FCC "LEARN" Workshop
November 8th, 2013

1st PANEL

Julius: Good morning. We are about to get started. If we could have everybody please take their seats. So, good morning and welcome to FCC's Learn Everything About Reverse-Auction Now or LEARN Program to discuss unlicensed spectrum issues related to broadcast television incentive auction. This morning's workshop will focus on the benefits and uses of unlicensed spectrum in the existing and future television bands, white spaces and in the guard bands of the 600 MHZ following the upcoming incentive auction as well as technical questions associated with the proposed unlicensed operations. To kick off today's workshop, we're going to do it with a bang. We are going to have introductory remarks from our new chairman, Tom Wheeler who is participating in his very first FCC workshop as chair of the FCC. And just like the Beatles concerts, you can all say you were there. I wanted to congratulate Chairman Tom Wheeler, not on the chairmanship but that he has survived his first week. Survived is not the right word because he has really hit the ball out of the park. It is my great privilege and honor to introduce the Chairman of the FCC, Tom Wheeler.

Tom: Thank you, Julius. The Beatles, Let It Be. That's how we should be doing this. Not only is it my first meeting, this is the first time everybody on this side of the DS – It's kind of nice up here. Thank you all for participating, and Julius Knapp, what a national treasure Julius is. So, I'm going to let you in on a little secret that heretofore has just been between Julius and me, but everybody deserves to know and that is that early on in this process, while I was waiting to be confirmed and thinking about how we would get things done at the Commission, I realized that Julius was a national asset and that I better call Julius and make sure he was sticking around. And so, I guess it's a true story, right?

So, I called Julius and said "You are going to stick around, right?" and he assured me that he was. And that makes the whole process much more achievable. So, bless you Julius. And Gary Epstein isn't here, you will see Gary in the process as well. He has the unenviable task leading the auction task force and just how in the world do we pull off an incentive auction, a two-sided auctions with real-time re-banding in the process, something that has never been tried in the world. But we are going to pull it off. And I am extremely mindful of the fact that the leadership of the chairman Genachowski, the leader ship of chairwoman Clyburn, the work of the task force and the staff of the FCC that have brought us to this point. The conduct of a successful auction is a top priority. And let me underline the term successful auction. We have been running it, and I can assure you we will continue to run it.

We will open a transparent process which this is a key component. It is interesting, they gave me some talking points today and I wanted to make sure I covered today and one of them was to make a reference to this blog that I had earlier in this week – It's always fascinating to see what

people draw out of what you had said previously. So the text that was written says “I wrote two things worth repeating.” Now, that always makes you feel really good, ok. That the people who were writing your stuff think you said something worth repeating and that’s ok. And they want you to repeat it. I hope there were more than two, but I do believe in a couple of things. One, the reason we run an open and transparent process is there is no such thing as a good surprise. It is the golden rule. And the second, and I think the one that resonates the most or I hope that resonates the most, is that not all wisdom resides on the eighth floor and I can guarantee you it does not reside in the corner office of the chairman. That is why what you are doing here is so vital and so important. Let me talk a little bit about unlicensed. I’ve had a little experience with spectrum auctions over the years from a different vantage point. But I know how claims are made and counter claims are made and if you don’t do it my way, it is the end of civilization as we know it. And you are for this industry or against this industry and how everything gets posited.

And I want to be really clear that what we are is we are pro-America. We are pro- How do you use spectrum most efficiently for the common good of this nation to drive the economic growth and to make sure that we maintain world leadership in the application of spectrum delivered services. There are going to be tensions between broadcast and mobile. There are going to be tensions between mobile and licensed and unlicensed. And our job consistent with the spectrum act is to continue America’s leadership in the spectrum world. And it is a process full of give and take. It is a process full of challenges, but it is also a process that is not as extreme and consequences one way or another as sometimes the “my way” or the end of the world presentations are. But let me clear about one thing, and that is unlicensed spectrum has been and must continue to be the catalyst for innovation. And therefore, we must make sure that unlicensed spectrum is a key part of whatever set of decisions that we make. I remember when the discussions of unlicensed spectrum were all about garage door openers. I remember a telephone call I got one point in time saying that they were going to name a new licensed capability after a Nordic king by the name of Bluetooth. And I have seen how far we have come with unlicensed, RFID, Wi-Fi, Bluetooth, etc.

We are not going to stop that path. Unlicensed has not been only a key to innovation, not only a key to making wireless something manifest to consumers in their daily life in a very easy way through a Wi-Fi or through your Bluetooth headset or the case may be, but it has also been a great enabler of the licensed services and the ability to offload services from the licensed. So, I have no doubt that the things that are going to from unlicensed future services are as unimaginable as being named for a Nordic king Bluetooth. And we are going to mature – make sure that the opportunity exists in how we make our spectrum decisions to see that pathway exists to build that future. You will deal with some tough issues today. You are going to help us work our way through this process and we are really grateful to you for the investment of the time and effort that you have put into this and I look forward to learning about the results of this workshop. Thank you all for coming. We look forward to the results and I will turn it back over to your host, is to Julius Knapp.

Julius: One thing has not changed, I still have a tough act to follow. I would be remiss if I thought about the workshop and not mentioning someone probably only a few of you knew, his name was Herman Garlin. Herman Garlin, when I first came to work at the FCC he was my first boss. He really invented the unlicensed rules. When the act was first written, it included a provision that says everything that has to be licensed. And one of the first products at the time they encountered was something called a oscillator, a device to transmit from a photograph and some of you may have read about those in history and a radio, an AM radio. Everybody knew it did not make any sense to license these things individually so they scratched their head and believe it or not it took a few years and they came up with the idea that these are operating and what the engineers called the near field. That is the magnificent field and that is not radio so, therefore we did not have to license them. And out of that seed grew all of these wondrous products that Chairman Wheeler had mentioned. So, what we will be talking about today is how we maintain that legacy of innovation and services that have been introduced under the licensed rules. I thought I would take just a few minutes to set the stage for the discussions we are going to have today. I know many of you in the room are familiar with this, but I thought it would be good for everybody to have the same understanding.

The FCC in 2010 finalized rules to allow for operation of low power devices in the so-called white spaces. These are the parts of the spectrum that may not be used in any given location for TV broadcasting. Which is not to say there were not other uses in the spaces, but in most locations, there were parts of the spectrum that were not actually being used. So, the rules were based on a very novel approach where the devices have to access a database of protected services and the database for all the services of TV broadcasting, translators, cable head ends, and so forth. The devices would list where they are located and get back a list of spectrum that was available at the spot. The devices were not permitted to operate on channel 37. Channel 37 is actually not used for TV broadcasting; it's allocated for radio astronomy. And it's extremely allocated and used for wireless medical telemetry. Believe it or not even to medical wireless telemetry had grown out of the unlicensed space.

Medical telemetry was operating on channel 7-13. They did not use database technology and when the first DTV station went on the air we had collision and that's why we moved it to channel 37. There were also provisions for coexistence with wireless microphones. They had two features. First of all, there were two channels that were left available at any given location where the white space devices would not operate generally on either side of channel 37. In addition to that, we provided for registration of wireless microphones for not the exact term, but for major events like sporting events, theaters, where they used many more wireless microphones than can be accommodated in just two channels. So since then, we approved the first devices. We have approved the databases for Spectrum Bridge which is now I connect of and Google and we have databases from telecom, key bridge, and concert is moving through the process so there's been a lot of interest in this and not to get off on a tangent, but we but we have also looked to build upon that idea because this was recommendations from the president council for science and technology with a proposal we have outstanding at 3.5 gigahertz. For licensed service that has many features of the database but more sophisticated then what we have in the TV white spaces.

So the FCC issued a notice of proposed rulemaking on the broadcast television incentive auction in late September of 2012. And relative to unlicensed, the NPRM sought to provide substantial spectrum for unlicensed on a nationwide basis so under the rules we have in place, there are spots where there may be little or no spectrum for unlicensed because for example, in in downtown New York, there are so many operations there really is not much white space to speak of plus if you look at the theater district, when the theaters light up, there really is not much space, if any left. What we try to do in the proposal is provide spectrum nationwide that would assure that wherever you are, the devices could operate.
We would have continued to allow the unlicensed operation of unlicensed channel and the repacked television broadcast vans we issued some proposals that we have received pretty extensive comment on and I'm sure you will be discussing today. These include things consistent with the legislation which discussed permitting unlicensed use and guard bands. We talked about guard bands in the proposal 6 megahertz. There's been a lot of discussion on the size of those and what they should be. We also invited comment and allowing unlicensed use in channel 37 which exclusion zones to protect wireless telemetry and we asked whether we should permit operation in what had previously been the reserve channels.

So, our first panel this morning is going to discuss the benefits and uses of unlicensed. You will hear from people who have been working on deployment of devices and services. It may seem like a long time since the rules were adopted but actually in the overall scheme of things I try to remind people that it takes time to develop products and services and deploy them. Nothing happens overnight. We hear about that in the first panel. Second panel, we will focus a bit more on the technical questions associated with the proposal. So with that I would like to introduce Alan Stillwell and Geraldine Matise from the Office of Engineering and Technology and invite the panel to come up and get started.

Alan: Good morning everyone. My name is Alan Stillwell as Julius indicated and this Geraldine Matise, co-moderators of panel one. On this panel we will talk about the benefits and uses of white space devices if the TV bands. Not just white space but unlicensed device in the TV band. We will look at the spectrum that will be used for white space after the spectrum auction and the bands remaining for use by television and also the guard band and duplex spectrum that is recovered after the auction. I just want to begin the panel with a little bit of additional background information. Julius provided some on this. Of course, as Julius indicated, unlicensed devices are just an increasingly important part of our everyday life and they are growing. I think the two things you could say about unlicensed devices for sure is that they've grown tremendously and they are still growing. And this growth is really attributed to the success of Wi-Fi and also to some extent Bluetooth.

We also think about Wi-Fi as just a link – a link that provides internet connectivity around homes and offices but it's more than that. For example, many cameras now have a Wi-Fi capability that you can use to download pictures to your computer. So it is a lot more than internet. No internet involved there it is just camera to computer to device to device. So there will be a lot more of

these kinds of applications developing. And with all of these applications, there is just more need for spectrum from unlicensed devices. We here at the Commission have been working very hard over the last few years to find places for white spaces to operate and one of these is the UHF and VHF spectrum in the TV bands. As Julius indicated, many locations there are channels that are not used for various reasons. If you plot the service areas of all of the licensed transmitters in the TV bands on a map and color them in, the spectrum or the area, the geographic areas that remain are white. So a few years ago, we observed that this white space spectrum, that's why we call it that, could used for unlicensed devices without causing harmful interference to any licensed services and that this spectrum could actually facilitate a lot of new applications and uses. This is because the UHF and VHF spectrum have different propagation characteristics and the higher bands.

These differences mainly have to do with longer range and better building penetration. So than a couple of years ago we adopted rules to allow operation in the unlicensed bands and to operate the unlicensed device first contact one of the whitespace databases Julius talked about and gives the databases geographic coordinates than the database returns a list of channels that are available for operation at that location and the white space devices only allow it to operate on those channels. This is how we prevent interference to the licensed services. The trick of the databases is that they have to be able to determine what channels are available at any given geographic area and even within a major market or submarket, channels vary from place to place. Here at the FCC, we have one list of channels. Over at the capitol, there's a different list of channels. We now have a number of devices that we have approved and white spaces beginning to move forward.

There are a number of organizations that are working on projects to exploit unlicensed resources. And then, after the auction, as I said, we will have unused spectrum in the duplex gap between the wireless bands and will be between the TV services and the wireless services. We anticipate making those vans also available for unlicensed use. So we are looking really for a great future with new white space devices or new unlicensed devices and that TV spectrum and so to kick off our discussion about that Jerry is going to introduce our panelists and then I will talk with the first part of our panel. I want to say a few administrative things before we actually get going. One is that – this workshop is being broadcast live on the internet. You can access that at FCC.gov/live. So view it right now on the internet that way. And after the workshop, you can also see a replay or you can view it on FCC.gov/events and look for this particular workshop. Also at the end of our main panel discussion if there is time, we will accept questions from the audience. Cecilia might have no card she will pass around. What is your name? Kilo will have note card she will pass around and we will take live questions from people on the internet and the e-mail address is livequestions@fcc.gov for those participating online. Now we will begin our panel. Sorry. Introductions.

Geraldine: I would like to introduce our panelists today. Starting with Dr. Andrew Afflerbach he is the Director of Engineering and Technology and specializes in system level planning and implementation of wide area and local area telecommunication networks. He is currently

developing the design for TV white space broadband networks for underserved and unserved areas in Garret County, Maryland. Next to him is Elizabeth Bowles she is President and Chairman of the Board of Aristotle Eight and the immediate past president of the Wireless Internet Service Providers Association which is a trade association which represents the wireless industry and currently the legislative chair. Next to her is Jim Carlson Chief Executive Officer and Chief Technical officer for Carlson Wireless which develops, builds, and markets wireless telecommunication services. They are focused on demonstrating spectrum sharing technologies. Next we have Harold Feld who Senior Vice President for Public Knowledge and advocates for the public interest in media telecommunication and technology policy.

Paul Garnett is Director of Microsoft Technology Policy Group where he focuses on promoting affordable broadband access. Paul and his team work with governments, research institutions, companies around the world to focused or new wireless technology business models that reduce the cost of wireless bandwidth and enable billions of people to get online more easily. Next is Joanne Hovis AM President of CTC which is the telecommunication consulting firm that supports public sector clients in the area of business consulting, strategic planning and market assessment. Joanne also serves on the Advisory Group of the Gigabit Libraries Network which is a pilot program to extend access to library Wi-Fi over a wide area using TV white space spectrum.

Next is Robert Rucker who is Vice President of Operations and Technology for United May Grow College Fund where he is responsible for overseeing governance of internal audit compliance and technology. They are one of the higher education partners which is a consortium working to expand broadband access to undeserved higher education campuses and their communities using TV white space spectrum. Next is Peter Stanforth, cofounder of Spectrum Bridge. Spectrum Bridge developed the first TV white space database that the approved and was deployed in North Carolina in January 2012. And last, but certainly not the least is Dr. Nicol Turner-Lee who is Vice President and Chief Research and Policy Officer for Telecommunications Counsel which is a national not for profit organization that is dedicated to promoting and preserving equal opportunities, minority ownership in civil rights and mass media telecommunications and broadband industries. She is a member of the FCC's Federal Advisory Committee on Diversity in the Digital Age where she chairs the subcommittee on use of unlicensed devices to increase the Moretti entrepreneurship – minority entrepreneurship. We welcome you all. Thank you for participating.

Alan: Now we will get into the meat of our discussion and we will begin with a section where we will talk about what the capabilities of unlicensed devices are in the TV bands. So I think we will probably address a lot of this to Peter, Jim and Paul. But other folks on the panel are also welcomed and encouraged to participate. The questions we want to look into are the types of equipment that are currently available, what types of applications could be deployed, for example, in broadband video, machine to machine or whatever. And how much is available and needed for different types of applications. So maybe Jim, if you could kind of begin and give us

a picture of what kind of equipment is available and what technical applications are being deployed. Maybe Peter and Paul you could pitch in.
Peter: Thank you, Alan. What we have seen evolve in the last 3-4 years or so is people specializing in looking at markets of machine to machine, whether this is the agriculture business or narrowband telemetry type communication between oil and gas and so forth.

We've seen projects that have evolved specializing in that and products specializing in rural broadband type or community wireless where you are looking for coverage as your major commodity rather necessarily then range. It's been proven in some of the tests that Microsoft did early on, the coverage capabilities of using the UHF and VHF frequency bands were approximately 3-5 times greater than the microwave bands that had been used in the past. We have this big advantage what I call High-Quality Spectrum Availability and the Sub-Gigahertz Areas. So sort of stepping into products as Alan had mentioned, there are a couple of manufacturers kind of focused on top performance in coverage, us being involved with that and others. A couple of companies are focused on the oil and gas telemetry and performance were range, not the demanding bandwidth and we have TTS and a few others there.

Alan: Good.

Paul: Microsoft is involved in a lot of different projects around the world on this. Kind of I would say a unique job in that I get to go around the world and talk operator partners and set up pilot projects in all kinds of locations.

Alan: That's pretty awesome and exciting.

Paul: It's great. We've done in on four continents. We have projects life right now in Africa and Asia. Three projects in Africa right now Kenya South Africa and actually Mr. Rucker, you are talking and I was thinking to myself, I actually have project right now with a college in South Africa and I'm wondering if there is a way for us to do a little tight up with one of the projects going on here in the U.S. And the projects, there in Africa, 2 in Asia, one in Singapore and the other in the Philippines, always in partnership with the network operator and with government and various other innovators and markets. We have done projects that really run the gambit in terms of application and churches – services delivered. In Tanzania, it is urban. University campuses and we are working with a partner there to deploy some networks in downtown and that will present its only host of challenges.

The spectral environment in urban marketing in Africa is not the same as it is in the U.S. There are interesting things we will learn from that. In Singapore, you are talking about probably a connected place on the planet and one would wonder, if they have all this conductivity, why would they want white space. After all they have gigabit connectivity at the home and the like. Nonetheless, they still want more ubiquitous, more available and cheaper bandwidth and there we are focused on a whole bunch of smart city type applications as well as broadband connectivity. The project involved 18 company's most of which are Singapore who are now

manufacturing radios. So I think from an application perspective, from a device perspective, the chairman said it earlier, as did Julius, really the sky is the limit. I think we should expect the unexpected from this just like we have experienced with the other bands and technologies.

Alan: What kind of speeds are you seeing on these different links that you are working with?

Paul: Of course, that always depends in terms of the server sure you are trying to deliver but if you look at what you're getting from a channel, in Kenya, we have the network set up there in a very rural area and get a ton Columbus or range off the space. Small base station, cheap, 30,000-dollar total basically for the materials for the base station, solar powered. And at the end of those connections basically 10 kilometers away at schools that we are now serving we get 15 megabits a second. And also, with low latency so someone could be at that school and Skype video no problem. We've done it. We've shown this is different events. In fact, the FCC wants to get on a Skype call with someone in Kenya and at some time on whitespace I'm happy to arrange that.

Alan: Earlier you had some nifty gadgets and you have some things to offer on this one.

Peter: What we do today is scratching he tip of the iceberg as it were on the service and there's a lot of focus on last mile broadband and it's elegant and appropriate I want to talk about a couple of different applications that have gotten a lot of traction since the rules became here. The first is the agriculture business is generally in farms and fields and in farms and fields there's no cellular coverage because there are not many cows that have cell phones. The other problem is they live in environments where obviously they talk about growing crops or harvesting them, orange groves or whatever so the microwave so too well. It's the issue Jim brought of about the range. So white space is well-suited to serving agriculture and so far we have seen two very specific, very useful and economically viable applications.

The first is really what I call monitoring controls. This is soil sensors in the field, sometimes tracking animals or actually controlling the big watering wheels that go around in quarter-mile circles. And the economics are very compelling. The cost of linking a pivot to a central control and management system can be offset if they either save or water one or two days more or less in a given year. They can get their payback very quickly on those. The other is a more automated farming application where now you are finding that the vehicles around the farm are driving themselves and they go out and there is a harvester and a loader and all sorts of things and they chat to each other as they roam around in the field next to each other using short-range technology like Bluetooth and Wi-Fi. But, a mile or two away the farmer wants to know what the vehicles are doing for safety and management, what they do is they use whitespace as ability will because it goes through the trees and over the hill.

When you look at the cost of equipment, tractors these days two or $300,000, harvester 700,000 a few thousand dollars for whitespace link is something they can get back. It's all about the fact that these things will run 24 sevenths and – 24/7 so the planting season is elongated and the harvesting season is evil on gate at the, you get more crops in and out of the ground. For a lot of

reasons they become economically viable. The other is these are whitespace devices and I actually bought these off Amazon for 20 bucks a piece. It's slightly different application. One that radio is a low power transmitter broadcaster that is designed for digital content distribution. The initial thought it was for putting into big box stores or you could put a TV ad and I'll or next to a checkout and from some location in the back put content, advertising or whatever. But when you start to look at this which goes in to translate my iPad, into a white space device, I can now stream content to this and it could be live video but because it is using digital transmission capabilities, IP it could be a textbook to a kid or a training manual to a policeman or a fireman. That opens up all sorts of possibilities. This is my iPad version. They are very simple and cheap. The reason they are so cheap is they use existing technology so they are reusing technology in the new unlicensed way. In these cases they are simply receivers. It is a broadcast, but it opens up all sorts of interesting new applications. Distribute in content to all the people in a stadium watching a game where they plug something in.

Alan: I could see this in schools, college classrooms where you get the notes from the instructor at the beginning of the lecture and you pay attention to what they say.

Peter: It comes back to something again that Chairman Wheeler said, cellular type technology licensed is very deficient in certain things, but in some cases, broadcast is by far the most efficient way of delivering something to people and others in the unlicensed in the agricultural world. So I think we have to find ways for them to coexist and use whichever is the best and most appropriate for what we are doing.

Alan: One last a little point in this area is how do you all see kind of the white space e-space developing? How do we go forward will it go forward around the world, here in the U.S.? It's like prognostication where you put your futures hat on. I've heard a lot of really interesting applications and some I was not aware of myself and this is exciting stuff.

Paul: The ecosystem is developing. There are companies out there who have radios and plenty of evidence of that here. In terms of the broader ecosystem it's great progress made around the standards with Wi-Fi and machine to machine standardization. But to be quite honest with you, it has been a bit of an issue and part of the issue really is around the regulatory changes, sort of apropos to this event. The fact is there are big companies who are sitting on the sidelines because they don't really see the regulatory certainty they need in order to move forward with the investment. So companies are doing it and they are willing to take the additional risk involved but there are many more that frankly have slowed it down because of what is happening in DC and other regulators around the world.

Alan: I'm hoping we can get that stuff straightened out soon. All of us here understand some of that and we want to get that worked out so we can move forward.

Geraldine: Are there other factors that are significant for driving the ecosystem positively or negatively?

Paul: In my view it will really happen if the regulation – the picture round regulation becomes clearer and there is a sufficient amount of spectrum bellow 700 megahertz that is unlicensed on a nationwide basis.

Geraldine: What is a sufficient amount of spectrum?

Paul: It is always is more is better obviously and you are at the other end of that and people will ask for smudges they can get. The Wi-Fi alliance has taken the position that out of this process and within the framework given to you by congress, there should be at least the equivalent of 4 TV channels available in every market plus TV white space where that might exist bellow 600 MHZ or below where the spectrum has been reallocated and assigned. That seems like a reasonable approach.

Geraldine: For some of these applications, does the spectrum have to be contiguous or is research going on to use noncontiguous spectrum blocks?

Jim: Contiguous or not, the issue is pretty close to over. The product design has evolved to the point where you know, it does not need to be contiguous anymore to be able to aggregate bandwidth.

Paul: That said, there are efforts done around that's an option available standard, but at the same time, you can do a lot with one channel as well. We are seeing that. It really depends on the application if we're talking about moving a lot of data, for example, within buildings trying to get beyond a couple of walls and the technology similar this is a global product market developing and that's why we are engaged in governments around the world.

Peter: The radios we support here in the U.S. the same radios fundamentally the same around the world and the TV band is relatively harmonized and the biggest difference is some countries use 6 megahertz channels in some use eight, but to a radio guide like Jim, that's a trivial thing to solve as long as you are in the same band. So the proposed regulation is similar so most of the radio bands we work with in the U.S. are the same folks we work with in the U.S. and Singapore and all the places as well. And their expectation is this will be a global market, not just a U.S. market.

Alan: And international community and an international effort.

Paul: Julius Knapp a treasure, actually I was going to say international treasure. The pain of international traveling coming back from Singapore a few months back. This is a great story for Americans as unlicensed has been. And the policymaking and technical innovation that has happened in the U.S. around TV white space is will be looked at around the world. It is a model that we can replicate around the world. We have to get it right.

Geraldine: Jim, you have something to add? Some of the points you have all touched on really flow very much into some of the applications and projects that are going on right now here in the U.S. especially for broadband access and some of our panelists do quite well to three in particular the Gigabit Library Project and Garrett County a custody's because these represent essentially public access, educational access and rural access. And certainly when we are talking about TV white space is we've all made the points, it depends on exactly where you are in terms of how much spectrum you will have, but we know in some areas is limited and then quite other areas. I'd like to start with Joanne in terms of Gigabit Library. If you could explain to it what Gigabit Library Network is all about and why it's so important.

Joanne: The initiative is an effort – It is an effort of a number of parties in many manufactures and with libraries throughout the country. The idea here is that one of extraordinary successes of Wi-Fi has been free public Wi-Fi at public libraries throughout the country. It's been incredibly important way in which libraries and the communities they represent have managed to get internet access to people who either can't access it at home or can't afford to access it at home. We all know there's an extensive story with families during the hard times of the past few years so children can do homework and so on. It has been a major area of growth in services for libraries and an important part of community access to broadband. The idea behind using this new technology is to expand that library access. It is currently estimated that 80 million people access the internet at the library's and probably half are using a wireless Mac it doesn't using Wi-Fi to connect to the internet.

That is however still just a fraction of the number of libraries there are throughout the country particularly in rural areas where bandwidth is very difficult to come by or very costly. The idea here is that central library facilities will be available to share their bandwidth to remote facilities including mobile facilities such as book bands, for example, to enable new access to Wi-Fi at those locations so the new whitespace technology which is even now relatively affordable. A low very are given that it's unlicensed will enable the sharing of bandwidth from one facility to another and Wi-Fi at that facility will distribute that signal to users who need public access at their libraries. That is the central thought. The idea is in the pilot stage. The Gigabit Library's Network has gone through essentially an RFP process inviting libraries to apply and they are then able to trial equipment with some technical support and help to see how the technology is working as the first indications are outstanding. A lot of interest and strong preliminary success the hope we move onto second stage pilots in the next year.

Geraldine: We read there were actually 50 libraries that applied in the initial pilot and six have been chosen and distributed around the country, Colorado, Mississippi, Illinois, Kansas and New Hampshire.
Alan: How are you providing the service? Directly from whitespace device to a consumer device or white space device to a Wi-Fi device and distribute that way or you have a mix?

Joanne: Whitespace to Wi-Fi.

Alan: You provide to a halt.

Joanne: Exactly.

Geraldine: Of course, some of the other commenters made and the benefit of that is everybody has Wi-Fi. If you have a smartphone you have Wi-Fi, laptop or tablet you have Wi-Fi. There is not a need to buy special equipment in the white space spectrum is basically bridging the internet to the library. Broadcast that out to the branches so then converted to the Wi-Fi signal and access it that way.

Joanne: Exactly. Those branches may have more than a T-1 and in some cases they may not have a T-1 because they may not be affordable. Small rural libraries are under resourced as any institution and this is a means of getting the bandwidth that most of their users will have some way of accessing.

Geraldine: I think a similar instruction Robert is being used for AIR-U and the importance of trying to reach higher education facilities in particular, many of which are located in small towns and rural areas throughout the country.

Robert: Absolutely. We are focusing on the "so what" factor so all we have heard, there is a "so what" factor. What does that mean? What is the outcome? Undeserved communities historically have not had the same resources and access as the greater population. What they are focused on is looking at this opportunity to provide services through those institutions in those communities to serve the broader good of the communities they represent. Oftentimes, the schools in the undeserved communities have a greater role than just the educational factor. And there are oftentimes primary employers there is a larger role they play and being able to use that hub as an opportunity, if you will to, not only enhance the capability of the schools to be sustainable and produce the products that they produce which our next generation leaders, but also to impact them and the surrounding communities that has a cascading economic impact.

We've had a successful launch in Morgantown at the University of West Virginia. And we are looking at other opportunities in South Carolina. The "So what" factor is and endless opportunity to connect part of society that heretofore has been disconnected and that in to correct – intellectual capital has not been tapped. This is an opportunity to bring those communities into the 21st century, if you will in a way that's affordable and sustainable. The pilot at West Virginia has had a very good feedback and success and we are looking to be able to leverage that type of capability throughout these communities and bring them into the broader fabric, if you will. For the contributions they are able to make given the opportunity to have access.

Geraldine: I would like to talk about the Garrett County Project. Your company was very involved in doing the mapping of Garrett County, that western area and it's an interesting report available online. There is definitely broadband service throughout the state of Maryland but what happened to Southern Garrett County?

Andrew: It's an area that has a lot of great things going for it, but one thing we have found upon trying to address the issues you mentioned, the lack of service areas is that there is not a huge business case among current carriers for serving much of the county very well and cooperatively but in this area in the southern portion and then throughout, there is not this build out through the infrastructures that they have. We are looking at the white space technology starting off to do a pilot and to serve the 3,000 there is scattered DSL and mobile. And it is low income wooded mountainous type areas. This is driven by economic development that Garrett County Development of Economic Development is funding. With the Regional Council to serve 200 homes and business in these areas. Broadband is the number one goal right now of Garrett County Economic Development in this particular pilot is to help incubate home-based businesses so we have those would be things like crops, agriculture, light industry, so the county's capital investment will turn around the economic equation so operationally this will be a self-sustaining venture.

Again, this is something that would not be possible without the whitespace spectrum. We've examined the full range of existing wireless technologies, 3.6 gig and 2.4 gigahertz license and this is a way to pull this off with three base station locations, one of which incidentally is located on a ridge top alongside wind turbines at the intersection of the technologies and the counties all in one space. The specification is to support the use that we are seeing here we want to have a delivery mechanism that would have data caps and would provide services in the range and as Paul mentioned it's important as while an interactive ability and the individuals running these businesses to connect pretty much anywhere in the world as well as the individuals who live there to be able to get the resources they need from schools, the online textbooks and all the other things that are taken for granted in the more built up areas and the rest of Maryland would be available to these individuals in Garrett County.

Alan: I know the population is dense there and how many people are you serving from a given link?

Andrew: This is a last mile whitespace implementation and unfortunately the density is exactly enough so you can't use Wi-Fi to distribute beyond individual home or business for the most part so what is happening issue are delivering to a whitespace device into the extent there is Wi-Fi area or something like that just within the individual home or business.

Alan: So in other words, it could be a three or four homes or something like that. We're just a single home at a location. I've been out to that area and its lovely country, but not too many people there.

Andrew: The density is such that it will be very unusual to have more than one individual home per device.

Geraldine: We have one question and I would like to get this on the table. Jim, you have been involved in a deployment to the tribe in Northern California. Could you talk about that a little bit?

Jim: That is an area where we worked with a group back about three years ago in trying to find ways to get their river canyon and move sort of in a pattern to try to find a way to get signals to some of the homes that were along the canyon. There is lack of roads and some of the people are accessing it through the river or though kind of back hills and connections so there was not wired service at all. It needed to be wireless and we did not prove the white spaces frequencies were able to penetrate a lot better than 900 megahertz or other unlicensed services. The other issue they had was infrastructure variation and we were able to do this project with maybe three towers that were hidden in the trees versus nine towers that had to be exposed.

Geraldine: From all of these examples, it's obvious the usage of TV white space technology has tremendous benefit for educational uses, public access and economic development. I think that was Andrew's point. I would like to probe a bit more about what are the opportunities for the small business and women and minority owned businesses and what role besides the regulatory certainty can the FCC play in encouraging participation and what barriers existed for the wider to climb in here. Would you like to address that?

Nicol: Thank you for having me participate. This is a really interesting conversation so far being a person who has been chairing the FCC's digital diversity commission, I would like to put out there and I will talk about vulnerable communities from the standpoint of minority and low income communities where you do have interference of concrete old buildings and other not as open in terms of the space. Having a more balanced approach is something that should be inserted in this conversation because we need that. It applies to multiple technologies we talk about. In the case of minority owned businesses, not just business owners and honestly vulnerable consumers, there are a couple of things that we have found to be interesting in the FCC digital diversity community, which how in contributes to three areas one which has been discussed. Clearly white space and I see Michael here because I was on the panel a couple of years ago.

White space is a great opportunity that complements unlicensed spectrum use and in urban areas where there's not a lot of interference and unused channels that can be tapped into, it's a great way to access to the people. It's a lower barrier to entry for lower – low income or minority entrepreneurs that want to get into an eco system that we've not traditionally been able to break into which is the new internet of things. And all the devices approved by the FCC in terms of compliance and the once innovated, minority entrepreneurs are less than 1 percent of those innovators. For this type of economy we have to solve this problem and create that lower barrier of entry of Laos much like we are seeing with the libraries. It allows more people to play in this space and did not traditionally been able to do that. We did a non-empirical study where we asked minority entrepreneurs of they've ever heard of unlicensed spectrum and if they used it and majority said, no, they did not.

So I want to stress a lower barrier to entry helps with training and engage folks in that area. The other piece is communities of color that are disproportionally low income that it's economic development driver much like in rural communities so if we get channels open for people to leverage the whitespace or in some way combine it to a more balanced spectrum and policy approach, we see success. It will be critical not only are minority consumers that they use these to develop different types of business opportunity ventures in our community and we find ways to get more entrepreneurs involved in that ecosystem, but we find ways to connect small businesses to these neighborhoods in prior work I've done where we were leveraging simple community networks and Wi-Fi based networks, that meant a lot to the small insurance companies that we could not get access at that time and now we are much more ubiquitous to these communities but had challenges in ensuring they could import and export out data to run their business.

And the third thing is public interest. We all have a goal much like the FCC and Administration of connecting our public libraries and being able to use the whitespace to create and I like what you are talking about in terms of the technology to create more supercharged hotspots. Churches, community centers, park districts, schools that may not be able to benefit from funding, what we've seen internationally in terms of success model. Getting more devices that could be activated and energized in schools will be a big challenge and leveraging the whitespace of vulnerable population is really important as well. I don't think we have seen enough in the United States in terms of those types of projects. I will put that out there. We want to see more of that. [Off mic comment] we want to see more of that, 99 percent of our nation's libraries and school being connected. If we cannot get access in the classroom or we can't get access, we don't have a lot of Starbucks in community of color, so we need to create opportunities in other communities to bring other communities that access. We will still have the problems of residential home broadband adoption but if we create those supercharged hotspots through whitespace or unlicensed spectrum, we will much more value and we will see the social isolation that is somewhat of a barrier to these communities be broken. This is a great opportunity provided it is leveraged and calibrated in a way we can do it and coexist to lead us to better outcomes and broadband adoptions. I will put it out there.

Alan: That makes a lot of sense. Almost everybody has a smartphone these days and you go to a hotspot where ever it is so in these communities, it gives you social connectivity. That is terrific.

Geraldine: I think your comment was interesting about not knowing about unlicensed and it's interesting because ten years ago our office of strategic planning put out a white paper talking about unlicensed and it was interesting because of all the things and all of us encounter everyday use unlicensed spectrum and a lot of us are not aware of that. They don't realize that radio frequency is a certain device and even you have no idea what your system is operation on, you just know it works.

Nicol: I was going to say for consumers particularly for minority consumers, this whole process is behind the scenes that as seamless as it can be, people are not monitoring whether they are on a licensed brand or unlicensed brand or whitespace. They just want to know it works where ever they are. We have to create that community of color particularly when we are trying to bring public good applications to communities. So if we cannot find ways to ensure and I thin the Wall Street Journal article woke of people with parking lot in McDonald's and those are horror stories that we actually have to bring because of we are trying to create a 21st century competitive for worst and learning environment and sustainable communities we have to ensure we can leverage the technologies to create access.

Again that's, but we are seeing these projects that we discussed before that are important. I want to stress we have to put women and minority owned businesses in the say-so to your point when we did that survey. These experienced entrepreneurs and innovators that were constantly engaged in the next best application. Guys and women that had conversations with venture capitalist, but they did not know anything about how to action to get into the space and it's somewhat complicated if you are not and engineer. There are different programs we are pursuing of the subcommittee that could be helpful in raising awareness and education and this ecosystem is beyond garage door openers and baby monitors. It's actually providing a great portion of our economy. We have to ensure women and minority owned businesses are involved.

Geraldine: Elizabeth, you used lots of different frequency bands to reach different communities so could you speak to that point and also you told me before we started that you are a woman owned company rich – which is rare.

Elizabeth: I'm often the only girl in the room. We are a woman owned business, headquartered in Little Rock Arkansas and with trade association that represents the fixed wireless industry we use any available spectrum. They predominantly serve rural areas, predominantly without government funds and predominantly the un-served and under-served communities. My company operates in the city of Little Rock but most of our diplomats outside of the city in the delta and rural areas and from our perspective when we look at white space, it seems like this fantastic promising hope that will address some problems that we deal with on a day-to-day basis. We have a community in Arkansas historically Africa-American and also a bedroom community of Little Rock. Side-by-side you have these farm communities with a bedroom community in the city.

People go there and want to work from home. We serve that community with broadband since 2005 but there in an area of 250-300 homes that no spectrum is available to us can't reach. Licensed or unlicensed when we want to deploy our test of equipment that's where we deployed it and that's the test we are running because we look at whitespace giving us that opportunity. When you talk about women businesses, minority businesses and small businesses, all of that says rural to me. There's a lot of issues in the urban area but when I look at the spectrum in Arkansas, I have plenty of channels available. I need to be able to bond them and get the speeds my consumers expect and have usable spectrum. With that I can reach these people. All of the

businesses in the communities are small businesses and a lot of women owned businesses are run out of home.

Particularly in the delta you have experience with people who are quilters and only sell their projects if someone drives to the town like your county. When you get them on the internet they have an international market and you see the growth of industry and kids able to stay home in the small communities instead of having to move out and looking at the test that Carlson had done with some of the other things. We realized our infrastructure cost could be 1/3 by deploying TV white space which makes places more economically feasible. Places right now because of population density you can't make an economic case for them. Suddenly they become workable if TV white space is the usable spectrum for sufficient bandwidth. That's our perspective in and not optional about the spectrum. I would like to echo the need for balanced spectrum policy. I don't think there's a single answer. Rural is different than urban. You have to take that into account. What will work for me in Arkansas will not work in Manhattan and vice versa. That's important. It's important to balance between licensed and unlicensed and bear in mind after the auction is over, what is left over and the space we have at end of the day needs to be if not perfectly contiguous at least perfectly usable and I echo what Paul said. 30 megahertz at least in every market is our number. We think beyond that will not be particularly helpful. To the port residence that need us and call me every week.

Geraldine: You spoken on the availability of unlicensed spectrum's and making sure we unlicensed the space. Of Elizabeth comments are a perfect jumping off point for you.

Harold: The thing to keep in mind is, and I expect we will get into this more in the next panel is there are a lot of different ways to get to the right number that we are talking about. We don’t need OSHA obviously a big piece will be around the incentive auction band plan and what is left. And even within the IR, there's a lot of flexibility depending on how we play it. The first step really has to be I think for all of us in the ecosystem who are not either the purchasers of the incentive auction license of the full power broadcasters who will be subject to the repacking. To understand what we will need to cooperate with each other to create a set of usable space. Not just for the white spaces but also wireless microphones, work out with low power television guys. The military and the broadcasters have agreed to share spectrum in the broadcast auxiliary space by 2.1 in order to clear out more spectrum to auction down 1755. If the military can put radar that guards are security and vital operations next to wireless microphones and wireless microphones can live with that I think there is some space where some negotiation around here about how wireless microphones and TV white space can live together. The other critical points are this is kind of like shaking the change out of your coach in order to find what you need. But you can do it. We have ways to deal with the repacking. There are ways to deal with the guard bands and the duplex gap that I know people will discuss on the next panel.

There is a re-examination of some of the riles now that we are more familiar with the technology. It's important to remember the commission has revised the rules on basic Wi-Fi and unlicensed to expand the reach of basic Wi-Fi. We had Wi-Fi come out as Wi-Fi set of protocols in 1999 and in

2003, the FCC said the rules we have about power and transmission. If we take sector riced antennas and focus those beams you could effectively get more power and more reach. In a way that we never envisioned and now that we understand the technology we can play with that. We can look at some rules like the out of band emission limits and some of the factors in this context and say what can we tweak here or do over there that we will be comfortable with. What channels that we took off the table in an abundance of caution we can now start to put back on the able are going to give us that extra spectrum we need and the final point I want to pull all of that together is all of the things that we've talked about don't happen unless there is a broader ecosystem that makes these devices dirt cheap.

The recent unlicensed is so dirt cheap and this stuff has been so successful so far is because it's broadly available and it's broadly available and there a virtuous cycle. That also has to do with the ecosystem and how the licensed and unlicensed ecosystem enhance each other. I can remember ten years ago when we ere first talking about this and it was like religious war. Either it was all about making this fourth licensed and the unlicensed guys would dump noise into the system or if you were unlicensed, you believe was here and it was evils licensed guys creating artificial scarcity to be the monopolists and we realized spectrum is good and you need a lot of pathways to access it and you need to match the right used to the right type whether it's licensed unlicensed or TV white space versus other Wi-Fi bands. We need a lot of this stuff. Like any real ecosystem it's a lot of verity and diversity to be sustainable. It will not just be the big guys and little guys and nothing in between. I often say the problem is we can have a diverse system like the ocean that supports everything from Blue Whales down to Krill but if you let Blue whales design the ecology the only thing you have is Blue Whales and Krill and anything L. should throw in there is how does that get me more krill. We need to be open to these things and not simply have one industry segment or another ask. How does that give me more Krill.

Geraldine: That is interesting because sometimes when you are talking about what is the value of spectrum or what is the value of new service, with unlicensed it's not always so obvious. We are not auctioning the spectrum so we are not talking about how much money you are going to make. But it would be interesting, what is the difference, what is the impact to your competition? What is the value proposition?

Peter: I used to build radios and we would come up with some idea for a new application or service and then we would go tot Silicon Valley and say it's a great idea and we need $1 billion the say what you need a billion dollars and we say first, we have to buy spectrum. So when you have an unlicensed model I can say you can knock some zeros off that because all I need to do is build the device and it will scale. If I get an incredibly successful, actually then have the auction saying let me see if I need or can get access to licensed spectrum. But the whole idea of how to develop wireless technologies, if you don't have that sandbox if you like of unlicensed, it starts right at the very beginning even where Nicole was in terms of how do you do something. Is the entry point is giving you guys a billion dollars or so for spectrum before I can do anything. It's a nonstarter.

Paul: We have sponsored some economic studies on this as have others and to Herald point earlier. It is a complementary technology to license and just one data point from a paper you looked at the issue of what would happen if unlicensed access were not available for mobile operators. What impact would that have on the infrastructure problems? He's not the only one that has looked at this. There is a direct relationship between the ability to offload data for example. And a reduction in the total amount of cap ex a mobile operator has to devote to network deployment. That's one example. There definitely is – it can't be there's no economic value to this so there obviously is some and some measurements are done and the picture somewhat incomplete so far but that's an obvious one.

Elizabeth: I would like to say one thing to say to that point which is there have been studies that have tried to characterize the value of unlicensed spectrum's and I have seen numbers from 1700 what he $1 billion a year because you are talking about innovation. There's so much more within unlicensed spectrum and therefore, you enable small business and you are enabling companies that came out of nowhere. Ubiquity which is a multibillion dollar company exists because of unlicensed spectrum. They are headquartered in California and they have a 32-year-old, 35-year-old CEO and they would not exist and not of those jobs would exist except for the fact of unlicensed spectrum. I don't think that can be overlook. You have to have licensed and you do what's necessary but having the unlicensed space that's usable and open is what drives incredible innovation in this country and that drives the growth and business and economic development.

Alan: I want to comment that this whole concept and model here with white space is kind of new technology sharing. It is really dynamic spectrum access point and we have it here. We think this can go in other bands and the kind of work that you folks are doing is really kind of proofing this model for us. I don’t know if anybody wants to comment.

Elizabeth: I do. I want to say that I have used this whole exercise that you are going through at the FCC as an in norms is opportunity for you to do some substantial good for large parts of the country that up to now had difficulty getting broadband access. It represents and enormous opportunity and I'm grateful you are having this workshop and you are focused on it because it represents an awesome opportunity to help move the country forward economically to bring us a little more. He competitively speaking of the international basis from countries that are outflanking us quite effectively in broadband.

Robert: Also again, to tie in not only the economic growth but the social growth, having sections of the society disconnected has a tremendous cost to the country and closing that gap, if you will has a cascading impact if done in a sustainable fashion will have those selections of society begin to contribute. Further innovate. Not doing that is a tremendous cost. It puts us in certain cases in a noncompetitive environment and I do think that while there are economic considerations clearly to make that there is a social and social consideration that should be in parallel. It is a disservice to parts of the country to simply be in the dark. Some cases literally in the dark and information age where you are disconnected from information is really a detriment that is self cascading in the wrong direction. I do think the value proposition is they are. And as a country, it

is a social good that should be fully exercised give the opportunities. The value proposition is bare for any of the providers, any of the entities if you will that heretofore have not seen perhaps an economic return on investment sufficient to warrant looking at these communities but individually and in the aggregate it's an investment that needs to be made.

Nicol: I was just going to say I agree with what Robert actually said so I echo that. Looking at having sat next to Peter and looking at these innovative plug-ins over here that operate in whitespace there's also a case to be made for some trials or experiments with whitespace technology much like we see in libraries and underserved schools or churches or community centers. I think this type of technology as we are still trying to learn more about how the technology actually operates because to Robert's point, one of the things that we actually don't want to see in my prior work is we don't want to turn people onto have been turned off at some certain point. You don't want to set the exception that broadband will deliver all these great promises but the technology developed in these communities is not consistent and able to empower them to get to the next level of that transformation. Particularly if you are in more complex applications that will require addressing issues related to spectrum in the country. But I think these devices that you have here are interesting particularly when we are trying to bring more educational devices and tablets to the schools to maybe look at ways for the FCC to try those. The FCC has trialed several different projects, but to look at ways to bring in some of these devices to see if they work in the schools. Can we enable a community center look at a park district to provide access or become the second place for learning. And we take a workforce development center and engage them with theses devices to ensure that. Digital ecosystem has from PCs and keyboards and they have become much more dynamic. I would like to see something like that from the FCC that might take us further in what the power of this new whitespace technology will be as it has advanced over the past few years. And to make sure it's constantly able to deliver to the communities we are trying to engage.

Alan: I think we are kind of – [Off mic Comment]

Harold: A quick hit. One absolutely they TV white space itself and this technology which is the next generation – we talk about 4g LTE, this is essentially to cheat on licensed. It is the next step up that enables a whole universe of cognitive sharing and those ideas how to enhance efficiency are directly benefiting the licensed to clear space for licensing and will benefit the licensed community as they incorporate these technology for more efficient licensed use as well. The last point I want to make about this with regards to the social good conservation that people have been having is it is enormously empowering for communities to be able to do this themselves for people like Elizabeth, like Nicole who when I first met her, she was working on a project in Chicago by the old Sears Tower to use traditional Wi-Fi to bring connectivity to that community to not have to go on bended need to the big providers and say please take an interest in my community and be able to say forget that. I will do this myself. That is just a social good that cannot be valued in dollars but is absolutely critical to the spirit of this country.

Alan: Thank you Harold. As I said, we are kind of running out of time. I have one question and it's a short answer. How many whitespace radios have been authorized by the FCC? Right now we have five authorized. A number are in process. Jim also has a number of devices that he has developed in the experimental context and I anticipate at some point we will see authorizations in that area. We are getting plenty of new equipment going on. So I want to thank all of our panelists. This has been just a terrific discussion. I've learned a lot of things and I've worked in whitespace quite a lot I'll tell you that. So a round of applause. Thank you very much

Julius: We will have a short break and pick up at 11:15 A.M. And if we could have the second panelist come up and be ready to go at 11:15 A.M. Thanks.

2nd PANEL

Woman 1: Could we have people sit down to start the second panel please? We'll go ahead and get started with the second panel. The moderators for our second panel will be Julius Knapp the chief of our Office of Engineering technology and Ira Keltz who's the deputy there. Thank you.

Julius: Welcome back everybody. Our second panel is going to have little more of a technical focus and we have another great group of people that have been doing terrific things. Some are in this space already and part of this will be educational for people who may not really be familiar with the details of the current operations that are there and with that I will have Ira introduce the panel.

Ira: I want to thank everybody for being here. Our Audience, the panelists and we have a real good robust discussion. By way of introduction real quick and we will get this kicked off. We have a very distinguished panel sitting with me to my left is Michael Berkman who is a senior director for the consumer electronics association. We have Mark Brunner who is the senior deputy director of Global Brand Management and also currently President of the Audio Manufacturers Alliance and has been active working with the commission and internationally on some issues with related to wireless microphones. Michael Calabrese who's with the New America Foundation, a non-profit think tank here in DC and he has been developing and advocating policies promoting ubiquitous broadband activity more efficient spectrum use including for unlicensed devices in the TV white space devices very active.

Andrew Clegg who is a program director at the National Foundation for Electro-Magnetic Spectrum and responsible for spectrum for NFS services including radio astronomy which one of

the bands operate is on TV channel 37. Tom Dobrodsky who is a senior engineer adviser with a law firm which provides technical advice to many clients on wireless spectrum matter including many of the wireless carriers and Mark Gibson, director of business development for Calm Search. He has been leading their efforts working with the American Society for Healthcare Engineering and they're technical partners which also as we heard in the last panel operate on TV channel 37. Alan Norman, who is a member of Google's access strategy team as a principal, he has been very involved with Access initiatives including TV white space spectrum and helping develop Google's access strategies. Robert Seidel the VP of Engineering and Advance Development for CBS-TV Corp. And Haiyun Tang who is the CEO of Adapt Form. He cofounded the company and is considered my many experts a leading technologist in TV white space. With that –

Julius: A couple of quick reminders for the panelists. Be sure to speak into your microphones so you can be picked up for the webcast. For the audience, again the questions if time allows, we will have the availability of the notecards and by remote, send an e-mail to livequestions@fcc.gov. To kick this off, I though it would be helpful to talk, before areas to start with a little bit more about TV white space the products and the vision that we see there that we did not cover in the first panel. Learn a bit more about he wireless medical telemetry, also about the wireless microphones and radio astronomy. We will get to each of the areas no need to be concerned. I know there's a lot of other services in this space, but this is what we are covering here today. Maybe on the white space slide AL and anybody rings that you want to add to what we've heard in the earlier panel?

Haiyun: We are developing TV white space technology. We have a device certified by FCC and a few more devices coming down the pipeline. Overall, you can see more and more devices becoming available. On the database side, Google gets recently certified and there could be a lot more also coming. I think we will see a wave of TV white space devices and database become available in the coming months.

Julius: Anything to add about the range and the bandwidth and the data rates that that we talked about earlier?

Haiyun: Actually, we are working with IKE Are Soft on the Kenya project. Some data we see is somewhere to what Paul described. Over 16 megabits over 8 megahertz channel and depending on the terrain the obstacles you go anywhere between a few kilometers to ten kilometer range. And then of course, channel bonding contiguous and the total bandwidth will be multiplied based on how many channels you bind.

Julius: Alan, did you –

Alan N: I'd be happy to add a couple of points. First of all Paul had mentioned 802. That standard was just recently completed and will be published either late this year or early next year. It's very significant. What that means in Wi-Fi, you will be able to see not only operations

probably in a single piece of silicone, operation two, four and five and the ability to get the range extension or lower power you could get in the UHF band. So think about it. Two and a half time the range which translates to six X. of coverage or a fraction of the power. All of the things. So that significant. For that to happen however some of the issues we already discussed about having certainly, about how much spectrum available, does not have to be contiguous. Knowing what will be available nationwide is critical to get people to go ahead and build products.

Some of the applications you might see that we don't see now. Metro Wi-Fi has a challenge where you are going from a light pole and trying to get indoors. 15 DB in games you get just because of the propagation characteristics of the spectrum made that possible. We did a development in the Mountain View, California to understand what it takes to make WIFI work and what the challenges are is there's too much noise in 2.4. We see too many things and we were not able to get indoors so it was limited to outdoors on the streets. Another example is indoors low power. All sorts of applications and it's really the propagation again that make that possible. The third one is we are big supporters of last mile access. Indoor backhaul connecting devices in the home. This is not a replacement for the current uses of Wi-Fi but really a way to eliminate wires when you want to get from your basement to where maybe your cable modem is coming to where you might actually want to put your Wi-Fi access point for example… Those are other examples.

Michael B: An important point in mentioning the 802.11 AF standard. The development because I think as most folks noted, there are two very different flavors of unlicensed access to the TV band is fixed wireless which uses the 802.22 standard which is finalized so most of what we heard on the first panel was on fixed wireless that's happening in rural areas. We heard about deployment in West Virginia University and so on. But they are what you have is you are using white space really as long distance Ethernet. You are going white space to Wi-Fi and then rebroadcast Wi-Fi in a localized area. That is great although much more powerful will be the other flavor of unlicensed online which is for personable portable devices because when that is integrated into chipsets as Allan said, consumers will have a direct air interface with TV white space.

So if you broadcast conductivity. So for example, West Virginia University has fiber, has no other Wi-Fi to speak of, they could very cheaply broadcast in a huge sprawling campus with hills and trees. They could tomorrow. If they have base stations could blanket the campus and downtown area with direct conductivity for devices if we had that. But what that will take. In practical terms, the industry people is that you really need not only regular certainty that a substantial number of 6 megahertz blocks in every market in the nation including places like New York City and Los Angeles. While we acknowledge that the incentive auctions because of the auctions and the repacking will inevitably reduce the total amount of unlicensed access in the TV bands, the soldier lining of this proceeding is to ensure something on the order of 30 megahertz and every market nationwide because if you have that, if you have that substantial amount that's critical for developing the markets of national scope. And scale not only for chips

but for devices. Applicants and services that how Wi-Fi really boomed and that super Wi-Fi can do the same.
Julius: We will get into more of technical trade-offs between the different services in a minute but let's keep going down the line. On wireless medical telemetry, maybe you can educate us a bit about that. We did read all about of the comments but I thought everybody should want to hear it.

Mark B: [Off mic comment] Wireless medical telemetry services is established by the commission back in 2002-2001 and it is primarily for, not exclusively for connecting patients to monitoring primarily for heart monitoring but other parameters including blood oxygen and breathing and whatnot. Like I said it is licensed by rule so that the existence in a database is what gives one the ability to operate or the FCC clearance to operate and that database is maintained by the America Society for Healthcare Engineering. By verses of these devices being in that database a gives of the regulatory approval to operate. As Julius said in the beginning of the panel, it started out as an unlicensed service so to the extent that hospitals understand unlicensed, they understand it in that realm and others. The idea behind it was because this is well documented and interference situation that occurred with the TV station.

They were testing and channel 38 and it was interfering with telemetry system and that is known as the Baylor Incident. There will be a document he or something on Television. The bottom line is that necessitated the commission establishing spectrum for wireless telemetry services. What is it used for? Patients with varying degrees of acuity and everything from presenting an emergency room with trauma to critically ill or terminally ill patients be monitored with heart monitoring and the ICU or the CCU. There's even some applications for Neonatal care as well. So the use of runs the Gamut of just about anything from some type of patient illness throughout the hospital including critical care, Terminal care and even the end of life care. Did I miss anything?

Julius: Andy. Maybe about astronomy.

Andrew: This mysterious thing called astronomy. We use sensitive antennas and receivers to lessen he natural omissions what are typical cosmic sources and we do this to study astronomy and gather information about the origins of the universe and other interesting phenomenon. We typically conduct these operations from radio telescope sites that re fairly remote in this particular band we talk about TV channel 372 Radio Astronomy and we make use of that allocation at approximately 13 sites across the country and I say approximately because it sort of depends on what the definition is. Some sites are actively observing and some sites are equipped to observe and the receiver is not literally on the telescope at all times. Other observatories are planning to observe and other things. But approximately 13 sites around the country. We use cryogenically cooled low noise amplifiers is our first component in our system and we integrate for a long period of time to get our noise level down to very low levels and because this, we are very sensitive to interference.

The ITU is established in recommendation 769 interference threshold for astronomy in the different in this band across six megahertz channel. Some telescopes have interference threshold of about minus 172 DBM and others have been interference threshold. Different type down to 131 BDM so I put that out there to explain the level of sensitivity we have to interference from either adjacent channel TV stations which are what we are faced with now, the potential for adjacent Channel TV whitespace we may be face with more in the future and I notice the NPRM suggested the possibility of co-channel of unlicensed devices which we think would be a big channel for us to work with. Having said that, we only operate these few sites. Most are very remote, not high density areas because we try to avoid RSI. Some sites we can't get away form population density like Hawaii or Puerto Rico or U.S. Virgin Islands. But for the most part we operate in fairly remote areas.

Julius: Go ahead.

Michael B: I would like to add there's a good discussion of these levels and issues in the 1995 NPRM on Radio Astronomy Protection and 9517. So I would recommend it to anyone interested in that topic.

Julius: Great. Let's talk about wireless mics for a second. Who wants to go first?

Mark B: Speaking through wired microphone. Julius, as you know and, most of the folks here know. The wireless microphone is the original white space device taking advantage of the unused spectrum between television channels and authorized under part 74 of the FCC in the 70's. Wireless mics are part of content creation, program making and special offense as they refer to it in Europe. And in All walks of life wireless professional audio equipment is deployed across a variety of industries. Hotel and convention center, the church, the large house of worship, the mega church which we could call it in the more familiar applications that we see and live events, touring concert reduction in Broadway shows and of course, Broadcast production which was the original home. The wireless microphones have utilized a variety of UHF spectrum over the years.

The equipment is coordinated by professionals in most cases and has been used without interference over the air broadcast virtually since their inception. What has happened with wireless professional audio products as more and more contents creation has taken advantage of wireless technology and audience have demanded this globally, more and more products have created in the UHF spectrum being similar globally. So the competitors have developed lot equipment based on UHF technology taking advantage of the propagation that's beneficial to all the other products. In recent years the 700 Megahertz auction took quite a bit of available spectrum for professional audio off the table and we worked closely with you and with the commission to devise a set of interoperability rules to utilize the remaining TV white space and we were very big proponents of the database concept because we thought it addressed one important issue which was the temporal and the Geolocation basis of the use of these pro-audio

products and knowing they will be in certain location at a certain set of times, sharing was possible.

But of course a large number of unlicensed wireless microphones required unlicensed wireless microphones required a more consistent day-today operating space that was created by the allocation of the channels in each market. Now we are in discussions on the incentive auction proceeding about maintenance of those channels and how they might be further shared and what operating rules have to be out in place around that. The wireless microphone is used live and in real-time which makes it fundamentally different from all these other uses and there's no second chance at a live performance. We can't resend the data packet it happens and the moment is gone. This nature and in addition, the high fidelity full frequency response for real-time audio nature of the wireless microphone and pro-audio product puts a special set of requirements around its protections for consistent operation.

Julius: Bob, why don't you talk little bit about broadcasters that handle these?

Robert: That is essentially how we use wireless microphones in our various areas of business as well as some of our experiences using the database. CBS operates many varieties of businesses including CBS news. Our 29 owned and operated television stations that provide pre – free over the air television. CBS entertainment division that made programs not only for CBS, but for other groups, for example in New York City we have Black Entertainment Network in our studios. We are producing a show for NBC, for FOX. We produce a variety of shows for different networks using our wireless technology, microphone technology. We also use it in our sports applications. We worked quite closely with the NFL with coordinated use of wireless microphones. Used to the referee on the field calling the player whether out of bounds or he was down. This is a wireless microphone.

As a result… it permeates our business essentially but probably the most unique application of this and we've participated 802 committee quite actively and we believe in sharing but these are certain circumstances when we don't where the event will place. I can predict when David Letterman is going to do his show and I can put that into the database. I can predict that I will be at United Nations or I can predict that I will be at the capitol building. I can predict that I'm going to be at the stadium. These are known things that I can put into the database and I can say we will be suing these frequencies during that period. What I have no way of knowing 48 hours in advance, where the plane is going to crash on Hudson, where the gunman to attack the Navy Yard, where the bombing is going to take place in Boston.

In those instances, in many cases World Trade Center collapsing we are the first responders on-site. If the local television stations providing essential information to the public free of charge many times what happens like in the Boston bombing, people were in chaos. They did not know what was going on. It was the local broadcasters not the network but the local broadcast providing vital public information as to what was going on. The first thing that happened as the cell phone networks became clogged. We could not even put in the latitude longitude of the

attack into the database let alone wait 48 hours for that. Database data to trickle down to the devices. As a result, we need the two channels that we currently have in the future proceedings. These two channels give us a way to share the spectrum among a variety of broadcasters.

For example, in New York City we share channels with ABC, with Telemundo, with a lot of other broadcasters. So when we show up on site, we are all sharing those channels. We play well with others. We are willing to share the white space, but on these breaking news instances, it the local free over the air television stations that is not only providing the broadcast over the air free, it is going to cable, it is going to satellite, it's going to the internet. I can watch our station on phones, mobile devices. I can watch it on the Wi-Fi. So we are going to locations, not just free over the air broadcast but we serve as dissemination for many avenues. Typically CNN, a cable network will sign up a local television station to be an access point for them because they can't get a crew on site quickly enough. We will dispatch in a typical day about 30 new screws around the city that are gathering news. A lot of times we will show up at the same location but there are many times where we can't know where the news will happen. Typically the news assignment desk will pick locations where they know they will have news. The mayor will be speaking.

The President will be speaking at the election headquarters. But there are time we don't know and it is those time we need those two channels because we are not always sharing among ourselves. We heard we are sharing with Broadway, sharing with churches and other people. So having these two dedicated channels really enable us to cover the news accurately. Recently we tried to enter database information that said we will be using our microphones at our studios 24 by seven. Many times we not only do 11:00 o'clock and 6:00 o'clock, we do countless news broadcast. We try to enter in the database State Capitol. We try to enter Federal Courthouse. We try to enter the Denver Health and Medical Center, the National Jewish Hospital, Presbyterian Hospital and surprisingly we were told that our database entries where not valid and we're deleted. This is a problem because these are places that we know we will be covering news. We know we will be covering protesters outside the courthouse. This is part of our job is to report and provide public information free of charge. This is what we do. As a result we were very surprised when some of our database entries were deleted saying we cannot cover the Federal Courthouse.

We are a little perplexed by that and part of the news gathering operation is not known. We don't know when the news is going to happen and in many cases, we are the first responders. During the World Trade Center collapse our crews were on site and were actually running from debris clouds as the buildings were coming down. Or were on site where the ammonia car has derailed. We don't know where that will happen. It happens. It's live action news and you have to inform the public of what is happening. For those reasons we need these two assigned channels.

Ira: We have heard the services that are operating with the TV band and in addition to the medical telemetry for the astronomy, the microphones, and broadcasting, as we march down toward incentive options we look at add in wireless broadband services. So let’s jump to the crux of one of the issues that the commission is always wrestling with and certainly in this

proceeding, coexistence of these various services and as we are looking at developing the band plan and looking at how to create a spectral environment to support all these various services, what are some of the critical points that the various panelist see that we need to consider in the various trade-offs as we march down looking at things of spectrum availability versus guard band time versus out of band emission and so on and so forth.

Julius: Go ahead. We can go right down the line.

Michael B: We have commissioned a paper through spectrum management consulting to look at different issues of coexistence. And the things we are getting out of this process. We will be presenting that hopefully in a few weeks. So the things we are getting out of this, I think one of the bigger items that comes out of this is you have to balance the coexistence issues that you are familiar with in other comparable bands like 700 megahertz with market variability. With market variability what that does and we recognize the critical nature of market variability in terms of the successful auction with market variability not saying anything everyone in this room knows but market vary ability being the ability to adjust the amount of spectrum clear to repack on the market by market basis to avoid the lowest common denominator effect of having to accommodate only fixed amount of spectrum issued by.

What happens when we look at that particularly looking in the context of [inaudible] what happens is the fixed filter banks where cell phones or televisions typically assume they can used a fixed filter to select their band, it challenges that model and so what is going to be happening is we will see less rejection for some of the consumer electronic devices we are dealing with in terms of protecting those devices from the adjacent services licensed or unlicensed. So that is a challenge. That challenge will go out to the engineers. And we have said in our comments that the rules for the repack should be based on currently available technologies not being projected for some years from now and I've not heard that is an unreasonable position. When we look at the services that are in this discussion, the technologies we've just discussed and television mobile phone, radio astronomy, some have some geographic advantages, radio astronomy,

Andrew mentioned that they do have 13 more or less sites to protect and those we believe with our understanding can have a certain amount of set aside where they can say you can't use a wireless microphone. We are doing a 20 minute integration right now. WMTS again it usage is in the hospital facility on a campus so there is some opportunities to protect some of these devices and some of the services. When you have an antenna sitting on a tower at a distance, such as an LTE base station or a TV transmitter, there are also some natural advantages, even getting close to the antenna and putting the signal primarily over your head than straight down you. Some of geographic general elegies we will get more specific when we get into the paper and can speak to the specifics but what we end up with is you do have some cases where if you put a transmitter and a receiver in close proximity within a few meters or 10 meters even with a wall between them, we may see some complex so there will be careful consideration required in terms of looking at some combinations. Thank you.

Julius: Who wants to go next?

Michael C: Let me address the wireless microphones. I think it should be fairly straightforward to address this sort of need that bob outlined. But first, it's important to keep in mind that a majority of TV channels in each local market are not available for unlicensed use. Unlicensed devices typically cannot use the vacant channels used by broadcasters in the neighboring TV markets even at the lowest power even at 40 milliwatts. What is good about this is that it creates the possibility for a real win-win that is we could have a three-pronged policy that can ensure that both wireless mic operators and unlicensed broadband users have a sufficient amount of low band spectrum available. We outlined this in the comments we filed on behalf of the public interest spectrum coalition, but to summarize, first and most importantly is to expand the number of locally vacant TV channels to microphones that are not currently available to unlicensed spectrum.

Second is to maintain the reserve channels for microphones but open them for sharing by unlicensed devices that places and times not in use because even if there's a concentration of use on Broadway or if there is a hurricane somewhere and 99% of the places and times that spectrum is vacant. And then third is to require microphone operators to use these TV co-channels that are not available for unlicensed devices before they fall back on the reserve channels. And to really understand this it's important to double back on that first point about expanding the channels for microphones. Microphones have a long and successful history of operating co-channel with TV stations in distant neighboring markets. Julius and OET found this where they found the microphones were operating co-channel to local TV stations in Washington because no one was watching television in the stadium so they had no problem doing that. So under current rules microphones must be at least 70 miles from a television transmitter.

In practice, microphone operators operate at considerably shorter separation distances particularly indoors like studios. So just to give an example, which we detail in our comments, Rockefeller Center in New York City, home to NBC Universal Studios, while there is no channel available for unlicensed use according to the spectrum bridge database, not one, microphones have a t least 18 vacant TV channels effectively available. For example there are six that are between – There are six channels that microphones often use that are occupied by distant market TV stations between 50 and 70 miles distance from Rockefeller Center and when you add the fact they are indoors, there's certainly no risk of interfering with television in New Haven from a microphone at NBC studios. As a result of that, what you see is that when you look in the database and the TV whitespace database you see NBC Universal regularly reserves may bring market TV channels that are less than 7miles away.

For example, when we look back in January they had reserved in the database five channels that were less than 15 miles from their studio. This has never been a problem. I would add to this – and so what this effectively does it means that microphones have plenty of places to go if we just make explicit what has been the common practice is use these out of market TV channels, where unlicensed devices are banned and go there first and let the TV band database sort of regulate

this which would be a bonus and a win-win because it would help the microphones quart mate with each other if there is this transparent registry in a sense. So like NBC Universal they can look at the database and see which ones they are using so they can use others.

They can use others. A final point and mark might want to speak to it in our reply comments we said we agree wholeheartedly with Sennheiser to go even beyond that, go beyond shortening the separation distance for microphones to allow microphones to operate avocations where a TV signal is below a specified threshold. In other words, when you're inside the Embassy Universal Studios, there is no reason to say it has to be 30 miles, 40 miles, it should measure the signal and if there's no effective TV signal there, use that channel. And the TV stations—I'm sorry the microphone operators do that all the time. You sought at the not wrote were the reserve even local DC broadcasts for use in the spectrum bridge database because it's not bothering anybody.

Julius: I know this will be another point of view on this. But I want to give some others a chance to talk so you get a chance to respond. We are talking about the coexistence and what is on your mind? We will get down the line. You will get a chance.

Andrew: I will just say quickly, are concerned about the coexistence issue is even if in the final ruling you do nothing with channel 37 and radio astronomy is still allocated and land mobile for WTMS is allocated we are concerned that there will be increasing crowding on the adjacent channels because you have fewer TV channels to pack in the remaining TV stations. When you look at the rules, a full powered DTV station, 1.6 megawatts TV station can transmit up to 55 watts of out of band emissions in the immediate adjacent channel and when you try to propagate 55 watts down to negative 172 DBM interference criterion, if you just take some random propagation model that takes that into account to plug that in, typically you look at 700-coulomb others to reach that level. We would have trouble coexisting with high-power adjacent channel TV stations if it's an adjacent channel for lie or something like that they are allowed about five DB and of out of band emissions in the adjacent channel and depending on the particulars you are looking somewhere of 40 to 100 kilometers operations to meet the recommended levels. Our concern is even if nothing happens to channel 37; we hope there's consideration given to congested neighboring channels of channel 37.

Julius: What about base stations?

Andrew: The LTE Base Station, they are the ones that allowed five DBM of power in the adjacent channels. A mobile station is a little easier but still 50-70 kilometers depending on what you assume for various characteristics and the TV white space for unlicensed devices because there's no specific rules for some of the things that were posed in the NPRM. Can't give you an exact figure. But we think it will be maybe over 100 kilometers depending on the nature of a TV whitespace type operation and it could be worse if it's a co-channel.

Ira: Could I clarify one point? When you give those distances and interference criteria it's just for a single dish and a handful of sites in Europe a bunch of sites networked together that I believe have a more lenient threshold.

Andrew: I gave a range there and the lower part of the range have a lower threshold so very quickly and adjacent channel TV station assuming the maximum amount of emissions we are looking at 125 kilometers separation for an adjacent channel base station like LTE Base Station according to the rules as far as out of band emissions ago we look at 40 kilometers separation. For an adjacent mobile, mobile broadband, mobile station, we are looking at about 15 kilometers. The distance there is because we assume the mobile station is that a 2-meter height and the base station 100-meter height. And the TV whitespace device we looked at the end an issue because in the NPRM it said maybe shared channel 37 TV whitespace and again it depends on the assumptions you make but if you look at a 4-watt device a couple of meters off the ground 75kilometers. Those numbers don't hold me to the exact numbers but that's a sanity check.

Julius: Ballpark.

Tom: I'm here today representing CTIA and they have members in the licensed and unlicensed community. There's a lot of trade-offs go into this band plan. CTIA on the record has discussed it. An approach that focuses on getting as much spectrum as possible out of the band plan and limiting guard bands to reasonable amounts, 10-12 per duplex gap and small guard bands to support the interference among different parties. The follow-on point that is helpful in terms of moving this debate forward would be having a discussion of technical parameters in these guard bands. LTE parameters are fairly well understood. We had a long discussion and debate about it so folks want to see what the requirements are, they are there and available. A number of folks who participated in that process. What is helpful is to understand and have in the record power level out of band emissions limit. What they're looking at in these guard bands independent on amount of spectrum available or not but that would I think help lead the discussion along further if we can get concrete technical data supported in the record for that.

Mark G: Moving down the line, like radio astronomy WMTS operates on the hairy edge of margins which is one reason the commission considered putting it in channel 37 band to begin with and radio astronomy is passive and WMTS is active. You have situations where you have hospital wide distributed antenna systems; everywhere a patient can be there's the ability to have coverage for WMTS. So that's everywhere a patient could end up. A patient can present in the ER so they are often down there. One issue of presenting in that location is the ER is away from or at least someplace not protected by the hospital building so you don't enjoy the benefit of having a building penetration so the reason these systems operate with such low margins is a combination of things to balance the link, but to protect battery power as well. You have a device that can cost roughly $10,000 so they have very specific types of battery technology they use to ensure they don't have to keep replacing batteries. So the issue with interference with WMTS is the same that Andrew addressed.

At DH,--adjacent channel the concerns are for television issues that WMTS faces right now with television and there are some 50 markets right now or 50 areas if the country where there is TV on one side or the other and the way WMTS and in about eight markets, eight or eleven markets where there is TV on both sides. The interference or the issues of interference or avoidance of interference with TV is fairly well documented and it is on the record that the WMTS file, what the WMTS community does and this is primarily manufactures encounter with hospitals they build in guard bands. The rule required for operation at 608 you do what is quarter band which all of us understand you pick 1.5 channels and that's how it's operated. If there is a TV above or below TV station above or below what the hospital does is they build in a guard band and sometimes it can be as much as to makes depending on how high-powered the station is and close it is. If you have TV above and below you have an automatic guard band built into the channel and obviously that causes concerns with the ability to fully enjoy these channels.

However, the good news out of that is that while the TV band are not – TV stations are not active in terms of moving around a lot in spectrum, they can work around that. With repacking, it could be problematic. It could be problematic from the standpoint if you could have more TV adjacent channels and more TV above and below. That is the TV issue. As Andy said, the other issue is CR M. S. base station above or below. They are not as bad as television but that needs to be studied. The concern there is that there will be maximum number of high-powered base stations operating nearby a hospital or on a hospital building. So we need to have some means to protect the WMTS. Some discussions put up there include checking the database to see which hospitals are there or like what TV stations do when they operate, they contact a hospital and there is a relationship established between the TV station and the hospital, then the operation inside the band and the whitespace operation there.

There is an emission mask that everybody seemed to agree on when it was filed. So the emission mask will help protect out of band emission into channel 37 fairly well. And then the operation of unlicensed devices within channel 37. Across the board for this 18 Megs that is adjacent within channel 37, the issue is patient safety. As described earlier, the chance for interference into WMTS, it goes up with more adjacent channel type operations or some operations that have been discussed. The WMTS community is concerned about the potential for increased interference which could manifest his issues with patient safety. Especially the use I case I described earlier where you might have a patient presenting in the ER where everybody who has watched any sort of healthcare sure –show it like that and worse. And it's not a context on my life but just doing technical work or the trouble is you have problems.

Anyhow, enough said. Anyhow, you show up at the ER, have a trauma and get fitted with WMTS and you are there. The reason they outfit them with WMTS is a move the patient throughout the hospital to a trauma center nearby or in ER nearby and they need to keep that link. If that link is interfered with, the hospital has to go through a lot of means to troubleshoot and find out what it is and if it's subject to interference the hospital is concerned about the reliability of that and that causes other issues. So I would bring everybody back to the record. The record on the WMTS proceeding—I'm sorry on the whitespace preceding was fairly solid in so far as all the

commenters on that record that answered the question about operation in WMTS agreed that the issue of patient safety was important and that we did not need to operate in that band. That has not changed. It's important to protect patient safety and those are the issues we face with all these other operations.

Julius: Just answer all of these questions.

Alan: I want to talk about all three. Let's look at the coexistence of low power TV whitespace devices, 100 milliwatts, 40 milliwatts, Wi-Fi again with channel 37 with wireless mics and with the LTE downlink which is related to the discussion on the guard band. In the case of the first two, the first thing I would start with if the charter is let's make more efficient use of the spectrum and 99% of the spectrum is not being used, let's find a way to share. We've solved harder problems than this. We can make it work. In the case of wireless medical telemetry and radio astronomy, those are fixed locations. Carve them out in the database, make sure the devices can operate in those locations, test it, validate it and that would be my argument for how to proceed there.

In the case of wireless mics, we agree 100% all the services Robert talked about are critical, they should work and we can find a way to make them work, Reserving to channels and setting that aside so it's easier for lots of places to know they have services make sense. We support that 100%. In the case of the news crews, we believe we can shorten the time intervals wherever they are, they can have access to those channels and share them for the other 99 percent of the time the spectrum is not being used. It does take more work than any of the organizations put in now and I would argue the reason is there's not a rule right for that to happen and I would ask the SD's—FCC to make that happen and challenge the organizations to work together to make that happen and meet the standards that a news crew can go deliver services.

Finally, with the coexistence, how big does the guard band need to be? Our argument is with 12 megahertz of spectrum we believe you can use 6 megahertz for unlicensed operations, 6 megahertz closest to TV and farthest away from the operating handsets and basically if you use the precedence that you already set it the H. Block in terms of the protections afforded to LTE, they will find a way to make that work and not interfere with LTE. So maybe that gives you time, some input on what the parameters we expect LTE, the standards they could operate at. If that is done, there may also be the possibility to offer the duplex gap. It depends on the rules. Clearly it would be better to separate LTE and TV. It makes it easier for everybody and where that is possible, that would be great. Filters and cost goes down for everybody.

Julius: Bob, you have been patient.

Robert: We are at our major production centers in New York we have eight sound stages operating. In TV City in Hollywood 8-10 sound stages, in our studio center, 25 sound stages. These locations where we can take advantage of building shielding, we are already adjacent channel, co-channel operations. If we can take advantage of building shielding we will do that.

However, when we are out in location under cover with 60 minutes trying to interview a bad guy where we don't know where he will be, having a wire coming out of your hand gives it away. So having wireless channels we can depend upon in locations where we don't know where we will be become essential. A lot of times if we are covering a breaking story such as a tornado, we don't have 15 minutes to wait. Public safety is at paramount importance.

The tornado is bearing down on the community, get out, seek shelter. We can't wait. We are dodging debris. Our reporters are running. They need wireless microphones to do that. As a result, waiting an hour might be too late. By that time the community has been destroyed. Getting the information out not only on broadcast but cable, satellite, internet and on mobile devices is essential. When we provide a public service, it's not just free over the air broadcast, it is too tall these other devices including the internet and mobile. And maybe broadcast LTE is a way to help that process along.

Ira: Haiyan, Did you have anything you wanted to add?

Haiyan: You might have one of the toughest set of rules to abide. From both the out of band emission perspective and also from the input to live in all environments you have interference from broadcast signals. And there is a lot of intelligence built into the device to handle these interferences. I think wireless microphones and other devices can take advantage of what actually the new technology that is used by TV whitespace to overcome some of the problem that some of the folks here mentioned. And regarding to the live event coverage, I think, first of all, the channels, these channels are variable channels in the first place or you don't have a dedicated channel to go to. So there is some level of intelligence built into the radio to be able to adapt. So adding reserve 2 channels with not knowing where these 3 channels does not help much. And on top of that, I think wireless microphones today in that case of emergencies can use some of the broadcast channels where the signal is weak. They are using that today anyway as Michael said.

Julius: I had a hunch there would be responses.

Mark B: I wanted to respond to your question about the channels being variable by market and therefore, you don't know where they are. The professional wireless microphone equipment has a wide reach and this has been increasing over time to take more advantage of the UHF spectrum and interestingly it becomes a smaller footprint overall but tuning to a vacant channel based on whether you are in Dallas or Detroit, it is a very simple exercise and any audio professional working at news gathering would be obviously know where they need to be. I wanted to respond to Allen's comment about can't we figure this out and a lot of the suggestions that are being made here are talking about increased capacity or capability of the database. And measuring signal strength where your location is. Freeing up more channels when things are not used.

This will require the database to be a very robust system. Now, for most audio professionals database is an untested system and the commission was balanced in the way it's set up the initial whitespace rules to bring these uses online well not disrupting operations and services. We began

to use this geolocation database for these large productions and in the future have greater capabilities come from that database and enable some sharing, that is fine, but right now, this is a relatively untested system and Julius and Ira, as you know, a lot of pro audio users can access this database in real-time and have their data throw—flow through so how do we expand that group of professional users aside from broadcasters and motion picture makers who now have the instant access to the database system? How can we expand that population to these other professional uses and make it more a part of the workflow in daily life for the pro audio community.

Mark G: I want to address a point Alan raised and we work closely with Google and the other nine to make this come about so we believe in whitespace. But I want to go back and address the patient safety issue. There are series of cases that could happen with this database and that is where hospital risk managers live and if you go back and look what's happened in the 5.8 gigabytes band where DSS was enabled and disabled where it caused issues with radar those are the type of cases where there may be only a few but like I said that is what's giving risk managers nightmares about issues with patient safety. And Allen has a good point, perhaps we can work together and trying to do testing or solve this, but those are the people we need to convince of the ability to share spectrum in that regard because those are the ones that will be making the determinations on whether this is going to work properly or not. So while we know where all the hospitals are and there are about 5800 in the country, if you enjoy and all of those from operations think about what that would do to downtown area where that might be worse you would want some whitespace availability. I go back to what I said and had him wearing his patient safety and if you have these cases that could cause impact to patient safety when you think about that and address that straight up.

Julius: I'm going to try to get to a couple of these questions that came in. And maybe just reframe it a little bit in some way. When we talk about guard bands and so forth and spectrum, when you start diving down into different levels, it is not just the amount of megahertz, I take you, three, five add them all up and say you have 20. In the end, it matters how these things are put together. In the earlier panel we heard a bit about channel bonding. So is there some minimum size here? You would like to have contiguous blocks and technology has gone to multiples of five across the board but when we start getting like when you have guard bands we wind up at some places and don't take away this is what we are going to do but surprise we end up with this that's 3 megahertz is that tossed away because the technology and any thoughts on that?

Michael B: It will be difficult to make agile filtering that will give you good attenuation and 3 megahertz space. We are looking at more larger numbers and we will come out with something a little more specific but closer to ten then three. When you are talking about trying to protect a delicate receiver from a high-power service you can't juxtapose them.

Julius: Just to be clear I'm not necessarily talking wireless mobile service, it could be 37 here.

Michael B: Absolutely. And the minus 152 DBM criteria is sensitive, delicate. So really we are looking at that and DTA and receivers and the base station receiver for the uplink and trying to figure out where all of these pieces can fit together. And going back to your question, 3 megahertz as a throat on the wall and see if it sticks.

Ira: Alan?

Alan: If you look at the guard bands in terms of protecting LTE downlink from low-power unlicensed operation, if it is 12 megahertz we are pretty confident that you can squeeze a 6 megahertz channel in there. With MACS separation. If you move it down to ten. Maybe, maybe not. If you move it down eight then what might happen is you save 2 megahertz and you've turn away six usable. So you've crossed the threshold at that point. We are happy to provide on that but that's an example where two megahertz cost you six.

Julius: It's something we are thinking about as well because you move around the pieces on the chart and you have a band plan you want to be sure when you think you have six or you have eight that's usable that's really what it is. Or close to it.

Mark G: I think we put on the record 3 megahertz bandwidth be appropriate for protecting WMTS is that 1 ½ makes. Specifically, the mask is still used and obviously we will not have television in that makes so we are not worried about high powered neighbors but one thing I want to address is the operation in the hospital and if we want to go back and forth on that.

Tom: I wanted to mention the fact as we talk about these guard bands the technically reasonable requirement we have is the protection of licensed services and adding in the licensed wall certainly is important is not something that should be overriding the licensed paired spectrum you get out of this. At the end of the day, the spectrum we are trying to get is occupied by the broadcasters and the way to get them cleared out is to get the licensed piece of this. I want to highlight the fact we need as much licensed paired spectrum other than this to clear any of the spectrum at all.

Michael C: Just a quick thing at this point which the caveat that I'm not an engineer, but I just want to—

Julius: That's okay. I'm not a lawyer.

Michael C: In thinking about, in thinking about the guard bands in particular for example, what Alan was saying about you may need 12 megahertz so the middle six is fully usable for unlicensed and so on. It's important for the commission to think in terms of the concept of protection zones rather than exclusion zones and that is true at the edge of channel 37 as well. This is something that Mark Gibson and Dennis Roberson, the chair of the FCC TAC and others came up with respect to sharing the 1755 band and that is that you just don't want to have a hard and fast exclusion zone necessarily because it could be if you power down as you go toward the

border that you can go and use more megahertz. So if you don't need to be operating – if you can operate at 100 milliwatts, you might be able to have a wider channel than if you are operating in a watt. So I think that is important that there needs to be variables loans and not hard and fast exclusion zones.

Haiyan: From the technology perspective, we can take advantage, smaller spectrum chunks as Julius mentioned. But what Alan said is very important, how much overhead becomes a big part of the band you are using, you are wasting, you pretty much don't use much of the resource at all.

Julius: Let me read one of the questions. I will read it verbatim. In the context of minimizing interference to incumbents, can any panelist provide further background around the tendering of low-power consumer oriented TV white space devices also known as 8.028 F. To help know what the future of TV whitespace ecosystem will look like? A brief example would be appreciated. Any thoughts? Alan you mentioned AF.

Alan: That is in the works. It will be published soon. I know there are some manufacturers who are Wi-Fi manufacturers who are working on prototypes. We will see equipment out at some point. If you imagine how this might play out, if it is integrated in the existing Wi-Fi it's an inexpensive way to expand the functionality into many consumer devices which have Wi-Fi. Think of it as another gear in your communications bench where you have this low-power longer-range option you can use in certain locations and the utility, as we mentioned before is broad. Julius, there was one other point to raise on the previous issue with coexistence and last mile access, we did a trial in Capetown, South Africa and instead of using that we use long rewrites to model the propagation of television and operate at high power. On adjacent channels, two televisions. We gathered data over six months and there's been no reported TV interference of TV reception and there was no issue with the broadcast. So, I would just say they are opportunities down the road as you get more confident in the rules and the operation to further optimize this.

Julius: Go-ahead.

Tom: Is that a DBA to system?

Alan: The other was DBT. So both. So we had to deal with both analog and digital.

Julius: I've got one more question, I'll just read it. Since I operate in unlicensed spectrum a consumer device operating in doors near an access point of the same channel can severely limit the ability to reach distant broadband users who are in great need of service. It will be more severe on the lower frequencies with TV bands because they can more easily propagate outward through walls and buildings. Can we make rules for unlicensed devices that ensure the consumer devices operate on different channels for fixed wireless broadband services and do not create this harmful interference? Thoughts and reactions. That's my question. What do you think?

Michael B: Some of the interference issues we've been talking about for the unlicensed devices regrettably some of these interferences will be harsh. They don't get primary service protection. When you are talking about a wisp type of device operating on an unlicensed band, they are unfortunately stepping into that zone so I think it is difficult to start off by saying here is how we will protect them however one of the things that probably should be done is again careful consideration to the out of band characteristics and power levels. Certainly that is ongoing. For all of these devices, take the opportunity to make sure as we translate rules from 700 MHz or other regions into this band, that we are making appropriate translation of the limits. I think one of the other panelists made that comment as well.

Ira: Maybe looking at a slightly different perspective on how this may play out as we go down and conduct these auctions, but obviously there will be a lag time from now until the commission gets rules out to conduct an auction and systems are built. Any thoughts on what types of devices can operate in areas that maybe we auction off in the interim until new systems come online and kind of a long with that. Any thoughts in the coexistence area with that and as you transition from those areas to the commission contemplating maybe some conservative type protection criteria at the beginning but as we go forward in time, obviously technology gets better, filter technology gets better. Do you see where that might be going and the ability we can modify the rules on a sliding scale over time as those technologies progress?

Michael B: One thing I would like to react to is the last part of your question which is on the technology and again we are recommending we try to avoid forecasting how this is—filter technologies will progress. Part of the problem. Aside from the obvious point there that I made earlier is that with the market variability, you will not have short cut offs and edges so people will be trying to switch in filter banks and they won't necessarily be wider than a single channel. You can't make a device cost-effectively that will have sharp hard filtering on a per channel basis as we do with band filtering. So that is a little bit of a challenge to be flexible in the interim with uncertain, I'm not trying to cast this in a negative way, away the environment is going because we don't know exactly where the device is going to be operating in a lot of cases.

Michael C: I can address the first part of your question which is we have already proposed that the commission simply maintains the status quo in the 600 megahertz band. In other words that is the spectrum is in an area is vacant, and it can be used on an unlicensed basis without interfering with the licensee, just as the way it with TV stations then you should allow it. So we can maintain the status quo and allow this whitespace after the auction to be used by unlicensed devices subject to the automated enforcement mechanism of the TV band database so that licensees when they are ready—when they deploy and are ready to commence service they notify the TV band database that we will start serving this local area and that channel or that frequency band, it won't be a channel any longer specifically but that then comes out and the device operates on different channels. So it really – the closest thing to a spectrum efficiency free lunch you can imagine because there is absolutely no downside or risk to the licensees because the only

thing they would possibly have to do is let the TV band database know that they are about to commence service in this census tract or this municipality.

Mark B: The pro audio community would definitely echo that, the longest possible transition time and you folks are painfully aware of why all the 700 megahertz equipment that was returned two years ago was largely replaced by 600 MHz band equipment. So I would agree with Michael here that the longest possible time in that spectrum is still unavailable before the new licensed services come online should be granted to the current users.

Julius: The shortest possible.

Tom: So they will be using it fairly quickly. It won't be a long transition process and I also would say it will not be commenced of service, it will be commenced bit of use there's a lawful lot of testing and stuff before they provide commercial service so it will be even before commercial service is up and running.

Michael C: Made a reservation.

Julius: We could go on a while more but people are getting hungry. I heard a report about when people get hungry they get grouchy. So just a quick observation, think the challenge for all of us is whether we have wireless microphones are unlicensed or medical telemetry or radio astronomy, industry to figure out how we make the most efficient use and accommodate all these different desires to use the spectrum and all the good that comes with it. Encouraged I think hearing this, there's still plenty of room for head scratching on how we figure all of this out. And mindful of the very real engineering challenges that we have and sometimes, as we are continuing to spectrum world to press the envelope on access methods and how we can do more than we did before and still have the confidence that things are going to work the way they are intended is really the challenge for all of us. I want to thank the panel. I thought it was a terrific discussion. I thought we had a great session today. Please a round of applause for them.