Pierre de Vries: We now have our second panel on challenges, moderated by Anne Swanson, who's a partner at Wilkinson Barker Knauer. Thank you very much Anne. Take it away.

Anne Swanson: Thank you.

In this second panel we're going to pivot from innovation and we're going to begin to drill down on challenges in the 3D wireless world, and one of my panelists got real excited. He said, "Oh, great. That means all we get to do is complain. We can just complain about all the problems that we're having."

We'll continue to talk about spectrum, and communications regulatory issues, but we're also going to start to add an overlay of aviation, and aviation safety concerns a little more than we saw in the last panel. Two of our panelists are from the world of satellites, the two in the middle. And two are from the drone space. One high-altitude drone and one low-altitude drones. I'm going to keep my intros fairly short, as Pierre instructed.

Mike Tseytlin – immediately to my left is our first panelist. He's the director of engineering at Facebook, where he's worked for almost three years on Facebook's Aquila project, a high-altitude drone project. He's an expert. I've seen him in operation on melding technical concerns with policy issues. Prior to Facebook, Mike spent seven and a half years at LightSquared.

Joe Cramer, our next panelist, next to Mike, is a director of regulatory affairs at the Boeing Company, in D.C. Joe has spent 11 years at Boeing, and before that, he was with Lockheed Martin, and Rockwell Collins. Joe has both law and engineering degrees.

Brennan Price describes himself as a technically-minded attorney with spectrum and IP experience. Like Joe, he has both engineering and law degrees. He's currently the senior principle engineer and regulatory affairs at EchoStar in Germantown, Maryland, which, as many of you know, is right outside D.C.

And, finally, Skip Miller, our fourth [00:02:00] panelist, down on the end, is CEO and founder of UASUSA. He has a long history as an entrepreneur, and developer, and he's now plying those skills in the commercial drone space, particularly working with low-altitude drones, fixed-wing drones that weigh less than 55 pounds.

So, we're going to have each of our panelists address a few questions. We'll wrap up with a couple of short questions directed to all of them, and then we'll turn it over to the first student that dares to ask a question.

So, Mike, I'm very interested in Aquila. I think Aquila, in Greek, means eagle, is that right? And you've been working for several years on this high-altitude, broadband platform. What motivated Facebook to get into this? How did you all enter that market?

Mike: Thank you Anne. So, Facebook is a obviously high-tech, innovative company. And as a high-tech company, you get excited about 5G, and augmented reality, and virtual reality. But, I think we should not forget that while a lot of people are excited about technology, there's still four billion people, but not connected. Not enjoying connectivity, not enjoying the social benefits of that.

And so, the major issue for Facebook is how to get these people connected. What should be the technologies? What should be the policies that enable the connectivity for the unconnected people? Even from the remaining four billion people, about half of them under-connected, and they're counting their…they're counting every month what they spend. And so, the mission here is how to make the walk from the people who are accountant of their internet, to their abundance, that everyone can make as much, get as much internet as they needed, and can consume as much data as they possibly can. So, not a single technology can solve the connectivity problem and the digital divide is very real. In the wealthy world, people cannot afford connectivity, and they [00:04:00] people that can afford something are already covered .

So, that's one of the reasons that Facebook developed innovative technologies that may reduce costs of connectivity, and cost of connectivity is the major factor. You know, preventing people to get…

Anne: And one of the main technical challenges in launching this kind of activity.

Mike: That's exactly right. And so, we, as a Facebook…I won't say that…we are relatively agnostic. Probably from a lot of panelists here, we probably don't [INAUDIBLE 00:04:27] that do not advocate for any specific technology. Our mission is connectivity in itself, and any technology that connects people, obviously gets our support. We work with NGSO and NGSO satellites, we work closely with [INAUDIBLE 00:04:44]. But, what we determine that there is something missing in these different markets, and the [INAUDIBLE 00:04:52], could be that missing link. That can provide inexpensive capacity in a lot of developing world. So that…

Anne: How does this technology work?

Mike: So, basically, this is between the…where's the ball? The ball we cannot see that [Laughter] half an inch, somebody said that.

Anne: So, you're 60,000 feet up.

Mike: Yeah, so, it's basically 60,000 feet up. It's a good balance of a footprint, which is about 100 kilometers in diameter. The latency is comparable to the terrestrial services. So, there are two types of airplanes possible, lighter than air, and heavier than air, and between different companies that now pursuing that. Some pursuing heavier than air aircrafts, such as, actually, Aquila, that's what we do. But there are a number of proponents that develop dirigible types of aircraft, like [INAUDIBLE 00:05:48] is one example. But the idea here is that the, basically, the plane takes off in some way. It goes to the altitude of about FL 600, [00:06:00] in kilometers, and then it's assumes the position and provide some back-haul services.

So, Facebook's focus for these platforms is mainly on the back-haul service. But, obviously…

Anne: Wait, what?

Mike: Back-haul.

Anne: Back-haul.

Mike: Yeah, basically, what we are trying to do is to enable a back-hole connectivity, which we see it as the major issue for the terrestrial operators to deploy, and it's about in Africa rural connectivity expense about 50 percent, from the optics on the back-haul, basically, taking the connect back to the fiber. And so, that's the market that we are trying to address, basically, reduce the costs on the back-haul, but it's obviously possible to use [INAUDIBLE 00:06:41] planes as an access, basically sending it straight to the devices.

Anne: And give us a regulatory snapshot right now. What are the regulatory challenges, and are those countries specific, or are those cross-border? Which is dominant for you right now?

Mike: I think, similar that the previous panel that I very much enjoy, harmonized requirements for spectrum and aviation is the biggest challenge.

Anne: On aviation or on Spectrum?

Mike: For both, actually...but let's say Spectrum initially. So, on the Spectrum side, there is some small slices of Spectrum that were defined previously, but they are not harmonized as a few [INAUDIBLE 00:07:25] accepted them. And that was done for the 2G technology, HAPS. Basically, support voice. While our mission is actually provide the back-haul for 5G and 4G connectivity, and that requires 20 to 30, maybe 40 gigabits of capacity.

So, identifying that broad slice of Spectrum that can support broadband connectivity is a major challenge. And, we working now for last year to harmonize these requirements, and the work of this [INAUDIBLE 00:07:52] administrations to basically implement the recommendations, and adopt the recommendations, such as [00:08:00] Julie mentioned, as part of the talk.

But, that's a major challenge because spectrum's a contested resource. Now, truly, in the areas where we try to connect people, that resource is not very contested. An example of that, I was stationed in Madagascar, and…

Anne: Madagascar?

Mike: Yeah, Madagascar, and [INAUDIBLE 00:08:21] and you could put a spectrum analyzer and it would show a straight line, like, literally nothing. Yet, all the spectrum was gone. Nothing left. So, that is example obviously, of policies that prevent connectivity. Spectrum was a [INAUDIBLE 00:08:42] resource, and you've got NGSO, and NGSO should manage interference, and, obviously, interference ideas that undertaken right now at

ITU, is something that we're looking forward to prove, that, HAPS, can coexist with other technologies as well.

So, on Spectrum, harmonization is everything, and, particularly, because a lot of other countries in Africa, in Latin America, they don't have their strong, regulatory borders, so they very much relying on, ITU, to give them [INAUDIBLE 00:09:13]. In countries like United States, UK, and Europe, they have sufficient number of expertise to do this, studies in-house. Now, but, for the aviation piece, if you want to go there…

Anne: And in the aviation piece, I'm particularly interested in craft certification. When we move into aviation, we focus on the aircraft, and type certification, and special air-worthiness certificates. What have you all done in that field to design, produce, and get the relevant certificates?

Mike: Right, but I would like to even start before that, with a disconnect. So, there's two aviation under the UAN ITU, which is the International Telecommunications Union, and ICAO which is the…

Anne: ICAO.

Mike: Yes, similar aviation organization. And, for the upper [00:10:00] E- class which is HAPS belongs to, relations really not harmonized, and actually no uncommon terminology exist. HAPS is the ITU terminology.

Anne: Let's talk about what ICAO calls UAV's. They don't even call them UAV.

Mike: HALEs, for example. So, that is different, even terminology

Anne: They call them RPA's. I mean…

Mike: Well, yes, RPAs and UAS, and any other words. So, but, ultimately HAPS, lives the world of ITU. In the ICAO, it's called, HALE. HAPS that at the Spectrum, our definition starts at altitude between 20 to 50 kilometers.

Anne: So, how is Facebook approaching this? What do you do with all this tangled web?

Mike: Well, first, it's not the Facebook alone, because, even companies as Facebook cannot sort out that, be set up, upper air-space alliance, where we can actually…a lot of partners join in, and [INAUDIBLE 00:10:57] for example, a member of this upper-space alliance. So, we advocate through the ICAO, through the, obviously, FAA, EASA, and other [INAUDIBLE 00:11:09] harmonized approach to aviation. At the same time, they're try to advocate harmonized approached for Spectrum. But, even in the World Radio Conference of 2019 that is happening. They're still this disconnect…

Anne: Can you say that again for me?

Mike: World Radio Conference, 2019. That is going to take place in 2019. That disconnect still remains. HALEs, or upper-class E aviation under ICAO, 20 kilometers…

Anne: For folks who haven't worked in the -- talk about HALE. Some people didn't go to the first one.

Mike: HALE, so, on the aviation side, [INAUDIBLE 00:11:44] HAPS, it's all called HALEs, high altitude, low endurance platforms. And their specification is totally different from the spectrum. And so, that's a disconnect between spectrum and aviation, where the high-altitude endurance platform operate above class A, which is [00:12:00] upper-class E, 60,000 feet and above.

But the [INAUDIBLE 00:12:06] identification under ITU is, HAPS, which operate above 20 kilometers. And so, it's unclear what separating…

Anne: We see the challenge. You've had a challenge.

[Crosstalk]

Mike: 18 and 20, is anyone's guess. But, that's a lot of challenges here, yes.

Anne: Let's move on to air traffic management. I mean, that's something that, we talked about collision totally different in the last panel, but air traffic management as we move into the world of drones and aerospace, what do you all see as the role for regulation of air traffic management?

Mike: So, our traffic management is very important in this case. In upper-class E, until now, was just military planes, until recently. But, as you hear, there are actually a number of companies that now want to utilize altitude above 20 kilometers. Commercial aviation, jets, unmanned aviation, and so, for people who not only, basically, UTM [INAUDIBLE 00:13:02] ETM…

Anne: That's another acronym. Can you…that's actually an acronym within an acronym.

Mike: UAS Traffic Management, which itself stands for Unmanned Air-vehicle System Traffic Management, if you take all the words apart. Basically, in a nutshell, it is how to identify the different airplanes, how they don't bump in one another, how they can inform if emergency happens, so they can go…

Anne: Air traffic management, for drones.

Mike: So they can go down to the class A airspace, and if they account for the class airspace, how can they identify by the [INAUDIBLE 00:13:35] class E. So, this is actually very important subject that should be determined, and the activity is championed by NASA. In fact, they have a conference starting tomorrow, for the first time, to talk about ETM, which is upper E class traffic management system. So, it will take, probably, a few years while the setup, it might be two or three years while they set up the procedures [00:14:00] and define the UTM scope of work. Then it will be recommended to ICAO, and other aviation…

Anne: I think at the domestic level, it's going to be shunted partly from NASA, back to the FAA for…

[Crosstalk]

Mike: At the domestic level, NASA will sell to the FAA, and then the FAA, obviously, will work with [INAUDIBLE 00:14:22] for the standardization piece and with ICAO for the harmonization piece. So, that's how it's going to work.

Anne: But, I think the Holy Grail, ultimately, for you, is going to be autonomy, right? And right now, there are some rules that prevent you from doing that kind of the, one craft, one pilot rule. What are some of the challenges you see in reaching autonomy and fully autonomous operations?

Mike: So, autonomy, lot of times we misunderstood, because when we talk to…maybe here in the U.S. it's well understood, but when we talk to middle-eastern administrations, they think it's, like, artificial intelligence. The plane flies…

Anne: You think it's like what? I'm sorry.

Mike: Artificial intelligence. It's like the plane has a mind of its own, just flies where it's supposed to be. In reality, for the most part, we're talking about semi-autonomous operations, in that, most of the time, aircraft, when it's in service, can get autonomous, but it's monitored. And, if any emergency situation developed, if there is any anomaly is being developed, then control goes to pilot. And, then the pilot actually operates the plane. So, when they're saying, one, solve the issue of autonomous aircraft, one pilot monitors multiple airplanes, or airframes, but really, just during the station-keeping and normal operations. But, in emergency scenarios, an anomaly has developed, then it's going to be, actually, pilot, actually, controlling the situation and flying the plane.

Anne: When do you think you'll ultimately get to autonomy?

Mike: You know, I would think that's about two or three years. Optimistically speaking, but [00:16:00] good relations can happen, and it's mostly because there's a large number of the companies that are now interested in flying autonomous or semi-autonomous airplanes in that airspace. Obviously, Joe can have a different perception of that.

Anne: I think we need to bring in traditional satellite a little more at this point, and talk to you, Joe, about your perspective on what you think satellite can do in the broadband space. I mean, you know what Facebook is up to now, but give me your perspective on satellite, and broadband, and the challenges that you see for us from a technical standpoint.

Joe: Well, first think I should say is, anything I say cannot be held against my company, because I haven't said anything that they can review, you know that as a lawyer. But, as you know, from some of the slides before, Boeing is proposing an NGSO system to provide broadband and high-speed broadband services to fixed locations. Mostly, like, your house. You know, small antenna, about yay big, flat, sits on your RV, your car, or your house, and you can get high-speed broadband via an NGSO network.

And so, we already talked about NGSOs and all the nuances about that. So, that's our proposal. That's what we'd like to do. We have a lot of the same challenges as Michael at the ITU…

Anne: What are your top three technical challenges?

Joe: Well, designing the antennas, getting the regulatory approvals, which, I think, could be are just as difficult, if not more difficult than the technical challenges, and how about just those two. How about that? You know.

Anne: Okay.

Joe: And then getting people to buy it, right? That's always a minor technicality for most people, so, those three. But, internationally, the fun challenge that we're having, and you saw one, Julie Knapp's, one of his slides, he had agenda item 1.14, which is the HAPS agenda item, one of the frequency bands that Michael's looking at for HAPS, is the same frequency [00:18:00] band looked at by the terrestrial cellular providers for 5G, which is also the same frequency band looked at by Boeing for its NGSO system.

So, there's a minor regulatory, not challenge, but fight or something. We're all going to discuss it very cordially in Geneva over the next couple of years, and we'll see what the 2019 WRC does with respect to the satellites there.

Anne: How about the intersection of satellites with aviation in providing broadband to planes, and is that just a natural progression, or are there going to be new challenges there?

Joe: Tons of challenges, it's always fun. I have to admit I don't consider myself too much of a satellite person. I do Boeings, Boeing commercial aircraft, Boeing military aircraft systems, and regulatory spectrum stuff. So, I find the biggest challenge with respect to communications, and command and control, to be less with broadband. Because, right now, you can get broadband to your airplane. And, those of you who flew here, you might have flown on United, or Delta, or something, and you're getting decent broadband speeds to your commercial aircraft. And that started about 10 years ago, 15 years ago, with connection by Boeing to bring broadband to your commercial airplanes.

And, it's just evolved and gotten better over the years, and I think it'll only continue to get better. That's good and bad for the businessman, because that used to be the last place we could hide, is on the airplane, catch a few hours of sleep, but now you're doing work. Double-time.

Anne: And how about the current process of getting spectrum allocated for aviation in general and assigned for command and control?

Joe: So, again, in the slides before, it's great. If you were here earlier, you've already seen my answers. You need to get approval from more than one international, and, generally, [00:20:00] administration regulatory body, in order to be able to deploy something on an airplane that travels beyond a single country's borders.

You need, first, the international telecommunications union, the ITU, to give you and aeronautical, generally for command and control, a safety allocation, because, what we haven't talked about today yet, is safety is number one. The reliability required for a communications, or navigation, or surveillance system on a commercial airplane requires a reliability of, failure rates of one to a billion.

And, what people don't seem to realize with respect to UAVs and, maybe even, HAPS, because a HAPS, in my opinion, is a UAV below 60,000 feet in terms of the regulatory perspective. You need to provide the same levels of reliability in your command and control. Especially, the larger the aircraft gets, because, obviously, the damage and consequences change to a 737-size airplane falling on somebody's house is a lot greater than the consequences of your Best Buy or Brookstone UAV, that you fly around, landing.

So, the requirement, at least in my opinion, have to be greater in terms of the reliability for the command and control, sense and avoid, and avoiding the other aircraft. So, you talked about the regulatory problems. The FAA is one of the biggest players in this. As Boeing, we make unmanned underwater systems. We make unmanned aircraft. We make satellites. We make airplanes. We make -- you name it, we make it. So, we have found that the FAA is putting requirements on our medium sized UAVs [00:22:00], that, before, we only used to sell to DOD. Well, guess what?

Now we want to sell to state and local police and fire like everybody else, these services. They're not the Federal Government, and the regulatory regime is different when you're not selling it to the Federal Government. So, the FAA will say, "You need to put ADB-B," which is Automatic Dependence Surveillance Broadcast. Basically, it's a device that sends out a signal at 1030 megahertz. This is who I am, and this is kind of where I am.

Anne: And what's the cost of it?

Mike: Of ADB-B? Well, we're trying to figure that out for our small UAVs, because they don't exist yet, the devices. They have to be yay big. Every pound of avionics you put on an airplane is one less pound of payload or other stuff that you, fewer even, that you can put on that same small UAV. And the FAA requirements are impacting our ability to do things, such as, high-definition video, over a longer distance, on a medium-size or 55-pound UAV. We find, or, at least, I'm finding the FAA technical requirements are impacting the Spectrum by putting on more avionics requirements. And, obviously, the larger the aircraft the more avionics.

I envision the FAA saying to Michael and Aquila, of large aircraft, "You need to have the same avionics on that HAPS, because it flies through commercial airspace, in order to get to altitude as you have to put on a Boeing 737." So, the regulatory challenges and trying to find ways around, maybe [00:24:00] not having to do all of the requirements that might come from one or more government agencies? To be a huge challenge.

Anne: At reducing its manned aviation down to unmanned. I mean, it's just…

Mike: Fundamentally, they want to copy and paste the requirements. That's my perception. And that goes the same for ICAO, as well as the FAA and the U.S., and EurOK, the standard setting bodies. They're taking what they've done for manned aviation and just, kind of, putting it into unmanned.

Anne: But, that's what you and I do on a daily basis. We advocate for lessening or elimination of a lot of that, and it is a challenge, because they really are, you know, manned aviation and those regulations are their familiar. How about traffic management in the drone context?

Mike: Oi yoi yoi. Okay, so…

Anne: Do you agree with his challenges? Do you see different challenges?

Mike: That, and more. How about that? So, who here has flown? I want to wake people up, because that's, you know. Who here has been on an airplane? Who flew here? Right. What you don't want to happen is a small UAV flying into your engine, right? It will take out the engine. Now, that's okay if it only takes out one engine, because we build airplanes that can fly on one engine. But, what if two do? Or a flock of them do, right? So, for me, the big regulatory challenge, and this goes to Julie and the FCC is, how do we mandate a technological level, the inability of a small UAV, small even, from flying in airspace used by the planes you fly on? Commercial aircraft. Now…

Anne: Well, you first need to identify it, so there's the aviation rule making committee going on on identification and authentication. Have you all been following that?

Mike: I'm sure we are, but I'm not. I only have so many hours in a day. I'm busy. They'll solve it for me, that's okay. And so, how do I do that? Now, the big challenge is, I saw on the board, multiple [00:26:00] times, cellphone systems. The cellular providers want to provide command and control of UAVs.

Well, guess what? I want to use my cell phone at an airport. Well, that's the same cell phone signal, theoretically, that's going to operate a UAV. So, if I'm the FCC, how do I prevent a UAV from flying at the airport, where my planes are flying, while still enabling at a technology level? The regulation can say, "Thou shalt not fly at an airport," but, realistically, how do we physically prevent that from happening?

And, really, we need to solve that. So, the engineers out there, here's a good project for you guys, for your grad school, and the law students, here's something to think about, the regulations that need to be put in place to do this. And I find that to be one of the big challenges. And it's the same with Wi-Fi, because unlicensed spectrum versus the cellular and other technologies.

The other aspect is the reliability. If you provide, if you have a UAV that has any kind of real size and weight, the FAA's going to require reliability in your command and control system, or, the smartness to, if you lose signal, to stop what you're doing, and fly back to your home base without hitting somebody else, or a building, or such-and-such. How do we do that? I find that to be a challenge that we still have yet to solve from the regulatory, and maybe, probably even, the technical.

Anne: Do you think international coordination going on, or not?

Joe Cramer: Only for flying in international airspace. But, it behooves the UAV, in my, the UAV manufactures…

Anne: Equipment manufacturers.

Joe: Because you want the economy to scale. You want the regulations to be the same, and fundamentally, if you're flying class A or E? I can't, the names, the certain airspace that commercial aircraft fly in, you're going to have to [00:28:00] follow a little bit of what ICAO says, International Civil Aviation Organization, and you're going to have to play in those regulatory bodies in order to get the standards and recommended practices, as well as the minimum operational performance standards, or MOPS, which are developed in the United States by RTCA, which is just an acronym, doesn't really have a thing for it anymore, and EUROCAE, which is the European equivalent of RTCA.

Anne: And what is RTCA, please?

Joe: Sorry?

Anne: RTCA, please?

Joe: It used to mean, Radio Technical Committee Aeronautics or Aviation. Now, they just got, they just say RTCA.

Anne: So, they're a standard setting body.

Joe: Yeah, you have to know what it means.

Anne: They're a shadow government entity that helps the FAA make rules, basically.

Joe: Fundamentally, yeah.

Anne: So, we've done challenges in high-altitude drones, we've done aerospace. Now we're going to return to traditional satellites and EchoStar, and Hughes. I guess you were talking about challenges with me, and one of the questions you wanted to cover was, how do NGSO constellations intersect with GSO operations, and are there sharing opportunities there, or do you see challenges?

Brennan Price: There are challenges, there are opportunities. We're optimistic that we'll be able to work through these things. But, just to add to the problem that Joe mentioned at the beginning of his presentation, the same band, of which Michael is interested for HAPS systems, and Joe is interested for Boeing's NGSO system, and the terrestrial wireless folks are interested in, is also a target of interest for a number of other NGSO applicants.

And, my company, the Hughes Network Systems subsidiary, which has applied to operate a geosynchronous satellite within the 47-48 gigahertz band.

So, the issue is complex and we continue the discussions over the next two years to [00:30:00] determine exactly what the sharing solution is going to look like. As far as the specific case of NGSOs, however, NGSO systems have been studied at the ITU in terms of compatibility with geosynchronous systems up to 30 kilohertz, pardon me, not kilohertz, good Lord, 30 gigahertz. What's six orders of magnitude among friends?

The agenda for WRC-19 is considering appropriate protection criteria and powerful [INAUDIBLE 00:30:37] limits for NGSO systems at the higher bands, the so-called Viet-cue [Phonetic] bands, going on up toward 50 gigahertz and above. The ITU limits on equivalent power flux density, essentially, how concentrated RF energy is, going up from Earth to a point on the geosynchronous arc, and vice versa, how concentrated energy is coming down from an NGSO constellation onto the surface of the Earth. Those ITU limits have been studied. We are gratified that the FCC adopted them in the recently completed NGSO rule-making. We view equivalent power flux density limits as important to our interests. In the bands that we're sharing, exists as far between GSOs and NGSOs we're optimistic…

Anne: Too many acronyms.

Brennan: Sorry about that, between geosynchronous satellites and non-geosynchronous systems. We're optimistic that coordination agreements can facilitate that call for reduction of power when necessary, can be reached. Determining when these reductions are necessary is easier in the GSO case, as opposed to the [00:32:00] NGSO versus NGSO case, because you have one target that's not moving, as opposed to two satellites that are moving at the same time.

Finally, as for opportunities for compatibility between NGSO, between non-geosynchronous and geosynchronous systems, we, obviously, the inter-satellite allocations do exist and provide opportunities for offloading of traffic from one web network to another. Within the fixed satellite applications, that actually does add a complication to the power flux density analysis. So, these are the problems that keep me up at night.

Anne: Let me get you to speak a little bit about the Space Data Alliance, because you guys are a member of that, and some of the specifics you're addressing there?

Brennan: All right. The Space Data Association, I thought it was, but it could be a…and their space data center, is a very great resource for evaluating collision potential and RF interference potential. I'm sure it will be part of the solution as to collision avoidance, as NGSO systems deploy. I'm hesitant to say that a private sector solution is the only solution in this case.

First, if you look at the list of members of Space Data, there's some very significant players that are absent. Second, the nature of satellite system co-existence involves the engagement of government and, frankly, multiple governments. And, finally, there's a significant amount of public sector operated space systems. So, I think it's important to all in our industry that governments continue to take active roles in both, in domestic regulatory bodies and through international organizations, ITU and the other appropriate organizations, so that these issues [00:34:00] can be addressed and mechanisms can be established.

With the amount of money that all of our companies are investing in next-generation satellite and aeronautical infrastructure, this is something that we really need the support of, not only ourselves, but…

Anne: Let's switch gears a little bit. How does the 5G bandwagon affect satellite? For instance, I'd love to have you talk about efforts to get satellite onto the 3GPP roadmap.

Brennan: We have been successful in getting satellite on the 3GPP roadmap. There is an open-study item in 3GPP on satellite networks and their contribution, pardon me. 3GPP is the 3rd Generation Partnership Project, is highly influential standards body in establishing protocols for various generations of telecommunications systems, and it has traditionally focused on the terrestrial, and we have been successful, along with other players in the satellite industry, in establishing a satellite item.

We view 5G as something that is not necessarily, that cannot be limited to terrestrial networks simply because terrestrial networks are not going to be able to reach every person on Earth. There are some difficulties in using millimeter wave bands for coverage in some parts of the country. The density that you have to, the density of base-stations that you have to have for a terrestrial 5G station to cover a particular area, is much greater than [00:36:00] what we would have at one of the lower bands at, say, three gigahertz, or six gigahertz or so forth, and the so-called mid-bands.

Our goal for 5G is to be an important player in the system, and to be a competitor within that environment. And we think, in order to do that, it's imperative for regulators to maintain technological neutrality, and to promote policies that allow the various platforms of GSO systems, NGSO systems, aerial systems, and terrestrial systems, to serve customers in the way that best fits the customer.

Anne: Hughes has been -- I grew up in the D.C. area -- Hughes has been a large government contractor for years. Can you expand that thought? I mean, how do you think new space is going to affect the space business ecosystem? I mean, that's got to be a challenge for your company.

Brennan: We think that GSO systems are going to continue to serve government and other users reliably and well. There is value in the wide-area coverage from a single spacecraft that is at a stationary point in the sky with reference to any given point on the Earth for government applications, and for other applications. Even in the case of Earth stations and motion, where we've done a lot of work with our government peers, where there's a station in motion, aboard an aircraft, a vessel or a vehicle, targeting a stationary point in the sky. Having a GSO system makes tracking very easy. So, we believe that GSOs will continue to function well in the new space environment.

That being said, we do acknowledge that new space [00:38:00] applications, such as NGSO constellations have great potential, particularly in applications where a shorter round-trip between Earth and platform, and Earth is critical for latency purposes. Hughes is among several investors in OneWeb, and we anticipate working with them to bring all aspects of their system to fruitions, though we do realize the landscape is changing. We believe we have a role to play as a GSO operator and NGSO partner.

Anne: Let's go from macro to micro. Skip, down on the end, is recently, fairly recently, entered the commercial drone service and operation business, and I think you've done it mainly with fixed-wing craft as opposed to rotor-craft. What are the challenges of operating fixed-wing drones, and how are those different than rotor-craft? Either small hobbyist craft or larger rotor-craft?

Skip: My company's name is UASUSA. That's Unmanned Aircraft Systems, and I designed with my partner, aircraft about seven or eight years ago for the University of Colorado, so I'm kind of proud to be here with the University of Colorado, to chase thunderstorms and tornados. And, I had a strong model aircraft background. I designed this aircraft, and the rest has, kind of, been history for us. At this point in time, I sell fixed-wing drones, fixed-wing aircraft. I don't think…

Anne: Why did you decide to do fixed-wing and not regular aircraft?

Skip: Well, I was going to go there right now. How many of you…I saw earlier, there was show of hands of how many flew out here. How many of you flew out here on a helicopter? Oh, there's one that flew out on a helicopter. I hope it wasn't too far away. A helicopter is a very, very inefficient object. It is very good for going up and down, and perching, and staring, etc. But, it has, really, no efficiency range. A fixed-wing aircraft is an aerodynamic object. It can go very far. For example, our Tempest [00:40:00] aircraft, on one battery, I can launch it out in the parking lot and fly a hundred miles from here, and look at whatever I want to look at.

So, I think, the big one is…the hobby grade people got involved. DJI is the big gorilla in the room that has promoted, basically, through the Phantom helicopter, the small one, very, very successful business story, but it's created its own little nightmare. And, I think the big difference is, when you deal with what I deal with, which is the future, which is, what can these vehicles really do? I am a strong believer in efficiency, and distance, and duration.

On the earlier panel, there was a discussion, briefly, about agriculture. Agriculture's really strong, and can be really strong for multi-rotors and for fixed-wings in the future. But, infrastructure, all the power lines, all the roadways, all of the infrastructure that we operate on needs to be inspected at all times. And, with a vehicle that's a fixed-wing, and the efficiency that you have, it can cover that ground every easily.

You actually are required today to do that with full-size aircraft. Unfortunately, youngsters coming up don't want to sit in the back of a Cessna with special glasses, looking at insulators on power lines. It's just not that sexy environment. You can do this all with the drone safely and carefully.

So, I think, the big one is the multi-rotor's excellent for, if you just want to pop up and look for 15 or 20 minutes, but if you have to get into some distance or duration of survey, that's where the fixed-wing comes in.

Anne: What are the fuel challenges with fixed-wing?

Skip: Well, we fly electric airplanes. So, our airplane flies anywhere from an hour and a half, to, a version of our aircraft that University of Colorado's flying right now, is flying for three hours on one charge, and it's a fairly small battery, comparatively speaking. Again, this aircraft, our aircraft, was designed to be efficient. I come out of the sailplane competition world, and I've been competing for a long time in that arena. [00:42:00] And sailplanes were the most efficient aircraft.

Certainly, what Michael's trying to develop, the high-level, about 60,000 feet area, that's a whole other beast right there. That's a very lightweight, another level of elegance of flight. But, at any rate, for our aircraft, the sailplane side has always been the thing that made it most efficient. You can do fuel aircraft, and a lot of the military drones that you know, are fuel oriented. And, they have long durations, four, six, eight, ten, hours. Bigger aircraft, need a crew to operated it and stuff. Our, basically, our aircraft takes two people to operate, a computer operator and a safety pilot, and you can fly for an hour and a half. But it can go anywhere you want.

Anne: But, I don't see commercial drones, certainly fixed-wing drones, out and about in the world every day. What are the things that the governments, specifically the FAA need to do to facilitate the growth of that industry? And I'm going to limit you to just a minute or two there. I know the list is long.

Skip: Okay, so the FAA is an interesting organization, and I'm sure there's some full-size pilots in the room, and the FAA, it's always interesting how they approach a problem. They've come a long way with the 107. It used to be you could only fly with a 333. University of Colorado has more colors of 333…

Anne: And with the 333 you had to get something before you could take off. Now, with 107, if you comply with those rules, you don't need advance authorization to fly.

Skip: Right. You don't need an advance authorization and it made all those hobbyists, they can actually fly a drone. But, here's the interesting thing, I think everybody in the room probably has a driver's license, right? How many of you went, studied, took the driver's test, without ever driving a car? That's what the 107 does right now. You can actually go get this test. You can be legal to fly the drone. So, the FAA is not quite moving with the speed. It's great that you can do this, but then, if you come up to me and say, "You have a 107. I have to ask you to show me how you fly."

Anne: So, there are pilot training issues. I think there are also going beyond visual line of sight issues, they're [00:44:00] flying at night, they're flying over people. There are just a whole number of issues, but I think if we could solve, we can, hopefully, get away down the road, right now, we can get waivers, but not for all of those, particularly not for package delivery.

Skip: The 107, it's a step, it's the best step the FAA has made for the commercial drone operation. Also, 400 feet and below is not a place where you want a 747, except on a take-off and landing. Why some of these idiotic people fly into airports with a multi-rotor, I have no idea. I really, really, I don't even understand it. But, really, the only place where you're in jeopardy, is a person that's out of control out there, and just said, "I don't give a about rules and regulations. I'm just going to fly the drone."

But, as far as 400 feet and below, if you just give me 400 feet and below, and tell me to stay away from five miles from any airport, I'm a happy guy. But, it's all, once again, time will tell on this one for sure.

Anne: And we're going to need to start teeing up solutions here. I guess I'd like to go down the line, really quickly, and have each of you give me two solutions that you'd like the next panel to solve. And then we'll open it up for Q and A. So, what are the two solutions you want the next panel to solve?

Mike: [INAUDIBLE 00:45:08] Spectrum…

Anne: Can you be a little more granular than that?

Mike: There is not enough granularity on that, but obviously harmonization of spectrum and was the best way to achieve it between so many competing services, right? So, you have 5G, and satellite, and NGSO, and GSO, and HAPS, and…

Anne: So, you're talking spectrum coordination…

Mike: Spectrum coordination, whatever the rules that needs to apply to spectrum of the future. That definitely could be an interesting challenge.

Anne: Joe?

Joe: Spectrum. Well, that was a tough one, because I didn't think about that one ahead of time. I think finding a way to realize that safety has to be number one, in terms of UAV's flying in the airspace. And, I think they can do that. So, I'll let them come up with the answer.

Anne: Brennan?

Brennan: I'm going to say spectrum and spectrum, and split it into two parts. Terrestrial spectrum, [00:46:00] both geostationary and non-geostationary satellite networks really need to have a slight degree of flexibility and the ability to sight the Earth's portion of their networks, and also some certainty early in the design process, so that the satellite can work with the network as established on the ground. The initial efforts to establish terrestrial wireless rules for 5G, in my view, do not provide the necessary amount of certainty for satellite operators. And, we, very much, would like to see that in other bands.

With respect to spectrum on space stations, the NGSO, of EPFD limits, are on V band, are something that will be of primary importance to GSO interests and we'd like to see that resolved. So, those two big issues.

Anne: Skip, one challenge for the next panel?

Skip: Okay, one challenge. I think the big one for me is, how do we solve teaching people what fully autonomous means. And, it's not just fully autonomous in pushing a button. It's fully autonomous with responsibility. And, how do we gain that responsibility so that we have no accidents?

Anne: Thank you. Who's the brave student who wants to identify himself or herself?

Jordan: So…

Anne: Hold on, the mic is coming.

Skip: Mic coming.

Jordan: Thank you. My name is Jordan. I'm a 1L here at the law school. Michael, I don't want to call you out, but you were asked about the Holy Grail of autonomy, and I feel like you gave a political answer about having a person always there, able to respond. Is that actually the case, or, and I want to open it up to the rest of you [00:48:00] guys, because, full autonomy, Skip, I'm glad you transitioned into that, is really the Holy Grail, right?

We don't want to have people to have to respond to these things, when we can have autonomy, full autonomy, action and control, in a safe environment, know how to respond to those emergency situations.

Anne: I think that's for you.

Mike: Yeah, so, ultimately it is going to happen.

Anne: I think you were referring to some regulatory constraints first, right?

Mike: For full autonomy? Full autonomy, you know, as anything today, there is, really, everything ruled by exceptions except for the part 107. There is not even the rules exist. It's all exception-based rules, so, waiver-based rules. But, as experienced company and the new statistics come in, then it's become a rule. And so, ultimately, I believe that full autonomy will be implemented. Maybe together with artificial intelligence, and, you know, another Holy Grail today. Everyone talks about it. But, before that happens, I think, certainly not for a long time, we should see self-driving cars first, that can drive people. And then, when that works, then we may have self-driving planes with, they have the mission determined. But, I don't think that we are…it will happen, but it's not near-term, I would say, many years.

Joe: Can I throw in that now? So, my prediction for autonomy is 10 to 20 years, all right? Autonomy is really…

Anne: That's from takeoff to landing.

Joe: I could do that today, but the regulatory and political…

The public perception will depend on Tesla's self-driving vehicle, and, as I get older, me being able to go to the grocery store with somebody else driving the car. When the generations, when we get older, we will want people to drive for us. When people are comfortable in their cars being driven for them, they will be comfortable having no pilot [00:50:00] in the commercial airplane.

But, to get there, the technology's there to do that today. I can back up the airplane from the gate. I can drive on the airport. I can take off. I can fly. I can land. I can go back to the gate, today. But, the regulatory restrictions don't allow it, and the public perception doesn't really, fundamentally, allow it. Autonomy is really, if this happens, then you go through a checklist of responses. It's that, and it's software programming. I mean, come on guys, you know, start working on it. You can do it.

Brennan: I think fail safes are important in considering autonomy objectives. In the satellite context, we have standards for the operation of Earth station's motion, where they have to remain pointed to a fixed point in the sky, and intervention is required if something gets out of kilter. Things are, generally, very well automated, but, when things fail problems can be caused, and I think, certainly, when I'm in a vehicle or on a plane, if an automated system failed, I'd like for there to be a backup, including a human backup, in case of this.

Mike: And even today, the satellite NOC, network operations center, which is…

Anne: I'm sorry, what?

Mike: Network operations center. If you go to any company, there's still humans actually monitoring. And that was 40 years, about 40 years that satellite launched. So, over these 40 years, with all the safety check, there's still person monitoring the number of satellites. So, that [INAUDIBLE 00:51:44] in a perspective for the autonomous, full autonomous aviation.

Anne: I think Dale had a question.

Dale Hatfield: Thank you. People who know me, will probably anticipate the question, but the sort of reliabilities that you're [00:52:00] talking about, and so forth, sort of looks at interference. For example, something that happens inadvertently, it's not somebody really intentionally. But, what bothers me is when people are intentionally trying to jam things or spoof, and they're hitting these control channels, which, we've all said, are so critical to the command and control channels. And, are we doing enough to look at the intentional? This is the really bad guy who wants to do something really bad. Are we looking at, because, when I hear numbers, like, one out of some billion, that, you know, it only takes one kook, right? I'm worried about it. Do you think enough has been done in terms of intentional interference in jamming?

Anne: Go ahead.

Dale: Spoofing?

Joe: I can speak for Boeing, and we are working on that now, with respect to, not just spoofing and jamming in the comm sense, but also hacking into the actual aircraft itself, you know, by anybody, whether it be wireless or not. And, we're working with government agencies and, no sense getting into details.

Dale: I see a lot of the work being done on the external electronics. What I don't see as much of is when the signals are coming in from outside the plane which you can't prevent. You can't shut off the communications. So, anyway, I'm worried about it, especially the externally generated intentional jamming.

Mike: But, I think, just to answer, we're obviously very careful about spoofing of the launch airframe that we are flying. But, I think that goes to show, the communication links help, so it's hard to spoof if you have a number of communications, terrestrial, satellite, line-of-sight, beyond line-of-sight. So, that, coupled with the better technologists, better relation techniques, [00:54:00] basically makes the plane certifiable from the safety perspective including spoofing.

Anne: Are type certifications looking at that kind of issue as your craft are getting certified?

Mike: So, that certification does not look at the jamming, for example, of the signals. It makes it certifiable to fly safe, the plane, but not if it's maliciously spoofed or tried to be intercepted by others. At least, not presently.

Anne: Right. I saw another hand up.

[Silence]

Anne: Any other questions? Join me in thanking this panel.