Pierre de Vries: But we turn now to our solutions panel. So, these are the folks, this is the standard joke, right, you will tell us how to solve all the problems we've heard about, or else you'll tell us what the problems are as well. So, our last panel, and after this panel, the moderators will come up and try and help all of us make sense of what happened this afternoon. Before we get to that, solutions panel moderated by Anna Gomez, a partner at Wiley Rein and a wonderful supporter of the program. Anna.

Anna Gomez: I am delighted to have this great… Oh, I wasn't on, was I? I am on now. Thank you again. I'm delighted to have this really excellent panel to talk about how we're going to solve all the challenges that have been raised so far. It's been an interesting day going from innovation to challenges to now talk about the potential solutions. What I've identified is two general areas that I thought we would talk about today. The first is preventing collisions and then, also spectrum. How to handle the proliferation of systems and the need for spectrum, which Julius already told us this morning, we can't have dedicated spectrum for every single one of them. Thank you, Julie. We have a wonderful set of panelists, like I said. We did not intentionally segregate the men and the women.

[Laughter]

Anna: They are set up by alphabetical order.

[Laughter]

Anna: But I'm going to start by introducing the gentleman to my left. That's my left, right? Tom Hazlett, Tom is the H.H. Macaulay Endowed Chair of Economics at Clemson, and he's also a prior FCC Chief Economist.

[00:02:00] He also directs the Information Economy Project and will give us our very needed economic perspective on the issues that we are discussing today. Next to Tom is someone that needs no introduction because he's already been introduced.

[Laughter]

Anna: And I believe he was introduced as a national treasure. So, [Laughs] part of my job, by the way, is to harass our panelists because it's the end of the day, so I will be doing that. So, Julie, thank you for joining us.

Julius Knapp: Thank you.

Anna: Next to Julius is Jennifer Richter. Jennifer is a partner at Akin Gump. She is a very established attorney in telecommunications and spectrum, in particular, and unmanned aircraft systems, so she will be providing her perspective on unmanned aircraft systems and anything else she wants to provide her perspective on. And then, finally, Jennifer Warren. Jennifer is the Vice President of Technology Policy and Regulation at Lockheed Martin. Jennifer can talk about everything we discuss today. She can talk about drones, she can talk about high altitude platforms, she can even talk about satellites and stratospheric communication systems which has not been raised today, but she will be able to discuss that. And Jennifer has an illustrious history in communications, so I'm

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excited to have her here. I'm hoping that we will be able to run today's panel as more of a conversation, so, please, speak up, break in, be rude to each other, but avoid acronyms.

Jennifer Richter: Good luck.

[Laughter]

Jennifer Warren: That's what those charts say.

[Laughter]

Anna: We will also look forward to our questions and answers period, so please start thinking up something really challenging to ask us.

Even though I said I want to start this off as a conversation, [00:04:00] I did want to ask the two Jennifers to give us a little bit of a baseline with Jennifer Warren starting us out on while we talk about possible solutions to the issues that we discuss, it would be very helpful to have a review of the international regulatory regime for satellites in particular. So, if I can kick that off to you to start us that would be [INAUDIBLE 00:04:27]

Jennifer W.:   Okay, if we can get rid of that interference. So, yeah. So, I'm going to try and build on the very good primer that Smitty did at lunch today on international treaty requirements. So, there's really two main treaty documents that apply and impact satellite or space more broadly, and one is the Outer Space Treaty. And the reason I raise that is because it requires under Article VI of the Outer Space Treaty that each state party have an entity designated to authorize and supervise any non-governmental or private activity in space. So, while we've talked a lot about coms here, there's a lot of other new ideas from commercial satellite servicing which addresses some of the orbital debris and longevity in space issues to asteroid mining to Mars missions, etc. So, keep that in mind that there's that, and that without the US and every other state party having designated an agency to have that role for some of the really cool technologies that are coming forward, we cannot be compliant with that treaty, so that is a challenge. The second is the International Telecommunications Union which you've heard several times, so I'm going to use the ITU with all deliberation. So, the ITU is a treaty organization UN affiliated that is 150 plus years old, so it predates the UN.

[00:06:00] And it has, as a treaty requirement, regulations and processes for satellite networks. How to register your satellite, how to coordinate your satellite, and how to notify your satellite. This is very unique. No other technology has this requirement imposed on it at an international level which is again, in addition to any national regulatory requirement. So, again, that's unique. The purpose of it is good. The purpose of it is to ensure that a space system is actually protected in space from interference and is recognized internationally. It has treaty status. So, good goals but it's a very burdensome process, particularly as space becomes increasingly congested. So, the more and more space-faring nations you have, with more and more robust industrial space programs and commercial programs, the more congested it becomes, and so, the concept of coordination between and among satellite systems is increasingly

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complicated. And there are rules for how NGSO and NGSO systems coordinate in certain spectrum bands. There's rules, as we've heard, for how NGSO has to protect GSO systems in certain spectrum bands. And then, there's some kind of wild west rules as well. But all of this coordination has to keep in mind that every satellite filing request at the ITU has a seven-year window within to bring the satellite into use. Otherwise, that satellite filing gets cancelled. So, all the work, all the investment, all the planning that has been done by any entity is for naught without a treaty decision to extend the life of that filing. That's 194 countries having to agree that your satellite filing should be extended for reasons that had nothing to do with your fault.

So, [00:08:00] again, this is all very different from any other technology deployment environment that we're in today. And one last overlay to bring to your attention is another element of the ITU. In the Constitution, there's a provision called article 44, and article 44 requires the concept of equitable access to orbital resources. So, every country is intended to try and minimize its use of just what it needs for orbital access and the use of resources, so that every country has the ability to access space. And in particular, or with particular attention to developing countries, and then, those with unique geographic interests, so keep in mind small island nations whether you're an Indonesia or a Fiji those aren't as well served. Their global connectivity is really best served to date by satellites. So, those are some of just kind of the pressure points that are very unique to deploying a satellite system and keeping it operational compliant with national regulations and then, this international overlay which I think is, again, something we haven't really talked about.

Anna: Yeah, so, basically, as we consider solutions on how these different systems are going to interplay, we have to also consider the treaty obligations that we have is basically what you're saying, and we'll hear more about that, I'm sure, as we move forward. Jennifer, on the drone side, what I was hoping you would talk about, we've heard a little bit about it from other panels, but in terms of collision avoidance, there are some activities that are going on right now, both at the FAA, at NASA, and even in some of the security agencies, so what are some of the activities that are taking place right now on drone operation and collisions?

Jennifer R.: Yeah, so, building off of what Jennifer was just talking about [00:10:00] before I get to some of our domestic activities, one of our frustrations over the last four and a half years is that we've been focused on low-altitude traffic management for small UAS, so drones that are 50 pounds and lighter and operations ground to 400 feet, so it's a very sort of specific environment. There hasn't been an international body that's been thinking about what the spectrum solution should be for those drones, for control links, and payload communications, and collision avoidance, and remote ID and tracking. The ITU has been really focused on UAS at higher altitudes and using aviation protected spectrum that is coordinated worldwide, and they talked earlier today about the spectrum for HAPS where there's a study item that's coming up in 2019 to make more spectrum available. But we haven't had that same kind of international coordination for low-altitude. Something really exciting happened at ICAO at their Drone Enable couple of days at the end of the conference just a couple of weeks ago in Montreal. We were there talking about international systems for low-altitude traffic management for drones because they don't really exist, and there are no standards. ICAO had let out an

RFI asking for people to submit proposals for what those systems would look like. Oh, sorry.

Anna: RFI.

Pierre: ICAO.

Anna: And ICAO.

Jennifer R.:   ICAO, International Civil Aviation Organization.

Thomas: Busted.

Jennifer R.:   Sorry. That really threw me. [Laughs]

Anna: Montreal, ICAO.

Thomas: Like a drinking game.

Anna: Yeah.

[Laughter]

Jennifer R.:   Yeah, right. So, we were all there to talk through. I think 50 or more proposals were made and 17 were chosen to present at this conference, very exciting.

But the most [00:12:00] exciting thing for people in this room and for me, in particular, because I've been working on this issue for so long, is that a member of the ITU came and did a presentation, and his presentation was about spectrum for low-altitude drones which they've never spoken about before. And he validated that using the LTE networks really is the most logical solution for doing this which we've been saying for years, but it was really wonderful to hear a regulator say it. I swear to God he'd hacked my presentations for the last four years because he said everything I've been saying about the differences between unlicensed bands and licensed bands, the LTE bands, and the aviation protected spectrum, and each of them has a place for drones at different altitudes, but some are better than others for certain applications, so that was really exciting. I think what we're going to see is ICAO trying to develop a blueprint for regulators worldwide around low-altitude traffic management and what those systems should include. And so, that's really exciting, and I'll talk about that a little bit more later. But back to domestic activities, so there has been a remote tracking, an ID ARC, Aviation Rulemaking Committee that the FAA started this summer. The purpose is to take a look at technologies that can be recommended for remote ID and tracking of drones. This is a really important concept because last year the Department of Homeland Security stepped in and wouldn't allow the FAA to move forward with flight over people rulemaking related to drones, low-altitude drones until this ID and tracking had been solved. So, we were tasked — I'm a voting member on the ARC, well, I guess I still am, it's not over yet but close — we were tasked with studying solutions.

So, over 50 solutions were [00:14:00] submitted, and we bucketed them and thought there were roughly eight that made sense to us, and we've made a report, and we're making recommendations to the FAA administrator about it. That ID and tracking technology also relates, then, to this UTM concept that we've been talking about here today, so the UTM is the Unmanned Aerial Systems Traffic Management, and I'm just going to refer to that generically as low-altitude traffic management because I think it just makes more sense. The ID and tracking of drones will be fed into this low-altitude traffic management system which will be a dashboard. It will be just like what they have for high-altitude navigable airspace traffic management providing situational awareness of all aircraft in the air both manned and unmanned. And so, the ID and tracking is necessary because you need to be able to identify the drones that are out there. If a drone did not have ID and tracking, that might suggest to law enforcement that there is a nefarious intent. There may or may not be, but we hope that these requirements will be applied in a manner that's widespread enough that law enforcement will have an easy job of determining whether it needs to be concerned about any particular drones. And the UTM project is a NASA project. It's been going on for a number of years, so they're in their third phase of testing right now, and collision avoidance is one of the items that they're studying, all different methods of collision avoidance. This is all part of real field simulations and trials that they're doing. The ID and tracking and the UTM together provide an external way of providing collision avoidance.

It's sort of a [00:16:00] management function as opposed to the drone itself having vehicle-to-vehicle technology that will allow it to avoid another drone or another object, this system is an external fail-safe, so you kind of want to have both. You want the drone to be very smart, and then, you want a system that's there as a fail-safe. So, that's how all this stuff works together.

Thomas: Can I just ask her a question?

Anna: Ask away.

Thomas: Well, just on the ITU saying LTE spectrum would be appropriate for the very low drone space.

Jennifer R.:   Yes. Yep.

Thomas: How would that accessed? Through the licensees, the LTE operators, or…?

Jennifer R.:   Yeah.

Thomas: Through an unlicensed or a shared sponsorship or something?

Jennifer R.:   Yeah. These communications functions will take place through the LTE networks as they exist today. And so, I represent a working group, the CTIA working group that includes Amazon, AT&T, T-Mobile — Sorry, you're losing me — T-Mobile, Qualcomm, Intel, Ericsson, Nokia, everybody that's sort of involved in that ecosystem, and they're all very much on board with having these systems used to support drone communications.

Thomas: Thank you.

Jennifer R.:   Yeah.

Anna: And as I recall when AUVSI did its call for papers, since I'm sure you can't talk about what the remote ID ARC is recommending yet, but when they did their call for papers, there were those that said that the same technology could be used for some of the remote tracking, correct?

Jennifer R.:   Yes. Yep, yep. Tracking and ID.

Anna: Well, thank you for that. So, today, we've talked about domestic regulatory regimes, international regulatory regime, and then, earlier in, I forget which panel, we also talked about the parties, individual industries getting together to put together systems for managing traffic and avoiding collisions as well as RF interference.

               One of the things we wanted to talk about [00:18:00] is what is the right mix of government and private party action and also who are the right parties? You just mentioned ICAO, the International Civil Aviation… God, it's so… When all you do is talk in acronyms, you forget what they mean. Organization talking about having its own processes and recommendations for regulatory bodies. Is that going to become a treaty-based organization that all of the sudden tries to regulate drone flights and drone registrations and so on and so forth. So, what is the right mix? Anybody want to jump in, in particular? Jennifer.

Jennifer W.:   Okay, I'll jump in.

Anna: You breathed.

Jennifer W.:   Well, I think it's more than just a question of what one body because what we're really talking here about is a lot of different sectors of industry that are all playing a role. So, we haven't talked about launch corridors, so you've got launch sites, state space boards, the Cape, Vandenberg for launching satellites, so they've got to have… They're part of the collision discussion. You've got the manned aircraft, the unmanned, you've got the cube sats, you've got things being launched from space, not just from the ground, so you've got maiden space launching small satellites from the space station. There is all sorts of different players that need to come together to talk because it's only that integrated dialogue that's actually going to kind of get to a safe environment. And what I'm happy about is I'm happy about seeing, for example, the FAA, which we all know through… We think about from the drone side, the UAS side, but they obviously, manned aircraft, but they also are the launch authorization, and they also have responsibility right now for mission authorization for a lot of kind of the new applications [00:20:00] in space.

               So, right there, you got a dialogue among three or four parts of an agency that has jurisdiction over a lot of space and airspace related activity. To me, that's a starting point. And the fact that on the Drone Advisory Committee we have manufacturers of manned and unmanned aircraft, we have pilots, we have state and local governments

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which we can't forget, aside from federal interests. Having those type of fora are really important. I don't know where the end of the discussion is going to get, but having everybody engaged is really important because there are a lot of moving parts just to transit the airspace, to get to a stratospheric level, or anywhere in between.

Jennifer R.: I agree with that completely, and I think if you look at the whole landscape of what's happening with UAS today, there are a number of working groups that include both government and industry together, so the DAC is one that Jennifer just mentioned, the Drone Advisory Committee, but there are many others. There are probably a dozen, and I have a presentation if anybody wants to see it, I'll give you the slides. But there are probably a dozen that are working on these issues. It is a joint responsibility because the technology has moved so fast, and the regulatory environment just has not been ready for it. And so, it's incumbent upon industry to build the safety cases, to figure out what the collision avoidance technology is going to be, to help NASA with the low-altitude traffic management system. It really is incumbent on industry to help drive the solutions, and the FAA is really looking for that kind of input.

Anna: And presumably there is incentives for those that would prefer not to have regulation imposed on them to actually come up with the solutions, and maybe that becomes the regulations, but it's at least it's an industry led solution.

Jennifer R.: You bet.

Julius: Me?

Anna: Yes, you. You don't have to answer that question.

[Laughter]

Julius: [00:22:00] Just a few things. We're focused right now on UAVs, so I think there's a lot of tremendous work going on in the private sector. And before we start running ahead and saying, "Hey, we need to adopt rules…" I don't even know what the rules would be. I think there's a lot of this that can be addressed through the private sector. I see a very collaborative process with government that's going on. We heard about a lot of different issues here, about things like the spectrum for the command and control, and the spectrum for the payloads, and can you use a commercial wireless network, and I know that there is good work going on out there to make sure that, "Hey, yeah, that can work," or, "What the problems are? And how you solve them?" So, I think the thing to do is to just keep going. Let the process play out. And I think what we've been trying to do is keep our finger on the pulse and participating in the places that have made sense. Some of these issues are not what we think of as FCC issues. Like the collision avoidance, that seems to be more in domain of FAA and things like the identification and so forth. It certainly seems to be more in the FAA domain.

Jennifer W.: Julie?

Julius: Yes.

Jennifer W.:	Can I challenge on that?
Julius:	No.
Jennifer W.:	Just a little bit? Okay.
[Laughter]	
Julius:	You wanted controversy.
Jennifer W.:	She said to interrupt.
[Laughter]	
Julius:	Go ahead.
Jennifer W.:	Okay, I wasn't sure. But I think everything you've said is correct for the small UAVs, but I and many other in aerospace and defense look at larger than small UAVs. And to use Michael's term, HALE, High Altitude Long Endurance, those [00:24:00] will require a different approach than the low-altitude traffic management, and so, dedicated spectrum for at least command and control is going to be something that you're going to see a different case being made for. But I think the challenge here is which comes first because the FAA has to set out performance objectives, we have to be able to meet those performance objectives with the spectrum that the FCC will make available for command and control, so it's going to be an interesting timing scenario. And the one has to be informed by the other, then the other has to be satisfied that the performance objectives can actually be met through the way the FCC has made that spectrum available. So, I just wanted to say there's a little bit of a collaboration that we're hoping for between the FCC and the FAA when we get beyond the small UAS.
Julius:	I disagree we don't disagree. One of the problems is we get so many things lumped together in the discussion. And so, for example, we actually did allocate the 5030 to 5091 earlier this year for command and control, and I think the idea there was — because it's federal and non-federal — that it would be licensed somehow, and we said, "Well, we'll deal with the rules that deal with the…for the services…" You're absolutely right. There's so many different kinds of UAVs in use by both non-federal and federal, and I'm not suggesting that we put them all on one bucket. So, I think that that's certainly a valid point. Just to touch on some of the other things from the prior panels because I was glad to hear that nobody said one of the problems was spectrum.
[Laughter]	
Julius:	What I think is interesting is that had you asked each one, they probably would've had a different answer for the spectrum because they think each one of these things presents a different [00:26:00] set of issues whether we're talking about UAVs and the multiple kinds of UAVs…

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Jennifer R.:   Different altitudes.

Julius: Yeah. I was certainly not suggesting that we would have UAVs that are operated large by the federal government that would be in the unlicensed band. I don't think they would ever accept that. [Laughs]

Jennifer R.:   Yeah, exactly.

Jennifer W.:   Commercial.

Julius: On each one of these things and I'm going to come back to flexibility last. So, when we talk about HAPS, we've got the work going on in the International Telecommunications Union. And I think it's important to see how that plays out. There's also those systems are largely being trialed, so in trying to understand how they may go forward, so that will play out. The questions of the satellite allocations certainly… We've moved forward on satellite allocations. There are issues of sharing between terrestrial systems and satellite systems and GEOs, geostationary orbits [Laughs] systems, so forgive me, GEOs and NGSOs and so forth. And you heard about the different kinds of altitude systems. So, we're working through those. Some of them are in an outstanding proceeding, and I think, one way or another, they will get settled. And then, there's the UAVs we talked about a minute ago. So, I think there's progress being made on each one of these. There's just a couple of other things that I would say about spectrum generally, and maybe, Tom, you have some things to add. Because I've been at this a long time and I still remember when somebody came in and he says, "I did my job. I came up [00:28:00] with the innovative idea. Your job is to give me spectrum." [Laughs]

                 And it's just not that simple. Most of the spectrum is spoken for in one way or another. You may debate whether you think it's valuable or you think it's heavily used, but it generally comes down to there's something there, and either you're going to share without modifying it or it's got to be moved or something. That usually costs money which means funding, and so, "Woah, I didn't want to have to pay for something." [Laughs] And so, a lot of what we're trying to do, we'd love to clear some spectrum, and I think that's something we still look for those opportunities, auctions will still be in the future, there's no doubt in my mind. And then, there's cases where, and a lot of this is what's going on in the ITU, can this share with some existing system? And we've got a lot more tools on the engineering side to enable this. [00:29:00] You heard about the focused beams, and the ability through technologies like MIMO and so forth. I still think we haven't fully tapped into artificial intelligence for…we call that a different term, for dynamic techniques to squeeze more out of what we have. So, you're going to see a mix of this, I think. Hopefully you understand the agency is fully committee to open up more bands not only for terrestrial, but I think for other services as well. But, it seems like each next thing we're doing is harder than the last, because there's more things there.

Anna: So I just read about an Intelsat proposal, which I thought was interesting and Tom may want to…I don't know if you've read about this proposal where they would do market-based mechanisms, enter into agreement with terrestrial providers in more urban markets for use of their spectrum. That also insured protection of their systems. I just read this, so I'm paraphrasing very highly. Have you read about that and do you have

thoughts on that mechanism? Is this an answer to the concern that the FCC is going to move forward with reallocating or forcing sharing of spectrum anyway, so let's take control of our agenda here. Do we have any lessons in history for some mechanism like that?

Thomas Hazlett: Yeah, thank you and thanks to the University of Colorado for inviting me out to beautiful Boulder. You mean the part where it says, "Advances the public interest without the risk and delay associated with the sharing framework by regulatory fiat?" That filing? Yeah.

Anna: We did not coordinate this.

Thomas: We are in a chaotic state, so the fact that we merged on that is…that's how dangerous collisions in [00:31:00] space are. So, it can happen that fast. Let me just say something about collisions in space. Hearing the challenges and the challenges are profound and it's 3D, so we've got this extra dimension to worry about. The fact is this is how rules develop. This is just a very standard property rights conflict. We got radio spectrum out of laboratory experiments that sort of sat around for a while and then all of a sudden in the 1920's there was a business model that forced conflict. So, even people talk about land being simple, land rights are simple. Well, when planes start flying over land, you have to figure out what the relationship to the landowner and the plane is. So, we have a 1926 act of the United States that says, "Well, the planes get to fly. They don't actually have to contract with every landowner down below." The traditional rule from Blackstone from the center of the Earth to the Heavens above, those were supposed to be the rights of the property owner. Well, that kind of gets set aside. We discover these useful pools of oil underneath the surface and it just turns out if surface owners stick a straw down and start sucking out oil, well, that really screws things up. There's a race to dissipate the resource. So, now all of a sudden, what they ended up with is, in most cases, unitization. That's kind of a common pool resource owned by all the property owners. You work these rules out, so now we've got these tremendous opportunities for just great efficiencies. The laboratory science is fairly well developed by now and so for the immediate future, the main beneficiary of the technology will be the travel and leisure business because of all the conferences.

[Laughter]

Thomas: Hotel and planes are going to do well on these. Part of it is, that's just the way the world works. [00:33:00] We have to figure out what…there does need to be a traffic cop. I can say that I don't think people are going to put up drones and be oblivious to the collision problem because they own the drones and they want the drones to stay afloat and do something productive. On the other hand, there are liability issues and so, fly by night drones…get it? Fly by night drones…

Anna: Which is prohibited today.

Thomas: I'm not talking about scheduling. "Wake up! It's four what?" Fly by night drones are an issue. You have to have liability fixed and you don't want accidents to be more expensive than people can pay. Things like cheap registration systems, they really do

make a lot of sense. Expensive sensing devices, maybe they don't make so much sense. We don't want to kill the technology because people in Geneva got sold something nice and it's now being mandated. So, I hope that as we go forward here, there are some new institutional structures including consortium and non-profit organizations that may take over a lot of the central planning and directioning on this that we have learned, that there are some regulatory rigidities that we'd like to avoid, even as we want some of these rules to go forward. We want a lot of flexibility. We do want stakeholders out there. Even as I smile to myself as you talk about the FAA, yeah, let's privatize the FAA. Oops, sorry. Didn't mean to…

Anna: Ooh, that's another panel.

Thomas: Extend the conference. But, the FAA, there's no reason it should be a government organization when it comes to air traffic safety and it should be rolled out into, like the Canadians and others have done, into a non-profit organization. Perhaps there is some innovation that can be done there. That's an analogy. [00:35:00] I'm not trying to argue for that. So, in the intel/Intelsat joint comment you're talk…just filed and I did happen to get a copy, just by coincidence and was looking at this. This is, to my way of thinking, a wonderful idea where you have incumbents and they're specifically here talking about 3.7 to 4.2 gigahertz. Can I say gigahertz? Is that an acronym?

Pierre: You can say gigahertz.

Thomas: Hertz? This [INAUDIBLE 00:35:31] hertz times how many?

Anna: It's an acronym in your head, but it's actually a word.

Pierre: It's a word.

Thomas: It's a word? Okay, it's a word now.

Anna: One of my lessons from today, just so you know.

Thomas: So, they're talking about incumbent licensees, including especially satellite licensees being allowed to make commercial deals with terrestrial, in particular, but it could be other application providers. This would be a situation where incumbents currently using the band are protected, but new users have an opportunity to come in and make business deals, to make bargains, to move resources around with money, changing hands. They specifically do make the argument, I think it's nice. I didn't consult on this, but it's a little jarring to be so peripheral to the process that you think you know something about. But, they say it just right. There are rigidities in the system that can be overcome by allowing the rights to go into the marketplace that allow bargains to be made. Then you have, in a decentralized way, you do have the players going and saying, "What are the opportunity costs of making moves and what technology can be developed so that there can be accommodations made to the incumbents?" You don't have to make, Julie, who has enough to worry about at night, have to make these [00:37:00] tradeoffs about all kinds of things that are completely unknowable like, is a

band better used for autonomous vehicles or Wi-Fi delivery of cab videos? I can frame that anyway, but he doesn't know the answer to that and, of course, neither do I.

Anna: Joe Cramer would say that it's better used for dedicated use to protect aircraft and cat videos should be watched on the airplanes, on their Wi-Fi systems, right? Sorry, that was another panel.

Thomas: Yeah, so I've got nothing against cats, but we want the opportunity cost to be visible, transparent. We want users to make rational calculations and we don't want resources to go to low valued uses when there's something much better. So, getting markets to deliver these answers, everybody agrees at a high level. I mean, there's certainly a consensus on that. Liberalization has gone forward and has intellectually become quite a compelling paradigm. But, how you move out of the marketplace, well, I'm happy to see filings like this at the FCC. By the way, I will say, in reading the FCC's rulemaking on this and I'm sure nobody on the panel had anything to do with this, but in the 3.7 to 4.2 when the, I don't know if it's a notice of inquiry or the proposed rulemaking when out, but whatever's the open docket now, I saw that good and the bad of FCC spectrum allocation. In some language it says to the marketplace, "Please tell us exactly what the costs and benefits of the new technologies are." That's…well, I'm looking here looking at Washington lawyers. You should love that language, okay. Your kids have to pay for tuition. [00:39:00] I understand that, but that's just an open-ended debate about things that, again, we can't decide.

          On the other hand, they did have some very nice language that invited a comment about how rights could be construed so that marketplace decentralized decision-making can happen. In essence, invited the comment, in fact they used the word in some places, for overlays. So new rights in the marketplace that are subordinate to the existing transmission rights that can allow the owners, presumably the new winners, by auction of those rights, to make bargains with incumbents and transition or reconfigure markets such that you can have new technologies, new services, and new business models deployed. That's what those FCC proceedings should be when they look out at the marketplace and say, "Help us. Give us some good ideas." Yeah, the marketplace is going to have the diversity of thought out there is something that Julie, quite honestly says, "I want you to tell me. I want a lot of coordination and collaboration."

          The FCC as an agency, predates anything in our lives. It has always said, "We want the interested parties to hammer things out and to make a deal and come to us and then tell us what's in the public interest. Then, we'll decide." That means that there's a lot of stuff. There's a lot of information out there that has to…it is distributed, there's no question. The whole rule making process, by the way, where this is always set up to ask the people who have that specific information, to reveal it to the regulator. The regulator wants to know what these folks know. So, yeah, those are great ideas, but it's good to tee that up in a way that it's not an argument. What's the example? This is my most vicious example at the moment. It's not an argument of how many work crews there are to change out TV station signals. [00:41:00] The argument being whether or not there are 14 work crews in America or 50 work crews in America. That's not a made-up example. You know what I'm talking about? You know the answer.

Anna: Television transitions.

Thomas: Yeah, there used to be physical scarcity for airwaves. Now there's physical scarcity for work crews. By the way, that's a very funny line to an economist.

[Laughter]

Thomas: I don't know why you people aren't laughing. The idea that there's a physical number of work crews in the United States. But, that's what you get when you tee up the wrong answer. You just get these debates that can be endless because the answers are unknowable. If you do invite people, as has been done, to do an Intelsat has done in that filing, talk about ways to devise rights for the agency to configure that can give us forward progress and introduce that innovation that essentially all of us want and still mitigate the costs to society, to the incumbents, to all the other users out there. That's what the agency should focus on. I'm glad to see that there is that language.

Anna: So, going back to the whole topic of today is this proliferation of systems, and they're at every level. So, what are the challenges of implementing something like the Intelsat proposal where all of a sudden, we have different systems operating in the same spectrum that can affect other incumbents at different levels? What are the challenges of implementing something like what Intelsat has done? Jennifer, I don't know, Julie.

Julius: I can't touch it.

[Laughter]

Julius: I'll just say a couple of words. So, this was a notice of inquiry and I think it also reflects the challenges in trying to find access to more spectrum. We asked a lot of questions in there as an agency. I do want to stress that we don't go into it with, "We think this is what's going to work," [00:43:01] and so forth or that there's a one-size-fits-all. We're going to take dynamic access and we're going to put it here. So, we just asked a lot of questions about it. I think, before I left, because they were still coming in, there was something like 80 plus comments. There may be more when you get into the record. They're kind of all over the map.

               But, just as a side bar, if you look at what we did in the spectrum frontiers proceeding, which was a little bit different, which we said, "Okay, you're a licensee. We tied your hands and said all you can do is fix. We're going to give you a right to do mobile and let the market figure out what the service is going to be." Even that, we had constraints to try to protect the incumbents. There's still debate going on there. In each spot, I think what we try to do is come at this as, how can we get more out of this? How do we protect the incumbents? What's the right solution here? Jennifer was mentioning to me about flexibility because sometimes we've got flexibilities in the allocations. We've got flexibility in the licenses. But, there's usually conditions that go hand and hand with it, to make sure that we don't have chaos reigning.

Jennifer W.:   I think one of the interesting things here is, what I've understood from the Intelsat proposal is basically the urban, non-urban split, right? Typically, at least in my

experience, and Julie can tell me that my memory is completely faulty, that there's been a reluctance to do that kind of geographic partitioning among services in quite that way, because this was explored at Ka-band and rejected because the view was wireless, 5G wireless, or mobile wireless needed to have the entire nation, and it would deploy across the entire nation. You read a lot today and it seems like it's going to be much more urban-centered and maybe suburban. It's very unclear what the trajectory is for covering [00:45:00] the non-urban areas. So, in effect, this kind of proposal reflects, it seems to me, again, this is personal, not Lockheed, seems to me to reflect kind of a reflection of what some see the mobile wireless industry doing, which is needing capacity, urban. Not needing it anywhere else and finding a way to maintain space operations, satellite operations outside of urban corridors and finding a way for additional capacity.

I don't know how the FCC policy approach is to that. I think it will be very interesting to see the discussion at the policy level among the government policy makers. It requires, in some ways, an acceptance that there may be some natural partitioning, if you like. I don't mean that in a spectrum sense, but some natural partitioning. I think it's going to be a really interesting dialogue to see how that moves forward and what that portends for future spectrum discussions, because one of the things I don't see is enough incentives. I think that's part of the solution, too. I think every single panelist said spectrum on the prior challenge. Incentives have to be incentives that are perceived that nobody will get what they want unless you come up with a solution that works for everybody. That's rarely the situation in a spectrum proceeding at the FCC. There's always an industry or a player that's perceived to have the upper hand, irrespective of how balanced individuals are. It's just that perception. So, how do you create regulatory incentives? Or maybe they're not that. Maybe it's an XPRIZE for RF spectrum sharing, which results in ten megahertz of spectrum nationwide to whoever really comes up with something?

Julius: Only ten?

Jennifer W.:   Yeah, I know ten is…500. [00:47:00] That comes up with actual spectrum sharing technology that doesn't constrain the incumbent and allows growth on both. Sharing, typically, and this is our challenge that all the other guys were talking about, means somebody gets constrained. How do you come up with a sharing regime that doesn't constrain? That may be bringing in more autonomy, but you've got to have the incentive for development of that. That may not be the DARPA role, right? That really may need to be others. So, just throw that out there. Tom, XPRIZE?

Thomas: Well, yeah, XPRIZEs are great, but the normal way you give people incentives is you pay them. The actual way that sharing is most often accomplished is pay them to go away. Then, they're sharing, I mean, they have rights to use some radio spectrum and a new user comes in and says, "Hey, have some money." They're sharing in the new…the value of the new use. That's the way you do it. In fact, that's extremely important. The FCC understands there's many proceedings and it just…I mean, even in the 600 auction, it was interesting in the assignment round how the FCC algorithm automatically tried to put everybody together to eliminate borders. It's just the way you see it happen in the marketplace, just to get this done. You were doing it without money. Part of this, and

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then you use money to, for the rest of the assignment around to just settle. The tie goes to the money.

But, so, to take something that happened 2004, 2005 on the 3650 band. We had these, I think they were government radar systems on the coast. There was this dispute and there was a debate about whether or not it should be licensed, unlicensed. The problem with doing an unlicensed, which is the FCC's decision. The band hasn't turned out the way it was [00:49:00] described in the order that it was going to have fixed wireless broadband. It was going to compete with cable modems and DSL and fiber and all that. As soon as you decide to have fragmented rights, which in this case are unlicensed, you don't have anybody who can buy out or substitute or do the real sharing, which is to figure out how to get rid of the government use.

Now, if they're private licensees, probably it's a little easier, but we've seen that even these overlay rights can put incentives in the marketplace, where private companies now can go to markets. They can borrow capital. They can generate new technologies. They can upgrade existing government technology. They can actually, in many cases, make deals to move out those…to change the spectrum allocation. There's just no way to do that, given the way the FCC took 3650, beautiful 50 megahertz band, but said it was going to be all unlicensed. Then there were all these rules that you had to have listen before talk. You had to have these kinds of restrictions on where the government radar was and so forth. I could go into white spaces with TV white spaces, exactly the same problem. As soon as you decide not to do an overlay, you've got nobody to negotiate with the TV stations to move them out. At that point, you've just sunk the whole proceeding. This has gone for 15 years now. It really is onerous to tell the white space devices, you've got to have all this listen before talk. You've got to be in the database. You can't really have rules for mobility because fixed is easier right now. We'll give you a chance to do mobility later, maybe.

Anna: So, I'm glad you're raising that. I apologize for interrupting, but we are running out of time and I need to give the standard question and answer period for the students. But, just want to give the thought of how do we enable innovation while imposing requirements? [00:51:00] We talked about it with the FAA earlier, imposing avionics requirement that actually have spectrum consequences. There can be cost issues. We're seeing issues with collision avoidance if we don't have propulsion mechanisms, we don't have adequate fuel. How do we allow these innovative services to come in without regulating them out of business, but still ensuring we have safety? I'm not going to let you answer the question because I have to go to the audience.

Julius: We have 30 seconds for questions.

Anna: Does anybody have a five…a student have a five second question? No, I'm kidding. Anybody have a…It could be a student.

Pierre: [INAUDIBLE 00:51:44] do you want to pick a student? Yes, Gabrielle. We'll try and go to people who haven't asked questions before.

Student: So, I was reading an article before coming to this panel that was discussing the fact that with all of the new space industry growth that we're seeing, particularly in the private sector, that it might be time to establish some sort of regulatory body for that. So, I've heard several different suggestions for how we might think about both encouraging and regulating innovation. If anybody on the panel has a reaction to that, I'd appreciate it.

Anna: I had a similar question to that. Do we need to have some type of division, bureau, separate body? Really, I wanted to be cheeky just to add a little controversy. But, thank you for adding it now.

Thomas: And the portfolio would be?

Anna: Well, I had actually thought whether we needed some kind of regulatory regime for the…we have space and we have terrestrial. We don't really have [00:53:00] more, sort of, a high altitude platforms. But this sounds like it's almost an entire coordinating body that takes all of the various bodies that we've talked about, domestic and international and puts them in one place to regulate all the different segments or the different matters around this shared use of the airspace and of space.

Jennifer W.: There is an advisory committee called Comstock, which is the committee on space transportation. It is a committee that makes recommendations to FAA Office of Commercial Space Transportation. The recommendation there was that basically the FAA AST, which is what that office is called, be responsible for all space authorizations with the exception of the commercial satellite jurisdiction that the FCC has for spectrum. So, excepting that, the recommendation there was that it would be appropriate to give the FAA AST office all of that authority. Now, current discussions in DC are looking at whether or not it should be there, whether it should be at commerce department, whether actually it should be elevated to another mode of the Department of Transportation, which has its pluses and minuses too, all for debate. But, that was the industry advisory committee's recommendation.

Thomas: I would say the only other time in my life I've been in this room was to celebrate the birthday of Fred Kahn. Professor Weiser brought him here.

Male: Best conference we ever had.

Anna: Except for today, of course.

Thomas: But I have a hard time saying there should be another regulatory agency, thinking [00:55:00] of the late Fred Kahn. He had turned 90 and I think it was 2009 you had that wonderful conference for him. I don't know if I can say, sitting where Fred sat, that there should be another regulatory agency. It is a good question, would that coordinate…

Jennifer W.: One, it's a consolidation.

Thomas: Exactly. Okay.

Anna: Whenever we have hard policy issues, we do tend to look at reorganization.

Thomas: I'm not…I just can't do it, out of deference to Fred.

Julie: We have another question up there.

Anna: That's right. You were first.

Julie: That's not a student back there.

Anna: Oh, sorry, microphone right here. How many minutes do I have? Two minutes?

Audience member: I was very excited about some of the issues that Tom brought up and I wanted to ask if that might be a principle that might be extended further. Let's assume you have an incumbent use and some band, some new innovative use, whether it be some of the ones you talked about or others comes along and says, "I'd like to make a deal with that. Here's new dollars for you as the incumbent." Could the FCC, instead of going to auction or consider that here's a market recommendation of a higher use and actually do a rule change to allow that?

Thomas: What a wonderful question and it is discussed in a new book from Yale University Press called The Political Spectrum.

Julius: All I get to hold up is the CFR, Code of Federal Regulations.

Thomas: Marketing. Okay, what was it? You want Euros or do you want dollars? Thank you for that. Yes, now there should be a liberal system where that can happen and that should be generalized. That's part of the [00:57:00] liberalization of the rights, the flexibility that I think we've heard about and in some cases, you do need extra rights coming into the market because there's unallocated channels or bands. Secondary rights are important to rationalize a whole bunch of spectrum, a whole bunch of frequency space. So, that's where the overlays come in.

Jennifer R.:   And in all seriousness, the TBRS, which build off of some of the 3.5 spectrum that Tom was discussing earlier. You know, the commission expanded that from 50 megahertz to 150 megahertz. The notion there is, they're going to protect incumbents in the band which include the naval radars off the coast and other incumbents. Utilities that are using that spectrum already. But then, making it available to others and there's a technology called the spectrum access system, a SAS that will be used to manage all of these uses. It's not really…it doesn't have to only be applied in the 3.5 band. I think that technology, those spectrum access systems can be applied very broadly in order to make more spectrum resource available for more different uses.