will be talking about in my book.

One of the other things I just want to say about the paper just for those who have not had a chance to get it -- it's available on the Brookings website, so please down load it and please look at it -- one of the things I like to say is that there's a role of policy making in this process to expedite 5G. And so I'm pretty aggressive on three policy proposals that I'd like to share with you that I will also discuss with our panelists.

The first is that we need to get aggressive on 5G infrastructure requirements to promote more ubiquitous deployment. I see my dear friend, Larry Irving, in the back. It's always good to get a good shout from him on Twitter. And one of the things that he mentions is that this might provide a pathway for more equitable deployment of 5G networks provided we do not redline these communities out of the existence of these opportunities. So I'm suggesting two things when it comes to infrastructure. One, that we have approaches that actually advance more nationwide 5G deployments. There's a lot of great products that are out there that are either becoming substitutes to traditional wireless or 4G wireless, there are other great products that are actually complementing 4G LT wireless products. But there's this opportunity that I think particularly in communities where we're looking at more concrete structures, a lot more obstruction when it comes to urban communities, where the people I care about are basically congregated, where a multi band approach when it comes to spectrum use could actually be looked at. I'm happy to be joined by Doug Brake, who is my spectrum educator, to talk about that. We debate this all the time. Right now many companies are looking at higher-band spectrum, which is a lot more costly, a lot more in demand. Perhaps there are ways to actually push more multi band. For

those of you that this is new, we'll talk about it a little bit more, where there's a mix of low band, mid band, and high band spectrum to make it more ubiquitous. There's also been a lot of talk about these things called small cells, which are the size of pizza boxes, that have to be in place to propagate a signal. So if you think about, and I always do a demonstration, under big towers -- I could probably put a big tower maybe across the street and under 4G LTE or under 4G I just would have a pretty decent signal. Because of the demand of 5G and what I'm proposing in terms of the use of enterprise based applications, you want to actually have small cells probably double or triple the amount between across the street and where I'm standing right now. That will contain the signal strength and that will be something that will be a success factor for the successful deployment of 5G networks.

There's a lot of discussion around that right now. Some of you who have watched this debate, it's not easy getting building permits, it's not easy having controls on costs, because a lot of that infrastructure is controlled locally. So I do make an aggressive push in my paper that we do not want to foreclose on the opportunities available to urban and rural communities, particularly where people of color are congregated, by having debates on whether or not we should employ small cells. I say that we move forward.

The second thing that I'm actually also proposing is that we need to ensure affordability of 5G services. We saw with the movement from 1G, 2G, 3G, data actually did get cheaper, for those of us who actually follow this stuff, but 5G will be more data intensive. And so I do propose in the paper that there are opportunities for more flexible bundles and pricings and prepaid, all products that have worked for low income people. And I want us to be real clear about this. We are talking about what has worked in the marketplace, that has actually created more than 75 percent of African Americans and Latinos who are using these devices as their primary gateway to the internet. And so I do propose that we continue to think about the affordability of the stuff, we do not gut federal programs, like the Lifeline program, that serves as a way for people to get on line access. We do not want to create a market of high demand, but we cannot get people on line. And that's something I also

propose in the paper.

And then, finally, before I bring up our first speaker, I do also redirect our attention back to the public interest value of 5G. There is going to be a tremendous marketplace value, it's going to expedite what we've already seen, the digital sharing economy, the digital marketplace. I mean I was so excited when I was writing this paper because I don't consider myself that old, but just to image that -- Antwuan, don't say nothing -- but those of you that know me, Uber and Lyft, and all of these amazing digital sharing applications did not exist without these. Just think about it. I have little kids. You know, I tell them I can't beat them at a lot of stuff, maybe Atari perhaps, but this use of the internet to enable ecommerce and the global economy -- 6.2 percent of the GDP is now attributed to the digital economy. These matter. And so I suggest in my paper they not only matter to these commercial conveniences and applications, but they also matter for the public interest. How do we get people who stood on the wrong side of the digital divide on the right side of the digital divide? How do we leverage the resources that they have available to promote services that really only are dependent on a high speed broadband connection. How do we ensure that smart phones are really smart and we're solving problems?

I'll close like this -- I was recently interviewed by a paper about my recent research and it dawned on me that with this horrible furlough situation that we're in now I have been picked up by government workers who are now driving ride sharing services. And they would not have been able to do that without the power of one of these. And just imagine if we go deeper into increasingly data intensive applications, like health and energy and transportation, we want people to have the same access. And so we need to get ourselves out of the way when it comes to 5G deployment. I'm one of those people who will boldly say that because if not, we're going to find ourselves with communities that sit in digital deserts, who have this but may not be able to do much, as we see more data intensive applications that go to the cloud or enable through high speed networks.

So I place that out there boldly, I ask you all to continue this conversation.

We're going to continue the conversation with the panelists. Follow us and tweet please at #5GOpportunities. And, again, the paper is available on the website and I ask all of you to read that.

So, with that, I want to actually bring up -- and we often get to do this at Brookings, because without the support of others I cannot do this work, nor can the Center for Technology Innovation. So before I introduce the panelists I would first like to introduce Marie Sylla Dixon, who is the Vice President of Federal Government Affairs at T-Mobile. Her company has provided the general support to the Center for Technology Innovation, which helps make this work possible. I'd like to reiterate, as we always do, that at Brookings, we have a commitment to independence, a scholarship of independence and underscore the importance that the views expressed today of any of the speakers are their views only and not those of ours.

So, with that in mind, please welcome Marie Sylla Dixon to the stage to just offer some general remarks. And thank you for your support to CTI. (Applause)

MS. DIXON: Okay. Good morning. It is truly a pleasure to be here today with all of you at Brookings to share some important thoughts on this topic. And as Nicol, I think, passionately stated, this is a critical topic that's going on right now. 5G and the internet of things will bring huge economic transformation and it will have a huge impact on our future. It's critical that we're having this discussion in talking about 5G and the role that it can play, especially how it can and should benefit communities of color.

By now we know that broadband connects individuals to jobs, opportunities, educational resources, affordable healthcare options, essential government services, and much more. We also know that broadband does more than just connect. High quality broadband connectivity, it creates jobs, it grows the economy, encourages innovation, promotes entrepreneurship, improves health and education outcome, boasts civil engagement, for those who have access to broadband, that is. That's why at T-Mobile we are proud to support Brookings research. Brookings generates ideas and analysis that help

in closing the digital divide. And for companies like T-Mobile, Brookings research helps inform our decisions as we work to make sure millions that are without a sustainable and affordable broadband connection have access. We know from the research and data that's out there, communities of color all over the U.S. find themselves on the wrong side of the digital divide. Even accounting for indifferences in income, age, education, and further factors, many racial and ethnic groups continue to lag behind whites in in-home broadband internet connection. These differences and access persist despite high demand for internet access in households of color without access to connectivity.

Just as access to 5G connectivity will amplify the social and economic benefits of broadband, lack of access to 5G connectivity will re-enforce social and economic inequality, hindering upward mobility for those with limited or no connectivity to the detriment of us all. And that is to the detriment of us all -- I just want to stress that. We must ensure that broadband is within reach for communities that need it most, allowing everyone to share in the social and economic benefits of 5G. Communities of color -- and I will tell you at T-Mobile are our most important customers, and they stand to benefit from the most robust 5G deployment. At T-Mobile 31 percent of our customer base are Hispanic, 22 percent are African American. The diversity of our customers reflects our commitment to providing affordable high quality service to everyone.

Following our planned merger with Sprint, new T-Mobile will build on this commitment. By 2024 the combined company's network is expected to triple the total 5G capacity of T-Mobile and Sprint standing alone and provide nearly 90 percent of the U.S. with speeds of over 100 megabits per second. As we strive to secure U.S. leadership in the goal to race to 5G, T-Mobile wants to make sure everyone is able to share in the benefits. Providing ubiquitous broadband is our goal.

That's why I will tell you today I was very, very excited to read Dr. Turner Lee's recent paper. I think she brings a fresh and needed perspective on advancing the digital divide and inclusion. Dr. Lee and the distinguished group of the panelists she's

assembled can help us understand what diverse communities and stakeholders need to fully share in the promise of the next generation of mobile broadband.

Again, I would just like to thank Brookings and also Dr. Turner Lee for putting this much needed paper out and having this discussion today. And I also would like to thank the distinguished panelists who are about to come on.

Thank you so much, and I turn it over to Dr. Lee and our panelists.

(Applause)

DR. TURNER LEE: All right. So now I get to hear from some folks that I've kicked around for a minute on these issues. I'm going to bring them up to have them seated and then we're going to go right into the panel.

Doug Brake. And, of course, I'm probably not following the seating chart. (Laughter) So just take a seat right here. Liz, don't kill me. So Doug is the Director of Broadband and Spectrum Policy at the Information, Technology, and Innovation Foundation. He does very important work I think on spectrum management. And, someone, like I said, who has become my spectrum educator when it comes to these issues.

My dear friend, Don Cravins. Come on up. He is the SVP for Policy and the Executive Director of the Washington Bureau at the National Urban League, who has taken on these issues for many, many years, and cares about them.

Mark Hugo Lopez, who is also a dear friend, who is Director of Global Migration and Demography Research at the Pew Research Center. Mark and I have done a lot of work together over the years and I'm very happy to see him here.

And last, but certainly not least -- there's always one economist that has to be on the panel (laughter), and that would be Michael Mandel, who is the Chief Economist Strategist at the Progressive Policy Institute.

Let's welcome all of the panelists. (Applause)

And just to also let you know, at the end of this we'll have Q&A.

Perfect. So welcome gentlemen. How are you? I can actually say that.

Somebody asked me the other day, they said where are the women. I said, I am the woman on the panel. (Laughter) It will be me today. All right. So I want to jump right into this. I sent you all the paper a couple of weeks ago, told you to dig into it, let me know what you think. Again, you all know how passionate I am about this issue, particularly this intersection.

So, Mark, I'm going to start with you, as a researcher to researcher. Can you kick us off by speaking to the current stats on mobile internet access by Latinos and African Americans? And I'd like to know specifically more about the smart phone dependency variable that I talk about. You know, Pew has been doing a great job with that. I want us to dig a little deeper so people actually understand and unpack what we mean by that.

MR. LOPEZ: So there have been some very interesting trends when it comes to both internet access overall, some convergence when it comes to owning a smart phone, and also some differences when it comes to how people are accessing the internet through their smart phones and whether or not they even have a broadband connection at home.

So, for example, today about 75 percent, maybe 80 percent of whites, Hispanics, blacks, have a smart phone. So that's pretty ubiquitous almost. In fact there's been a real convergence in this and the divide here has really kind of gone away. But what's interesting about this is how people are using those smart phones. So, for example, Nicol was just talking about what about smart phone dependent Americans. I mean you take a look at Hispanics, for example, you'll find that about 40 percent of those smart phone users are people who only have a smart phone and no broadband connection at home. For African Americans, it's about a third. So when we're talking about smart phone dependency, we're seeing that many Hispanics, many African Americans are choosing to only have a smart phone connection to access the internet.

Now, we've also done some work at Pew Research about why people don't

have broadband at home. So what are some of the reasons why they don't? The number one reason is cost. And this is one of the big reasons why many people do not have a broadband connection at home is because they say the cost is too high. So as we're talking about 5G and the cost of data, I do think it's interesting that the cost issue could potentially be a challenge for some communities, particularly when we're talking about the cost of data and the cost of data usage.

One last thing that you also had mentioned, which I think is interesting, is being on line continuously. About one quarter of all Americans say that they're on line continuously. That is, they're going on line -- the day starts and they're on line all day long. For Hispanics, that number is about 35 percent or so, and for African Americans, about 30 percent. So when we're talking about the African American and the Hispanic communities, we're talking about people who are smart phone dependent, who are also on line constantly. These are also generally, by the way, younger audiences or younger people. So we often times see that young people are the ones who are generally most likely to be on line continuously, most likely to only have a smart phone. So these are populations for which talking about 5G is an important question, because they are some of the people who use mobile access to the internet most in this country.

DR. TURNER LEE: Thank you, Mark. Don, I want to jump over to you then. So Mark has sort of set up this scenario where we do see this reality of smart phone dependency, particularly, and I think you said it, like where this is the only gateway for people to come on. This is technology, but speak to us a little bit about the other divides, and this observation that this actually may overlap with economic mobility and social mobility.

MR. CRAVINS: Good morning.

DR. TURNER LEE: Good morning.

MR. CRAVINS: Good morning, everyone. First of all, let me thank all of you for being here, and I want to thank you, Dr. Nicol Turner Lee, for your vision, for your

leadership, for your passion on this issue and in this space. You are making sure that African Americans are not locked out of the next great American revolution. We were locked out of the agricultural revolution because we were in bondage, we were locked out of the industrial revolution because we were in bondage and restricted through racism and discrimination. And here we are on the cusp, in the precipice of the next great American revolution, economic revolution, and communities of color have an opportunity finally catch up, to finally participate. And it's because of people like you, that you are making sure that this is staying in the forefront. It sounds good, it looks good. Who couldn't love 5G and all of the great technology? But if they're not strategic, well planned, well thought out strategies to make sure that no one is locked out or left behind, it will be another missed opportunity for our great United States of America.

I want to thank Brookings for having this discussion. This is the second time I've been to Brookings Institute in the last six months to talk about jobs and people in communities of colors.

DR. TURNER LEE: That's it.

MR. CRAVINS: There are a lot of discussions that go on in Washington, DC about people of color, and very seldom and rarely are people of color actually in the discussion. And so I want to give credit to Brookings this morning, again, for including us, including the National Urban League in this discussion. The National Urban League was founded in 1910 when African Americans were leaving the Deep South, moving to places like Washington and Baltimore and New York, New Jersey, in search for the four basic necessities of the American dream. They needed a job, the wanted healthcare, they wanted education for their children and for themselves, and they wanted a home. And the Urban League has been fighting for those same four things since we were started in 1910. Because of some of the reasons I've talked about in the past, we're still fighting for those same things. And if you say well, times have changed, things have gotten better -- well, we have been tracking the state of black America since the 1960s. And I'm a lawyer and I don't

do math, but I'll give you two very easy math equations to remember that unfortunately still exist in this country. If you want to know what the black unemployment rate in this country in any city, look at the white unemployment rate, multiply it times 2, 2.5, and that's the black unemployment rate. And in the District of Columbia the African American male unemployment rate is 14 percent. And so although 1600 Pennsylvania and many people in congress are talking about how low the African American unemployment may be, the fact remains we are still twice as high, sometimes three times as high, as the national average. If you want to know what the median black income is, look at the white income in your city, divide that by 2, and that's what my people's median income is.

And so when we see, doc, the opportunity of 5G, that's how I looked at it. So when I read your report I felt as if you were calling to people like the National Urban League and to other non profits, and to all leaders, to say here it is, I've set the table for you. This is a great opportunity to pull people up by the bootstraps. And maybe here's some boots and some straps for the first time. And so let's see if we can work to make this really a come up for all Americans.

And so I'm looking forward to continuing this work with you. And as we go through the panel discussion I want to talk about some specific ways I think we need to be strategic in making sure that African American, Latino Americans, all Americans --

DR. TURNER LEE: Yes, yes.

MR. CRAVINS: -- are able to participate fully in the 5G and the technology revolution that we're seeing.

DR. TURNER LEE: Yes. And I'm glad you picked up on that, because I mean my intent, even though I focus on African Americans and Latinos because it's a particular interest of mine in terms of underrepresented communities, it applies to vulnerable populations generally, right.

MR. CRAVINS: Absolutely.

DR. TURNER LEE: Anybody who sits on the side where they're not

benefitting. So I appreciate that and I'm humbled by your remarks.

MR. CRAVINS: Well, we are proud of you and thankful.

DR. TURNER LEE: So now, Michael, I know you're an economist, but keep it real for us, right (laughter), in terms of --

MR. MANDEL: No, I do, Nicol. (Laughter)

DR. TURNER LEE: -- the assets within the digital economy that bring value to populations. I will (inaudible) one of them. You know, a lot of people ask me well why internet of things. And the internet of things was really important to me, particularly because of the enterprise based application to these communities.

Can you talk a little bit about IoT access to social services, why this could be a possible lever to sort of help people in these communities?

MR. MANDEL: Thank you very much, Nicol, for having this and for inviting me. At PPI we've been doing a lot of research over the last couple of years on a different sort of divide and how it affects communities of color. The divide between the digital sector, which has been growing very rapidly, and the physical sector, which has been growing much less rapidly, less job growth, less wage growth. The physical sector includes industries like healthcare, manufacturing, agriculture, transportation. And what's been happening is this divergence between one part of the economy and the other has negatively affected communities of color. And this is something that we've written about and what 5G enables us to do is enable us to extend the digital transformation to the rest of the economy, to the retail sector, to healthcare, to manufacturing, and make sure that more people are benefitting from digitization.

And I'll just give one example at this point. Well, actually, I'll give two examples. One is in healthcare, as Nicol talked about, telemedicine. Telehealth has the possibility of bringing relatively cheap healthcare to urban communities, to rural communities, people who can't afford to travel long distances, who bring these services to them more cheaply, requires 5G, requires pervasive 5G. I guess the question, the word that

you use is resilient or -- it's very important to sort of think of these things as not being about move downloads, not being about entertainment, but about enabling the extension of digitization to very mundane industries and creating more jobs at higher pay. And we also see this in retailing, where the retail sector, whose racial and ethnic makeup basically maps the rest of the economy where people of color are concentrated in low paying jobs, and what we're seeing is that the shift to ecommerce fulfillment centers has opened up a lot of new opportunities, a lot of growth at higher pay for a wider range of people.

So I encourage you to sort of think about 5G -- and I think this is in the spirit of what you wrote -- as not being an entertainment tool, not being a social media tool, but as a way of actually enabling a transformation of a broader part of the economy, faster growth, more jobs, higher pay for more people. And this brings it what you were saying, we have to have policies to make sure that everyone can take advantage of it, but the opportunities are there.

DR. TURNER LEE: Right. And, Mike, before I actually come off of you, IoT as an industry, just tell people where we are. I mean what are the statistics -- maybe just explain internet of things and then tell us where we're at.

MR. MANDEL: So there are several different terms that cover the same thing. One is internet of things, another might be internet of goods. It's the idea that digitization is not just about bits and bytes, but it's about the physical world. That's what it means, internet of things. So when we're talking about healthcare we are talking about remote sensors, remote diagnosis, remote treatment, the ability to actually bring dentistry to people in poor areas, the ability to bring eye exams to people in poor areas. It's a very broad range. You know, when we think about internet of things, I don't actually think in the end that that really kind of enables it for people. It's about the physical world, it's about physical industries which basically is what we spend most of our day interacting with. So the internet of things is about better sensors and it's about communications that is fast and reliable and requires 5G to be operative because basically the physical world is a lot more

difficult than a digital world.

DR. TURNER LEE: That's right. And I'll come back in a minute, because there's been some conversation on whether or not the networks we have now are sufficient.

But, Doug, I'm going to come over to you. I know that I didn't ask you this, but I'm going to ask you to do this anyway, can you explain 5G, just so people can unpack that.

QUESTIONER: You could have started with that.

DR. TURNER LEE: Because I didn't do the job in my remarks. I was too passionate, right. And then can you also then dissect why more spectrum -- because I do make this argument again around spectrum availability being much more mixed use -- and small cells? So kind of give us 5G definition, why spectrum needs to be available, and then why small cells are important.

MR. BRAKE: Absolutely. Okay. Sure thing. So, I mean first of all, echo a lot of the thanks for Nicol for having me on the panel, Doug Brake with the Information and Technology Innovation Foundation. It's a real honor to be here, Nicol.

My work at ITIF, I tend to focus very narrowly on the economics and the real technology at stake. And you continually remind me of the way in which those issues intersect with much broader social policy and continue to make me think about that. A real leader in this space. So I really appreciate it, it's an honor to be here with you and Brookings as well.

So define 5G, is a bit of a lift, but I think the best way to think about it there are sort of different flavors of 5G, different versions. The most important I think is what's defined by the 5G specification, the 5G, the 5G NR radio specification that's defined by 3GPP, an international standard setting body. And so that's actually a pretty flexible specification that can be put towards different spectrum bands, as Nicol pointed out. A lot of the excitement, a lot of the conversation, is focused around utilizing that technology, that 5G specification for high band spectrum, for millimeter wave spectrum. And that spectrum tends

to have a much shorter propagation distance, if that makes sense. So that has left to this shift in architecture for 5G that will see a much denser network deployment, much more small cells, as Nicol mentioned.

And so this is the conversation around how do policy makers leverage infrastructure policy to help see a more ubiquitous deployment of 5G. And that, I mean, is a big can of worms, a big topic that maybe deserves and entire panel of its own. But that's one idea. But I feel like that has been a focus of the conversation and that's not all that 5G is. 5G is not quite spectrum agnostic but can be used for a wide variety of different bands. And so there's a lot of focus on millimeter wave, but there's also increasing focus on mid band spectrum. If Nicol can make a shameless plug for book, which I'm very much looking forward to --

DR. TURNER LEE: Go ahead. Shameless plug away.

MR. BRAKE: -- ITIF recently released a report on mid band spectrum that has been a hot topic at the FCC. So please check that out.

But also low band spectrum is also usable for 5G uses. And so, again, millimeter wave, much shorter propagation, but there's a tremendous amount of bandwidth that's available at those high frequencies. And so you're talking about those are the bands for tremendous through put, you can watch your dozens of Netflix videos as the same time. But, at the low band, it can propagate much further, can get through walls, can get through foliage much more easily, and can cover wider areas.

So absolutely important that we see 5G deployed on all of these different frequencies. The FCC is doing well on the spectrum front -- or at least would be doing well if they were open for business. (Laughter) But, yes, hopefully that will continue.

DR. TURNER LEE: Right. And then talk to us about small cells too. I mean I gave the example about the tower cites being the predominant, but now with these small cells and pizza box sized antenna, what is that going to look like and why is that important too?

MR. BRAKE: Absolutely. So this has been -- a lot of the discussion around the sort of infrastructure conversation with 5G has been driven by this architecture, the architectural shift towards small cell deployments. And that's where we want to see small cells deployed to get sort of the biggest whiz bang aspects of 5G. You would need to have small cells on basically every light pole, every utility pole, to really blanket an area. And so a lot of the infrastructure rules historically were written assuming cell towers that are these big 150-200 foot tall towers. And so there's a big conversation around taking a look at those rules and updating them for this sort of new change, this new architecture.

FCC took a crack at it. I think it's a pretty reasonable attempt to try to tighten shock clocks and lower the cost, streamline the process of deploying these. It's in litigation now, I think from both sides of the coin. And so we'll see I guess. If I had my sort of dream world we'd see a piece of legislation that would take a much broader look at this broadband, updating the Communications Act for broadband more generally.

DR. TURNER LEE: Right. And this is a sensitive topic. And the reason I asked Doug and all the panelists to sort of outline this topic, one, some of you may have some knowledge of this, some of you may not. I think we always assume as moderators that everybody knows what we're talking about. You all now have basic knowledge of what this debate is about. But many of these issues also, particularly on the infrastructure side, are being debated in real time. And it's really important for us to think about and that's one of the reasons why I was sort of pushing this narrative. You know, we don't take positions here at Brookings with respect to any locality. It's just important to have some kind of congruent access. I live in Alexandria, I want to go to Arlington, and I want to have the same type of access. And I think that's the expectation of what consumers have. And this is a debate that we're in currently, but something we should thing longer term in terms of what we're bringing to communities and what we're not.

Now, I want to bring it back to Michael and then maybe Doug or whoever would like to jump in, you know, there is a lot of conversation about 4G LTE being sufficient.

What we are actually seeing in enhanced 4G. For those of you, like my mother, who don't know what I'm talking about, just look at your phone. In some places it says 3G, in some places it says 4G. If you go out to rural America, it says no G (laughter) that is actually there. I've had that happen to me several times.

QUESTIONER: G-less.

DR. TURNER LEE: Right, it's G-less. I'm not going to have a G conversation with you, Michael, today. Not the right place. But some people would say that 4G LTE is actually sufficient enough capacity to run a lot of the things that I'm proposing in the paper. And I had to really think carefully about that because in many respects it could be correct. But I think going back to Doug's point, and maybe both of you kind of chime in, if I'm suggesting that we want multiple devices basically carried on this network simultaneously, much more data intensive, what are your thoughts on that?

MR. MANDEL: Absolutely that 5G is necessary. And the reason why -- think about this, you think about healthcare and monitoring a patient's condition, diagnosis, you're actually talking about enormous amounts of data being transmitted in real time. If you're talking about a manufacturing operation where you're sort of monitoring processes in a lot of different places that may be moving, where you're talking about something that is very different than the current wireless system can do. If you're talking about the ability to provide a lot of insight into the physical world in real time, if you've actually looked at any of the studies that sort of talk about tracking physical objects, there's a lot more data in tracking a physical object like a person and getting information about the health of them than there is even in a movie. Movies are comparatively small compared to the physical world. So we're actually talking about a jump up in the sort of capabilities that we need. And, partly the reason why we know this is true is because we haven't seen the digitization of physical industries. Part of the problem is that the bandwidth hasn't been there.

DR. TURNER LEE: Right, right, right. Doug, you want to jump in?

MR. BRAKE: Yes, happy to add to that. Total agreement, just a few extra

thoughts. I think when it comes to IoT the real distinction between sort of some of the 4G flavors that can do IoT and some of the unlicensed technologies that can do IoT and 5G, the real jump is in the density of sensors that you can pack in a particular geographic area. And it's really a dramatic change. With 5G you can really, really pack those sensors in and there are ways in which the network can adapt, basically simplify the communications to enable sensors to have an extremely long battery life. The specification is designed to be extremely flexible, extremely adaptable to different use cases. So if you want to have an extremely high through put, you know, augmented reality experience as you walk down the sidewalk, it can do that, but if you just want to take little sips of data, measuring a water pipe, or something like that, and try to have a battery life of a decade, or something like that, 5G can adapt to those different use cases.

And so that I think is maybe the most important difference as we move to 5G, is it enables this real sort of civic IoT where you can put sensor all throughout city services of all different kinds. And I think that opens up real new possibilities that new technologies maybe didn't have before.

A few other just quick thoughts.

DR. TURNER LEE: Oh, no, no, go please.

MR. BRAKE: Another characteristic that 5G enables is extremely low latency. And that, again, is not something that 4G does very well. And so that's for when you want real time feedback, real time loop between two end points, two distances. So things like augmented reality would need it. And, again, the tremendous bandwidth, the through put for 5G. I think one of the sort of underappreciated aspects of that is some of the early use cases of 5G we're seeing fixed wireless using this sort of new 5G technologies that competes directly with cable. And so to my mind, 5G is sort of the fabled third pipe that we're seeing a new level of competition.

DR. TURNER LEE: Yeah. And I think that's an important distinction, right, as has been said by everybody. We're talking about one particular technology roll out.

There are other technology roll outs that are out there and there's no way to actually say that those don't exist. But I think you're right. I mean when I look at this, and I date myself. I mean my first network that I ever put together was a community wireless network in the west side of Chicago with D link routers and duct tape, you know, went as far as the neighbor's house. And now we're seeing deeper, broader capacity, which I think, again, I was in a low-income community doing that work as a digital evangelist years ago. I want to see more of that, because the technology has just gotten so much darned better.

But, Mark, I went down to Stanton, Virginia to see Chris Wood over there, talked to a lot of people in the community -- data. Young man by the name of Joseph Mulgrave said that he couldn't afford the data just to do the basic stuff. How do we look at this cost issue when it comes to its use? Because obviously there are going to be implications and assumptions around affordability.

MR. LOPEZ: Affordability is a major concern of many users, whether we're talking about broadband access at home or we're talking about what packages for data consumptions they purchase when it comes to their smart phone use. And this is something that many folks in our surveys, if you research, have raised as a concern, why they may not have broadband access at home or why they may not have or be able to afford all the data that they need for their smart phone. So they might own a smart phone but they may not be able to necessarily regularly afford the data package. So this is something that particularly is of concern to Hispanics and to African Americans and to, generally speaking, people how are of lower income or in rural areas. This is one of the concerns that comes up in our surveys by people who live in those parts of the country or are part of those groups as well.

So this is a challenge. And I think this is going to be something that isn't going to go away. But I do think one interesting thing about the way things are currently set up for, particularly for Hispanics, is that when you take a look at the foreign-born Hispanic, for example, they are less likely to have an internet access at home. They might have a mobile device, but it's just a cellular telephone, for example, because that's what's

affordable. And where do they get their internet access? They might go to places like the library to actually get that access, so that becomes an important place.

So when we're talking about this, I think there's more to this than just what somebody has in their hand or might have at home, but there are also other opportunities to influence the way people might have access to the internet.

DR. TURNER LEE: That's right.

MR. MANDEL: Nicol, can I add one thing here?

DR. TURNER LEE: Yeah.

MR. MANDEL: So if you remember back 10 or 15 years, we used to pay for text messages and we used to pay for phone calls. Now we don't pay for the most part. Text messages are free, phone calls are free, and you're paying for data. Because what happened is that the pipes got broader, okay, and you -- I'm an economist, right, so you shift the supply curve, the price goes down. What's going to happen with 5G, and nobody will say this, okay, nobody will say this, what will happen with 5G is the pipes will get bigger and basic service will get cheaper because that's been the history here, that as you kind of move up, that it creates more space in the network. Now, no one will say this, but it's something that's going to probably happen.

DR. TURNER LEE: That's right. Well, Donald, I want to come back to you then, because there are arguments -- now, I make the argument because of the numbers, you know, that the investment numbers will be high and there will have to be some tradeoffs. You know, some are arguing that more small cells are actually cheaper and so there might be some infrastructure affordances that come because small cells are a lot different than leasing big towers, et cetera. There is this thing called Lifeline that is currently being debated and somewhat gutted at the Federal Communications Commission -- and I can say that because they probably aren't watching, right. You know, what do we do about that? I mean how do we look at that program and where do we maybe push for 5G to be an eligible service so that people don't get redlined out of this new opportunity?

MR. CRAVINS: Well, I mean, as many of you know, about the Lifeline program, which was created for our poor communities to have access to cellular service, it has been a lifeline for many of those men and women who live in those neighborhoods. It's a way for people -- as you said in your report, doc, we really do over index as African Americans and Latinos on our handheld devices. But it is our access. It's a way to help our children do their homework, it's a way to apply for a job, it's a way for us to check on our prescriptions, it's a way for us just to know what the heck is going on. And so Lifeline has been a lifeline for many communities of color.

And so at the Urban League we have been a strong supporter. We want to see the program continue and continue to help people, but we also want the program to keep up with 5G, and so that we would be able to benefit from those technologies, the great things that you talk about in your paper. And so we want to see programs like that continue. And I've said it, and these gentlemen have been saying it, it has to be strategic, it has to be intentional. This is not going to be an organic equity; it's just not going to happen.

DR. TURNER LEE: Right.

MR. CRAVINS: It's unfortunate, but it won't happen that way. Unless we take a very intentional approach to making sure that communities of color and underserved communities get this technology, get these jobs, get the access, it doesn't happen organically for our communities. Our numbers show that, our Pew studies show it, our State of Black America shows it. It's not a finger pointing or a blame game, it's we know that it doesn't happen organically, so what can government leaders, what can all of my wonderful friends I see in the audience who work for the industry, what can we do to be strategic to make sure that we don't miss this opportunity. How do we make sure that STEM programs really do work for our young people? We've been talking about STEM for 40 years, still a big divide when it comes to STEM, huge divide when it comes to African American children in advanced placement classes. Our kids don't take advanced placement classes. Their parents didn't take them either. So it's a cultural thing in many cases, and in some it's a

systematic discrimination thing. It's a divide. How do we fix that? How do we get all these wonderful returning citizens who've paid their debt to society, who because of the First Step Act and many of these pieces of legislation that states are passing, they are looking for jobs. We want these men and women to return to society and be good job seekers. 5G is a great place to put some of those men and women to work. But how do we take those people from prison to that pipeline you're talking about, those bigger pipes? I want to see black and brown people building some of those pipes. I want to see black and brown companies manufacturing the pipes, or being responsible for putting the pipes into the ground, or wherever they're going to be, on top of the telephone poles. Are we making sure that we're strategic, that African American owned businesses and women owned businesses and Latino owned businesses are able to participate in the supply diversity chain that's going to take place? It's going to require our friends in the industry and our politicians in government, the men and women who we elect to serve, to be very, very strategic, or we're going to miss it, doc.

DR. TURNER LEE: That's right.

MR. CRAVINS: Because it doesn't happen organically. It's got to happen intentionally.

DR. TURNER LEE: That's right. Okay. And a view that I'm about to express is my own, it's only my own. I want to see the black, brown, and the white people go back to work at the federal government. Just want to say that, because you got me like riled up about this. Because we have to do something, which is why I keep saying it has to be nationwide, right.

MR. CRAVINS: It has to be.

DR. TURNER LEE: For any of you, I mean if we miss this market, again, I want to point you all back to please tweet at #5GOpportunities. In a few moments I'm going to open it up for Q&A. As we've mentioned, nationwide deployment is critical. I say it. You could disagree with me, anybody, please. This is going to require a lot of work, a lot of

infrastructure investments, a lot of thinking about what applications that will go over those networks, even some coordination with the device makers and what's actually going to ride a 5G network, if our smart phones are going to be able and aptly equipped to do that. Digital redlining is real. Nationwide, not nationwide? Doug, am I on the right track by at least suggesting that we need to make sure that everybody can get access?

MR. BRAKE: I think you're absolutely on the right track.

DR. TURNER LEE: I just want to make sure. I mean sometimes I sit in a corner in a cocoon all by myself, and I'm okay with that, particularly when my kids are not around. But nationwide and not nationwide.

MR. BRAKE: Well, nationwide, if you mean filling like every canyon, every mountain top, it's going to be a real challenge. We're going to have to have course correction along the way, government subsidies in uneconomic areas, a lot of work on the demand side as well. But no, absolutely, that should be the goal, to have ubiquitous coverage.

Of course, it's not going to happen overnight. We can't have unfunded mandates that say this be built everywhere all at once. That's not going to work. It has to be, you know, pragmatic. And I think over time, course correction to identify where to address the gaps.

DR. TURNER LEE: Outside of Lifeline, a role for government in this? I mean I think we all like put our nose up when the administration announced they wanted a nationalized 5G network. Don, Michael, in terms of the role of government, to make this happen?

MR. CRAVINS: I want government to be pragmatic. I hope government sees the big picture. Government should not stand in the way of this technology and of this progression. But government should ask tough questions and should make sure that all of the problems we just talked about are being addressed by our friends in the corporate space and making -- but they should not stand in the way of this progress.

DR. TURNER LEE: Michael?

MR. MANDEL: Well, we just have to remember that these networks are enabling not just -- we keep coming back to the Netflix -- not just communications but jobs, and a wide range of jobs and a wide range of opportunities, and that localities should be encouraging these networks to be built rather than sort of viewing them as a high end item that can be taxed or regulated or put fees on. There really is a different attitude.

DR. TURNER LEE: And, Mark, I know you don't do advocacy. I want to talk to you a little bit about if these networks are built, will they come?

MR. LOPEZ: There will be demand for it more than likely. We saw, certainly, with the roll out of previous technologies that for the U.S. public there was growing use of just about everything. And you see this convergence over a few years of just about everybody, for example, being on line, about three quarters of Americans having a smart phone. We'll probably see similar patterns here as well. It may take a few years, but we'll probably see similar patterns.

DR. TURNER LEE: And I'm surprised actually as a researcher and looking at the trajectory of broadband use, there were years ago when we actually looked at the broadband use and the numbers were just disparaging. I mean I was at the Joint Center for Political and Economic Studies, the first study I did was the National Minority Broadband Adoption Study. Thanks to my friends at Pew, who revealed to me like, hey, take that space, right, and go a little deeper on our data. We actually did a stratified sample and found out there were glaring disparities in terms of internet access and use. Today those numbers are actually converging, which is really promising, particularly in the mobile space. It's about 77 percent white, 75 percent African Americans, and 73 to 74 percent Hispanics. That's really unheard of. And we're not talking about that long. This was a decade long progress.

So I think as we're hearing in this conversation, the train has left the station. The key thing is who is still sitting out there trying to get on, and who has a ticket and who

does not. And I think, again, matching these conversations with infrastructure requirements is really important. And I appreciate you, Doug, by saying that's what I do, make sure social policy is always in this discussion.

We have time for some questions. I could go on and on. I was going to keep talking, but I wanted to just make sure how many questions were out there. I ask that you keep your question to a question and your commentary to yourself (laughter) so we can actually make sure that we get enough questions in, because I know everybody has wonderful things to say.

I'm not going to try to get into trouble, so I'm going to ask our wonderful person here with the mic, we'll start on this side and kind of go across this way, okay?

QUESTIONER: Thanks so much, Doctor. I'm (inaudible) from Intech Cyber Security. My question is mostly for the economist, but others who want to talk about it as well. What is being done or should be done to address cyber security alongside the development of 5G and IoT given that the NTIA and other surveys have pointed to a lack of confidence on the public's behalf for engaging in the digital economy? And there are also efforts in congress to create legislation around privacy and data security, so how might we sort of address those cyber security issues, you know, in this sphere?

DR. TURNER LEE: Michael?

MR. MANDEL: That's a really terrific question. We're absolutely going to have to address them and it's going to be a combination of the private sector, the public sector, and then ordinary people saying that we're willing to actually accept some of these cyber security issues. It's funny, you know, people say they want cyber security and then they're not willing to actually do what's necessary for it. So it's a combination of these.

DR. TURNER LEE: Did you have something to say on this, Doug? If you don't, it's okay.

MR. BRAKE: Yeah, we might as well get more questions in. (Laughter)

DR. TURNER LEE: Okay.

MR. RABINOWITZ: Thank you. I'm Dave Rabinowitz, a retired engineer. And I look at the panel here talking about technology innovation and I see people with backgrounds law, economics, sociology, and all that. There's been a lot of hype on 5G and much of it, possibly most of it, is nonsense. And without a strong technical background it's really hard to filter out the fake news. For example, right now the closest technical analog to 5G is public Wi-Fi, which exists. And the main difference is that 5G is going to expensive and you have to buy new equipment -- cell phones are not getting cheaper -- whereas public wife can be installed quickly today with current equipment and be much cheaper.

And my question is, why are there no technologists on the panel?

DR. TURNER LEE: Well, he is a technologist and I've actually built networks. But go ahead first.

MR. BRAKE: I'm not quite a technologist. I took some engineering classes when I was in law school, so I do (laughter) my best, but. So I must say I do disagree a little bit. So public Wi-Fi can be extremely useful for basic connectivity and offering a sort of maybe a free service for people to get on line, but it can't do the same sort of things that 5G can. And it's really built into the specification the way in which it can offer massive amount sensors connecting to the network. There's too much signaling overhead for a technology like Wi-Fi to be able to handle it. They really are different.

DR. TURNER LEE: And I'm not a technologist, but I've actually built networks and some folks in this room can attest to that. So I think what we're actually seeing differently than what we saw when we did actually public Wi-Fi networks dating back to community networks that were actually leveraging open bandwidth, whether it was free services that were coming from government programs. In my case our network was actually leveraged through e-rate services that were actually in Chicago and were able to actually build out a widespread community Wi-Fi network that was public and open. But the challenge is that the coverage wasn't deep enough for people to do very interesting and robust applications. At that time email was not able to be done. And I'm talking about 15-20

years ago.

I think what we're actually going to see now -- and I agree with you in terms of more technologists, but this is Washington, DC, so we always can kind of get away with not having an engineer, but next time I will take that into consideration. (Laughter) As barely our sociologist can barely get on this kind of panel. But what I would say to your question, I think what we're talking about in terms of the depth and the capacity and coverage that we want to see with 5G technology, having been a person who was a naysayer about its potential, there are some technical specifications, including the leverage use of licensed and unlicensed spectrum in many of those networks that's going to bolster that.

Right now many of you don't realize that our networks jump from commercial to unlicensed spectrum. In many ways we're an amplified public Wi-Fi. The FCC under Jessica Rosenworcel made that possible. But I think when I'm dealing with my telehealth and I'm dealing with an autonomous vehicle, that I want a network that has much more capacity and has the ability to be much more sustainable and resilient. That split second resolve may result in an accident. And you know that as an engineer.

So I think those are really valuable questions, but we've got to go deeper folks. I think we talk about the hype of 5G, we talked about the hype of 4G LTE, we talked about the hype of 3G, 2G, 1G, and we're in it. And every time that it changes, somehow all the devices change simultaneously because it's no longer about industry demand, it's consumer demand. And that's something as a researcher, these trends in market I've been looking at, those are real trends. What's driving this ecology, my friends, are consumers. And I think that's where many of us, to your point, sir, we need to understand how we're accommodating the demand of consumers to want to do more stuff off of these networks. Like Michael said, the pipes are getting bigger, but the applications are getting even bigger than the pipes.

So thank you for that question, but I will definitely parking lot that.

Let me go to this gentleman back here and then I will sort of move towards somehow in the back in the middle without getting in trouble.

QUESTIONER: Hi. Christian McCray. So my question is how are we going to get the sort of inspirational experiments to young people? Because I've been here before. Seven or eight years ago I was helping Muhammad Yunus basically challenge historically black university colleges all around the country and, okay, it was broadband then, but you go up and down the sort of old age professors and things, and the youth are always the last ones to get the chance to experiment with the kinds of things you're talking about.

So how do we get them involved?

DR. TURNER LEE: Don?

MR. CRAVINS: Great question. It's the same frustration that we deal with at the Urban League. I think, again, it has to be intentional, it has to be sustained, and we just have not had that. As I said, when I went to college in the early '90s we were talking about STEM and we were telling African American men and women you should be engineers because that's where you needed to be. And yet we've still been talking about STEM and engineers in the African American community and there's still a big divide there. So it's going to take government, it's going to take organizations like the Urban League, it's going to take our friends in the private sector, to say we need these jobs, we need these opportunities, we want Americans to do these jobs.

So as I've told my staff, we're going to have to really dream big and think big on this thing. But it's got to be sustained and there's got to be some checks on it. It's not going to happen organically. That's the best word -- that's all I can come up with this morning as I was trying to get my -- I'm still on my New Year's resolution, I'm trying to work out every morning -- as I was on my bike this morning (laughter) -- it's not going to happen organically because we know it doesn't happen organically. We do symposiums and we go to HBCUs and we tell people, let's do this. And it does this. We can't afford as a country -- it's not just about African Americans and HBCUs, we can't afford as a country to let this do

this again. It's not good for us as a people, it's not good for us as a country.

And so I'm with you, it's going to take sustained -- it's going to take, again, very strategic -- we're going to have to think big. If a company knows that they're going to need a workforce that has certain qualifications and certain skills and they can't depend on the schools to give it to them, then maybe that company has to figure out another way to get those people trained. The Urban League tries to do it. We've got 90 affiliates in 36 states and including the District of Columbia. We've got work training programs. We train 10-15 people at a time. It's not enough, we could do more, but with funding and resources. So we as a country are going to have to figure this out and we have to figure it out very, very soon.

It's not just technology, it's energy. This 5G technology is also going to revolutionize the energy industry. The energy industry is changing. With autonomous vehicles this technology is going to be all part of that. So there are opportunities at all those spaces, but we're going to have to be intentional on how we come up. And I don't have all the ideas, I don't have all the solutions, I don't.

DR. TURNER LEE: Although the Urban League, they do have a program that is funded through the Department of Labor working with the Multicultural Media, Telecom, and Internet Council to actually train -- and the Wireless Infrastructure Association -- to train people of color on wireless infrastructure jobs, small cell deployment. So I think that's a beginning stage too, to make sure people actually get into that workforce.

Okay, I don't want to get in trouble, but I'm kind of stuck here. Let me go back here to Antwuan. Raise your hand -- the gentleman in the brown jacket, and then I'll kind of swing my way here and respect everybody's time that we still get out by 12:15.

: Great. Good morning and thank you for this panel. Thanks, Nicol. Antwuan Wallace, Urban Research Strategies & Logistics. Can I just problematize this for a minute? The resiliency has been on the market failures, right. We have talked about disproportionately people who are black or disproportionately poor, disproportionately in the south where the rural convergence of policy and rural broadband is really the greater

number of people. And so when we talk about market economies we have to really think through why are we seeing a resiliency in price for bandwidth and for data, because they saw the markets shift. When that demand curve moved data became the premium and that they could get that. How do we change the conversation and introduce policy results like a nation state if we're talking about the word that nobody wants to talk about, which is the public good. And if we provide the opportunity for market and for monopoly power, how then do we wrest back the access and the deployability for people to be in the demand drive market?

DR. TURNER LEE: Michael?

MR. MANDEL: So let me just start with one note, which is that according to data from the BLS, the price of internet connection has been falling, the price of data has been falling. I think part of the issue is at the same time the demand has been rising. So people have needed more and more. So one question is, and I think that we're kind of grappling with this a little bit, is that if you have a rapidly changing technology should the leadership come out of the private sector, should it come out of the public sector, or should it come out of some combination. It's hard for the public sector to be a technology leader on scale. And this is something we can sort of disagree on, but it's easy to sort of do a one shot and it's hard to get the sustained investment out of the public sector on a new technology. It's very hard to think about cases where that's happened. And we can sit and have a kind of constructive discussion about this, but where the public sector has been best at is sort of funding basic research and less so the implementation. But then, as you say, you have to make sure that it gets to the places that you want it to get to.

So the question is if I look globally, say to Europe versus the U.S., Europe is actually struggling with the investment for 5G at this point. And they are very much worried that they are falling behind. And this raises some really interesting questions here in terms of innovation, in terms of manufacturing, in terms of who is going to benefit, that the question that you and I could sit down and discuss productively for an entire afternoon, perhaps not

come to an agreement, but actually be able to sort of figure out kind of where we disagree and we agree. I agree that these are really interesting and important questions, but from my perspective, and I end up spending a lot of time in Europe talking to people, there are a lot of worries that Europe is falling behind in 5G.

Then it comes to your question, is 5G a critical technology. Well, China thinks so, Japan thinks so, and so we sort of -- this is kind of where we -- these are the interesting sets of discussions where we are at this point.

And let me just say one final -- for me, it falls on the slow growth of the physical industries and how that's hurt a lot of people and what we can do to have the growth push out both industry wide and geographically.

DR. TURNER LEE: You want to say something real quickly? Because I want to make sure I get to as many questions as possible. Go ahead.

MR. BRAKE: Sure. I mean just really quickly, I mean our competition in market base, you know, model of getting broadband and mobile access to the country I think has given us such tremendous benefits, as Michael noted. While the price might stay steady at the high level, the price per gigabit has dropped dramatically over the years. We have seen tremendous innovations. I mean 5G like we're talking about. Those don't come out of a vacuum, those are driven by competition and investment and driving towards new inventions.

At the same time, these are networks that are clearly affected by the public interest. We need intentional government programs to fill in gaps either where it's not economical for these private providers to invest, to make sure that there are grant programs to address things like digital inclusion, digital literacy. All sorts of ways in which those can be supplemented. It's not an area where it's sort of a free market laissez-faire sort of model that will work best. We need a combination, support, competition, where it does well, and fill in gaps.

DR. TURNER LEE: And Antwuan, just quickly on that, a caveat on that.

That's where I think where we need to move from a conversation of divide to solution. So on the infrastructure side you'll see a lot more come out of our shop with regards to rural solutions and urban solutions. And there are a plethora of solutions that can apply across both spectrums. It's all a matter of what's going to work, as Doug said, to make sure we get as much access as possible.

Can I have a show of hands of how many questions that are actually out in the queue?

QUESTIONER: A lot of them.

DR. TURNER LEE: Okay. So I'm going to try to do this really quickly. If you could actually do rapid fire on your question, I'm going to do this, I'm going to take the next three questions, just rapid fire, rapid fire response. And the last two questions I'm actually going to take both those questions, summarize it, and the panelists will end with those.

So let's go to the woman in the back.

QUESTIONER: Good morning. My question is when we hear about moving the physical sector into digital a lot of people hear that they're losing their jobs because they think, oh my god, right, like it's going to be given by a robot instead of me. How can we demystify some of those worries?

DR. TURNER LEE: Okay. So can I just say this? Because I know that will lead us into a whole other discussion. (Laughter) Our Vice President at the Center for Technology Innovation wrote a book about the robots, automation, and the future of industry. Darryl West -- get the book. If you don't have it, I will get it to you, because that is obviously a whole other conversation. I know, Michael, you want to delve right in there, but it's 12:00 right now.

MR. MANDEL: I do.

DR. TURNER LEE: I know you do. I promise I'm going to bring you back so we can actually talk about and answer that question. But Darryl West has wrote a

fantastic book on this whole premise of robots coming and what that's going to look like in the future of automation. But clearly 5G will enable that. So just parking lot your question and I'll talk to you right after.

Who else had a question on this side? Just keep going down. We'll go to this young man on the end. That would be you.

QUESTIONER: I'm Fred Altman, I'm retired. My question is you talk about the private and public sector, but the most effective part of the public sector are cities and states not the federal government, but this all best on a broad basis. How do you handle that problem?

DR. TURNER LEE: Okay. Anybody over here?

MR. LOPEZ: This is what we're grappling with right now. We have a federal government which is suffering from -- well, the word we used to use is gridlock. We can use all sorts of other words these days. The state and local governments are much more effective, they have a lot of different possibilities for experimentation, they're much closer. But that raises the issues of non-homogeneity of regulations across the country. And, once again, if you go to Europe, Europe looks longingly at the U.S. single market as being very power. So it's a really great question that we're kind of grappling with and that's another question of governance that we could go on all day.

DR. TURNER LEE: I know these are great questions. Dirk? Let's get the mic to you because we are recording this.

QUESTIONER: Quickly, you had mentioned just in your remarks how we've gone from 1G, 2G, et cetera, et cetera. And for those of us going way back, we've always been promised here's -- technology is going to be the next big thing. How do we ensure that this time it's going to be different? I mean Mr. Cravins had mentioned intentionality, but I've heard -- and those of who consult for a living, we have message points about the promise, but how do we ensure that communities of color, rural communities, disability communities, et cetera, are not left out this time?

DR. TURNER LEE: Anybody? Don, you kind of preached this word.

MR. CRAVINS: Rules, fairness. You know, we talked about the legislature, the states. I'm a former legislator and I struggle with this. African Americans, when things have been left up to the states, we've not always got the best deal in every state in America. And so I get nervous about every state being able to make the promise and keep the promise. So I get nervous about that. Maybe it's better to have some federal standard. But, at the same time, as a former legislator I understand, I knew my people, and the needs of my people better than somebody here in Washington, DC, was the argument I made. I got elected three times. But I worry about that. I think it's going to take governments working together at all levels.

And I didn't get a chance to say this, doc, earlier and I'm going say this, governments can't look at this as the next windfall to build the next football stadium or to pay its bills. Governments are going to make money from the expansion of this 5G through the permitting and the licensing and will. But if governments don't see this, as you said, as a holistic thing, as this is a necessity for its constituents, and they see this more as a windfall for the budget, then we've got trouble. And that's what I think any government, federal government, state government, local government, they need to really, really be strategic in how they look at that and making sure they're not looking at it as just a way to pay some bills.

DR. TURNER LEE: Right. And I just want to add on that, Dirk, this is not -- and I want anybody who is watching this here and watching it on line or following the Twitter feed -- this paper is not about a 5G set aside. I want to be really clear because there will be some troll that will come up and say that to me. This is about certainty in rules, consistency in investment, cooperation between public and private sectors, as well as cooperation with the states. This is no way pushing somebody aside from the process. As it's been mentioned with previous technologies, that coordination has been there in the past and we're actually looking forward to that happening in the future.

And I go back again on what I said earlier, the train has left the station. So at this point we know that there are already experiments being done by various companies on this. We need to make sure that that's a consistent roll out by -- again, I think somebody said getting ourselves out of the way so we can get this done.

At the end of the day, you know, I talk to state officials all the time and people who represent them, there's no pinky promise that this is actually going to be a good thing. But what we do know is that if you live in a community where you do not have access to ubiquitous coverage, you will be left behind in some way because your kid is not going to come back with an iPad or a laptop, they're going to come back with a backpack with a book in it. And that's really the implication in my paper. Like we cannot continue to have that happen because it furthers disadvantage among various communities.

Okay, let me bounce back. How long was your hand up back there?

QUESTIONER: About a week.

DR. TURNER LEE: Okay. (Laughter) I'm starting to feel like a referee. I don't know how many people watch football, but you're starting to make me feel like those state referees. I don't want make a bad call here.

MR. SOM-PIMPONG: As a former football player, I appreciate you. My name is Kwame Som-Pimpong with Deloitte. Great conversation. I'm wondering if we could finish the barbell. We've talked about kind of getting access, we've talked about kind of supplier diversity. I'm wondering kind of who are the hidden figures who are building the technology who are of color, what's the ecosystem to connect them to that access? Like are there innovative ways that we can think about -- you know, federal agencies right now are not really using their innovation funds to fund kind of venture capital backed companies. Are there opportunities there? Who are those people?

DR. TURNER LEE: You just gave me an idea for paper number two.

MR. CRAVINS: That's what I was going to say. And, Dr. Lee, that's exactly what need next. And those are the questions the Urban League is asking. When we go to

those closed door meetings with our friends in the private industry, those are the questions I'm asking.

DR. TURNER LEE: That's right, that's right.

MR. CRAVINS: Look, we love this. This is great that you're going to roll out 5G and you've told us about all the great benefits it's going to be for our community. How many black and brown people are actually in the workshop with you, how many small businesses are actually getting an opportunity to grow? And so those are the questions we're asking and we're hoping to get good answers. That's why government has to ask those questions too.

But that would be a great paper, Dr. Lee.

DR. TURNER LEE: Yeah, it is. I've just got to look for some funding to actually write it. (Laughter)

Okay, I want to close out with these two questions here. I'm going to have to close out those questions here. And I know this gentleman had his hand up. Makes me feel so bad, I'm so diplomatic. Let me see what you have to say.

QUESTIONER: Exceptional presentations. I'm president of the MIT Club of Washington and am an engineer. I am particularly concerned in listening to everything about the urban-rural divide, particularly with the range of 5G. And that urban-rural divide is a big cause of a lot of our political problems. And how is that being addressed?

MR. BRAKE: So this is a big issue. So as we talked about, there is something of a distinction between the really small, dense network of the millimeter wave 5G. You can get a lot of the same capabilities, the adaptability, the flexibility, on lower spectrum, lower frequency spectrum. And so I'm hoping that we'll see eventually 5G rolled out on existing -- T-Mobile is already deploying on their 600 megahertz frequency, for example. And I assume with time a lot of the LTE will be re-farmed into lower bands.

At the same time, the sort of real small cell dense stuff, it only really is necessary where there's a tremendous demand for data, where you have hundreds of users

in a single cell that all want to stream video. And so it's a different profile. The small cell dense stuff is really necessary in the urban areas and rural areas will get the same adaptability, the flexibility to bring these services.

And so it's a hot topic. And I'm more of a sort of a wait and see how serious the problem is. I'm hopeful that with a lot of the low band spectrum being used that we won't see quite as dramatic a divide as people fear.

DR. TURNER LEE: And I would say on that -- and I was really deliberate about not really discussing the rural divide, because I do think that there's a different solution that may be complementary to 5G or may be totally different than 5G.

I do agree with Doug that some of the lower bands will actually propagate better. When we talk about small cell technology, again, if you're looking at pastures and cow farms, a place I'm actually going to visit later this afternoon, you know, it may be harder to do small cell deployment. The jury is still out. But there is still promise. I mean I want people to also hear in my visits with my book, there's wireless access in rural America too. Because there is also this assumption there's no wireless access. We just have a harder time propagating those networks. But I agree with you, some of the lower bands may actually work better.

MR. BRAKE: I just want to mention the FCC subsidy program for the mobility fund to help get money to where it's not economical for private providers to deploy in high cost rural areas, that has to continue. We'll continue to pour money into those.

DR. TURNER LEE: That has to continue. That's my third panel, fourth paper on that.

Last question, absolute question. If you'll keep it brief and then we will wrap up and thank our panelists.

QUESTIONER: My question is about the government. So at the local level currently there's been some opposition from the government because if you put small cells on every tower it's going to drastically increase the amount of radiation because right now

it's just limited to cell towers. So if we do input these small cells on all these polls in these areas, is it possible that radiation could adversely affect all communities, including communities of color, and how can we ameliorate this and handle the economic impact of this?

MR. LOPEZ: So, I don't know, I'm not a medical scientist or anything like that, and there's a lot of sort of conflicting research out there. My general understanding is that the health risks related to wireless are minimal, if any at all, or certainly negligible as compared to say sunlight or something like that. And the real risk is not from radiation as we typically think about it, it's from the power level of the equipment itself. For example, a microwave, which operates at a much higher power than most of the wireless equipment that we have around town, you wouldn't want to stick your head in a microwave, it's just not a good idea. At the same time, you don't want to live like right up against a giant broadcast tower. But as you get smaller devices, lower power, the risk really, really drops off. It's the risk of burning yourself from the energy used by these devices.

And so this transition to 5G, moving to more smaller cells, that's a drop in power. And so, if anything, the risk gets lower. It's a little counterintuitive in that there's more, but it's a lower power. And so the actual medical science indicates it would be a much lower risk.

DR. TURNER LEE: And since I'm definitely not a medical doctor, like I said, I'm not an engineer, I won't be writing about that. But I think also one of the things that people should also realize with small cell deployment, small cells are actually being positioned against existing boxes that actually exist around utilities, et cetera. So this is actually happening as we speak in terms of placement. It's just, again, servicing this next generation mobile wireless.

On that note, I want to say thank you to our panelists. Can we give them a round of applause for attending? (Applause) I want to say thank you to all of you. I am always humbled by both the people that decide to come spend an hour with me and those of

you that come from there. Keep following us at Brookings at the Center for Technology Innovation, follow the conversation on Twitter, and enjoy the rest of your day.

* * * * *

CERTIFICATE OF NOTARY PUBLIC

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

Carleton J. Anderson, III

(Signature and Seal on File)

Notary Public in and for the Commonwealth of Virginia

Commission No. 351998

Expires: November 30, 2020