Pierre de Vries: Thank you very much, Professor Braun. Our Keynote speaker Julius Knapp is, you know, he's a national treasure. Sorry, Julie, I have to say this. He's a public servant par excellence, he became chief of the FCC lab back in 1994. For the FCC people here they don't think in terms of years, they think in terms of chairmanships. So that was Reed Hundt, he became chief of the office of engineering technology in 2006, Kevin Martin. So far, I think it's at four chairmen and counting...as chief, at least.

Julie has contributed his expertise and counsel on every major technology decision that the FCC has made, especially the spectrum ones. One of the things that Julie masterminds is the FCC's Technological Advisory Council, and in fact one of the working groups of that body on the implications of the mass adoption of aeronautical and space transmitters and receivers was the thing that prompted me to think about this area, and in fact we have the co-chairs of that working group Mike Tseytlin and Steve Lanning are both here today. So that was just one of the many things that Julie has done for us. Today, he's going to give us an introduction to the topic of 3D wireless. Ladies and gentlemen, Julie Knapp.

[Applause]

Julius Knapp: Did we lose the professor because I wanted to sign up some of the students. We need engineers. Oh, there you are. Send them our way. Yeah, before we get into it, just a couple of thoughts. Yeah, this is so much about the intersection of policy, engineering, [00:02:00] economics, and the services that they provide…provided.

So, I was so glad to hear you speak Professor Braun say, "Why aren't we doing this at the Engineering school." So, where are the students? Okay, so I'm going to do some things as I go through this that maybe a little overly simple for some because we have some folks in this room that know more about this subject material than I do, but I think sometimes we forget, for those of us who are involved, what the things are all about? Why do we have these different systems? What are there different characteristics? And the other point I wanted to make, I was just so happy to see the way this was structured with a session on innovation and challenges and solutions. I tried to get on the challenges section instead of solutions, I thought…that would be easier.

So, I'm going to run through some things here and right up at the front, I will tell you this is…a lot of this is plagiarism from the work of the TAC, but if you've got folks who have done something before you, better than you could possibly do it, steal it! So, how many of you have played chess? Most people in the room. How many have played 3D chess? Would have to be the department head. So, 2D, it's challenging. 3D, mind-boggling. So, now let's turn to wireless communications. So, for the most part we're often talking about terrestrial systems and how we can make them fit together and not interfere with [00:04:00] each other, whether it's cellular systems in reuse or land mobile systems or microwave systems.

We're usually thinking kind of 2D along the surface of the earth. Well, 3D isn't really something new. People will tell you right away, they've been aiming signals at satellites for years and years, but it's getting more complicated. What you heard before, there's a lot more things going up in the sky. And if we had the luxury of giving them all of their own separate bands maybe it wouldn't be so hard, but we don't have enough to do that so, so much of this is about doing the engineering, so that system's in some cases can share spectrum that they can aim their signals in such a way that they don't interfere with each other and so forth. So, what's new? All the satellites you heard about, in some cases systems with thousands of NGSO satellites. The high-altitude platforms, I threw 50,000 feet and I know folks will say that's not the right metric. They're not up in space. They're not as low to the ground as UAV's, and I think that's the important thing. And all of the unmanned aerial vehicles, the UAV's.

So, this is a 3D problem. So, at the Commission we said, "This sounds really hard, let's give it to the Technological Advisory Council." "We've got the world's leading experts here to advise us." And so, we had a working group that made recommendations just at the end of last year on what we call the implications for mass deployment of aeronautical slash space transmitters. And just to give you an idea of the folks that participated on it. You name the company or the area of expertise and almost all of them were in this, [00:06:00] and they reached out.

So, what we've been doing with this TAC—Technological Advisory Council—has been to tell them, "Well, don't just limit it to the members, let's include experts in the field." So, they reached out to all these folks, so the thing that I'm going to talk about are slides they put together and some of their recommendations on this subject. So, NGSO systems, so why… Yeah, non-geo-stationary satellite orbit systems. So, why, why? So, the Geo's because there are roughly 25,000 miles out in space to get to and back is roughly half a second. So, if you want to do real-time communications that becomes something you're going to have to deal with, not necessarily complete impediment. And for data communications sometimes that's not a problem at all. The whole idea of the NGSO's in most cases is to get world-wide coverage, to have lower orbits, so I can reduce the latency. And if you think about these things, they're almost like cellular systems inverted. There instead of having all of the base stations on the ground, now the base stations are in the air and handoff is happening between the satellites as they move.

So, the way we do things, and I am not an expert on satellite licensing, is there…are people here know more about it than I do. It's handled by our international bureau, but they're set up in terms of processing round. We put up a public notice, put out public notices, with everybody who's interested follow your application and we'll figure out how we can grant them. So, this is just a list of what got filed, quite a few different companies came forward to submit [00:08:00] applications in the filing window to establish satellite systems. And, in some cases, as you can see space X is over four thousand satellites.

So, here's an update. What have we done? We issued a public notice in May of 2017. We accepted applications for filing and it was just a few months ago, there was a cut-off established for additional NGSO-like satellite applications were partitions for operations in a number of bands. And there's the list of these applications that have been filed and got you the link on the bottom there if you want to go get more detail. And just last week the commission issued an order and a further NPRM to update the rules for NGSO satellite systems. So, what's so hard about this and why are we here at law school? So, if you had to put up a satellite system or a terrestrial system, you want to be sure that the investment that you're making…when you put it up there somebody isn't going to step all over your signals, that the system is going to work. And when we've got all of these moving pieces going on with multiple providers, it takes a lot of work in 3D to coordinate them. So, basically what the commission did is say, “Look, we’ve got a default, but we want you to all work together to try to figure out the details of how you can share.”

So, I’m going to move onto HAPS. So, what’s the difference relative to HAPS? What are they all about? Well, they’re not trying to achieve worldwide coverage like the NGSO systems. The beauty of HAPS is [00:10:00] get them low to the earth, so I don’t have the latency issue.

The power levels are higher, so I can get better penetration on the ground. I can use them to fill in areas that don’t have service. And in times of disaster, I can move them in place and get coverage to restore broadband. So, that’s kind of the real high-level difference about what HAPS is all about. And there’s lots of parts of the world that have no coverage at all, where if you had a population center where you might be able to use this as the most efficient way to provide service. There’s only one global allocation, perhaps, right now. So, you heard, I’m going to talk a little bit about these other bands you heard about 600 megahertz of [INAUDIBLE 00:10:57], 47, 48 gigahertz. But when you start getting that higher problems with re-invade. So, as long as you operate when it’s not raining you’re good. It’s really a problem too in the tropical zones.

The good news is that spectrum for use by HAPS was accepted for an agenda item for the World Radio conference to study and make recommendations for the 2019 conference. So, in part because the technology has advanced and the need to provide service to fill in these places, and it’s not just fill in, some folks out of ways that they intend to compete in providing broadband services. It’s all being studied right now. So, here are some of the bands. I won’t go through it all. 47, 49, 27, 31, et cetera. So, we’ll see what comes out of it. What you heard before too about, well, what about these other bands?

[00:12:00] The commission has got flexible rules. So, in many cases we’ll say, “Here’s the band, you can use it for service, you can provide it however you want.” Sometimes they’re not so clear about what happens when you put things in the air. I use the analogy of a light bulb, so take a transmitter, you put it on the ground, it illuminates the area around you, put it up in the air. Same thing with a light bulb. When I put the light bulb here it lights up the room, when I put it up higher it lights up a broader area. So, people are actually doing things using the unlicensed bands at 2.4 in five gigahertz, because this flexibility, there’s no restriction going up in the air. And some have said, “Yeah, but what’s that going to do to interference, to all those folks using [INAUDIBLE 00:12:47].” Well, so far at least nobody has identified a problem, but it’s in part the flexibility provides alternative ways to get services and then, of course, you can file for waivers or special temporary authority or an experiment and so forth. But the good news here is that there is work going on to identify more spectrum for HAPS, and you heard a little bit about…there is several companies that have got plans to deploy platforms. These are a few of them. Little bit more on HAPS, I’m going to move on, I think in the interest of time. So, we’ve moved… We didn’t really talk about GSOs – geo-stationaries. We talked about NGSOs, little lower. We talked about HAPS, little lower than that. We didn’t talk about cube SATS, which kind of ride along a free ride off an experimentation supported with unlicensed frequencies or supported by amateur frequencies, write on payloads with rockets they higher up.

But now we're down [00:14:00] to things kind of closer to the ground. The UAVs. And so, FAA has been working along with NASA and DoD, and we have been involved but we're not, I wouldn't say, the lead issue. First, they're trying to figure out how are going to make all these pieces fit together and not collide and manage them and so forth. So, NASA has been developing working with the FAA kind of drawing on the experience with air traffic control systems, a system to be able to manage the devices that are going to operate relatively close to the ground. And it's not going to involve air traffic controllers. It would be a set of rules, set of principles, and a set of information that would help people to determine what's the right flight path. Get information about what the weather conditions are and so forth.

So, there's a lot of work going on by NASA, FAA, and working with industry. There was an advisory committee we heard a little bit about before trying to figure out, how do we manage all of these things? Coming back to the innovation, they can do things that we couldn't do before that are terrific. Being able to go up and inspect the tower, for example. We certainly hear about the delivery of packages. Movie industry, lots of industries, the applications, the ability to do things that they couldn't do before using this technology.

So, the challenge here is. How do we make sure that can be done and meet those demands in a safe way? This is more on the NASA UTM project, you'll have the slides and you can look this up, there's plenty of information on it.

[00:16:00] Current uses divided, of course, between commercial and the recreational. A lot of the recreational. How many of you have got an unmanned aerial vehicle? All right, you're out. The thing that's, you know, quite a few people do this as a hobby, which is terrific. And most of the things that are operating below the 400-foot level are a line of sight and they're operating using those unlicensed frequencies, which always makes me a little bit nervous because there's no interference protection.

So, one highlight that I'd flag here, there the command and control and there's the payload, and they're two different things. So, the one is, I want spectrum that I can make sure I control where this goes. And the other is, okay, now I want HD video down from it, takes a lot more bandwidth. So, where's that going to come from? And I think there's been much more focus on the control part which is good. Not quite as much on the higher bandwidth, but that's where it also comes in with commercial wireless. So, commercial wireless has been looking at this as a potential solution, and they've been doing some test because it's that light bulb issue that I mentioned. You design a cellular system, free use and for re-use, and managing interference largely on the ground. And now what happens when you have part of your system that's up in the air? And how do you manage the interference in your system?

So, there's work going on that. And I think at least in some quarters they feel is a lot of promise both for the control [00:18:00] and the payload. So, the TAC recommendations. This was on part 107, which is the FAA rules. But I think it also kind of related to the FCC, was we should promote the use of existing communications infrastructure wherever possible. Commercial wireless networks present solutions for control tracking and payload communications for small low altitude UAS. One of the beauties of that is you already have a network that's widely deployed, so you don't have to build another network for access. You do have to ask…what happens when you get out of an area that's not covered? What does it do then?

Commission should act now to study if any rule changes or additions are required, in order to allow for airborne use of commercial wireless bands, and I think that kind of goes to the question of, does the agency need to do anything or hands off relative to making sure, as we don't have just a single licensee for commercial networks. There's not a single band. Some of these have got adjacencies and so forth. I'm going to make sure that everything still works together. And the commission's work can be done in parallel to the FAAs. We're still working with the FAA, but I think most of the focus has been on the things I talked about before — controlling the devices, and what are the rules of the road for how they operate? We should harmonize the 800 Megahertz began with other commercial mobile wireless bands. Anybody break the code there? Go ahead.

Audience Member: [INAUDIBLE 00:19:55]

Julius: Yeah, that's the only [00:20:00] band we had, a rule that says you can't operate onboard aircraft. And so, that's really what that was saying. [INAUDIBLE 00:20:11] consider collision avoidance spectrum, in other words radars, these things are all flying around, how do we help make sure that they don't fly into each other? Support use commercially available license in unlicensed bands wherever possible, support the use of ADSB technology which I think is still somewhat being debated. What did I skip? So, we had a continuation of the TAC workgroup on satellite communications. These are the folks that this is going on this year. They're due to get us recommendations by the end of the year. This just described what the charter of the group was.

Look, the recommendations for processes and communication solutions to support both start up and venture satellite operations, et cetera. Assess the challenges faced by these new satellite ventures. Some of the folks who are working on this are actually here. This is their work plan. To define use cases, satellite as a primary platform for access. IoT often, and I know satellite raises their hands were, "We're IoT too." So, what role do we play in IoT? Vehicle to space vehicle communications part of a network in the sky as generalization from bent pipe operations, you hear a little bit about that. And a white paper itself. I'm going to just touch on this last point which we can largely thank Pierre for, and this is risk-informed interference assessment. And I'm going to jump through some slides, it's probably not fair but hopefully I can capture the points.

[00:22:00] The goal is what? A frame of risk informed interference assessments. GSO and non-GSO co-existence, and why? I'm going to use a little bit different words. So, I started out talking about innovation. And often what happens is when we're doing interference analysis it gets what people would describe as worst case, worst case is often in the eyes of the beholder. And coming out of the TAC from work that was done two years ago, said we really ought to be looking at, well, what's the risk of interference? So, if my analysis says, "I might get interference for five minutes once a year." And the consequence of it is my bit rate goes down by 25 percent, and that's going to be the roadblock to an entire new service, where's the balance? And that we ought to be looking at the risk, obviously if it means there's a disaster you don't take that risk, but risk analysis is done in other areas all the time, whether it's the nuclear industry, the aeronautical industry and so forth. If you think risk is zero you're misleading yourself, you're trying make it really small, but it's usually never the zero. This is just the complexity of the co-existence. The 3D problem, and more on with space interference. That's it! So, thank you.

[Applause]