



Transcript: Day 2 - September 10, 2020

#### **Panel 4: Beyond Earth Orbit: Cislunar and Lunar Sustainability**

- MODERATOR: **Christopher Johnson**, Space Law Advisor, Secure World Foundation
- **John Carrico**, CTO, Owner, and Astrogator, Space Exploration Engineering
- **Mike Gold**, Acting Associate Administrator, NASA Office of International and Interagency Relations
- **Tanja Masson-Zwaan**, Assistant Professor and Deputy Director, International Institute of Air and Space Law at Leiden University
- **Audrey Powers**, VP of Legal and Compliance, Blue Origin
- **Jessy Kate Schingler**, Director of Policy and Governance Research, Open Lunar Foundation

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**CHRIS JOHNSON:** Welcome to today's second panel, Beyond Earth Orbit: Cislunar and Lunar Sustainability. My name is Chris Johnson, space law advisor at the Secure World Foundation and based out of our Washington DC office.

So joining me on the panel--and my panelists can please turn on their cameras and their microphones. Joining me on this panel are Mike Gold, acting associate administrator at the NASA Office of International and Interagency Relations, the OIIR. Audrey Powers, vice president of Legal and Compliance at Blue Origin. Professor Tanja Masson-Zwaan, assistant professor and deputy director at the International Institute of Air and Space Law at Leiden University and a president emerita of the International Institute of Space.

Also joining us are Jessy Kate Schingler, Director of Policy and Governance Research at the Open Lunar Foundation, and John Carrico, Chief Tactical Officer, Owner and Astrogator at Space Exploration Engineering.

So cislunar and lunar sustainability. So why this panel? Well, today--to date, much of the current discussions on space sustainability have focused on the challenges and activities in earth orbit. But now, as you're seeing as multiple countries and companies and actors are engaging in and planning and aspiring to engage in lunar exploration and lunar development, we need to expand our thinking. So I'm gonna post right in the chat something that I've seen recently and has spurred a lot of thought on my behalf.

Is this two reports, one is the ISECG report, Global Exploration Roadmap and the supplement to that roadmap which talks about lunar exploration. And then that--just a graphic from Bryce

about projected exploration missions from 2020 to 2030. When I look at, and you don't need to look to it now, but, you know, when I look at that, I see a variety of actors, a multiplicity of actors who are looking to go to the moon either to return or go there for the first time.

So, you know, we now find ourselves discussing lunar policy, lunar governance, lunar norms. What are they? And are they sufficient?

So this session will discuss potential sustainability challenges posed by lunar activities, including lunar resource utilization, non-interference safety zones, inherited sites, and even lunar orbit traffic management. And hopefully we'll hear some opinions on which directions and which avenues the deliberations on these topics should go. So thank you to our panelists for joining us.

I think first I'd like to start off with--is Mike Gold in the room? Mike, if you could turn your camera on, I see him. I think first I'd like to start off with this National Space Agency perspective.

Mike, as head of the Office of International and Interagency Relations, can you kind of orient us and give us a kind of a global picture in terms of space activities and more importantly, space activities and governance for the moon? Well, what's the global picture?

**MIKE GOLD:** Thank you, Chris. And as always, appreciate the Secure World Foundation in creating terrific events like this for us to speak at. And I also appreciate that you're saying, what's the global perspective? Because it isn't just NASA. It isn't just the government. It's the public private sector together, it's NASA with our international allies. Those lines have blurred and we're all proceeding together and I think are better for it.

I know this is something that's probably well known by everyone in your audience, but just for those who aren't familiar with the Artemis program, Artemis is the sister of Apollo and the name is very apt since the goal of this program is to put the first woman and the next man on the surface of the moon by 2024. In order to do so, we're developing new government commercial rocket systems to carry people, to carry resources, to carry the logistics to the moon, the SLS and the Orion to take our astronauts to the moon.

But there needs to be differences between what happened to Apollo. We all love Apollo, but there must be changes. And one of the great differences is in the very title of this activity: sustainability. The problem with Apollo is that it ended. Therefore we need to have a permanent and sustainable exploration utilization program, and that means infrastructure. That means building the proverbial roads in space that will allow for a continual exploration program and growth.

And that's where Gateway comes in. And the Gateway will be an orbiting outpost. It will have substantial international contributions, really the physical manifestation of those contributions,

and the important part of Gateway is it will enable surface operations because we need to have robust and permanent surface operations on the moon, all in order to get to Mars. It's terrific that we have a moon because it allows us to practice, to develop technologies, to build the international coalitions in order to mount the historic human mission to Mars.

And let me just end by saying that the key to the Artemis program and this whole new era of exploration is diversity. It's diversity in peoples, as I indicated before that Artemis will be the largest and most diverse international human space exploration coalition in history. With Apollo, maybe we had Australia supporting with the dish, but with Artemis, we will lead the world going forward to the moon and then onward to Mars. It is a truly global effort. And diversity in organizations that, again going back to Apollo, there was no robust private sector space entities like we have today.

Now we can leverage private sector capabilities. We can have public private partnerships to create technologies and systems that would have been unimaginable 50 years ago. So by leveraging and using this diversity as fuel, I think we're going to be able to accomplish things. And let me just say for the overall purpose of goal of going to the moon, we're not only going to answer the questions that we've got, but to create new questions, and that's what's always so inspiring about exploration and the human spirit. And by doing so together in partnership with our commercial friends and our international allies, it is something that--I don't want to say we'll never forget Apollo, but I believe that the goals, the objectives, the accomplishments that NASA and the world has ahead of it will dwarf what's occurred in the past. So back to you, Chris.

**CHRIS JOHNSON:** I agree. I hope you're right.

I want to return to some of that and get some, you know, a couple follow up questions. But first, before I return to Mike, I'd like to now turn to Audrey Powers.

Audrey, I have questions about your company Blue Origin and its participation and its activities and aspirations for the moon, both in terms of how you're partnering with the US government. And if you have this other Blue Moon program, that seems to be, you know, it's kind of standalone exploration program. So just if you could give us kind of a perspective on the different activities that Blue Origin is up to now and in the near term.

**AUDREY POWERS:** Sure. Thanks, Chris.

I appreciate being invited to speak on this panel, and at this event, I think you'll see sustainability is a theme that's very much connected to some of the foundational tenets of Blue Origin. And a brief introduction to our Blue Moon Lunar Lander program--we have been developing that lunar lander for several years. It's capable of delivering several metric tons of payloads to the lunar surface.

We used that design as the basis of our offering for NASA's human landing system project under the Artemis program. So we are the prime contractor, put together what we call a national team. Our partners are Lockheed Martin and Northrop Grumman and Draper and the collection of us have designed this architecture that's comprised of multiple different elements and Blue Origin is, in addition to being the prime contractor, we're designing the descent element, which is the actual lander portion based on our Blue Moon lunar lander program that was already in development.

An important aspect of that lander is our engine, our descent engine. So the BE-7 lunar landing engine is one of many engines that Blue Origin is developing. Has precision landing capabilities like, like all of our engines, deep throttling capabilities. Reusability is a primary goal of that engine program.

So we started testing that engine back in the summer of 2019 and that is occurring primarily at Marshall Space Flight Center. So one of the engagements--one of the other engagements we have with NASA for our lunar purposes is that we test our engine down at Marshall. We also have an agreement in place with the Air Force Research Lab to test BE-7 out at Edwards. So we have a number of different government relationships that are supporting our development of the Blue Moon program more largely, and then the human landing system offering for NASA. So we also have--Blue Origin is part of NASA's CLPS initiative, which Mike and the administrator mentioned this morning in his remarks.

So the Commercial Lunar Payload Services initiative, Blue Origin is eligible to bid on proposals to deliver cargo to the lunar surface. So that's kind--it's a very, very brief overview of the Blue Moon program. And to focus a little bit more on the sustainability piece of it, since that's why we're all here, you know, sustainability has really direct application and connection to one of Blue Origin's core tenets. And I imagine many people watching are aware that our founder, Jeff Bezos, back in May of 2019 gave a speech that laid out his vision for why exploration and settlement of space is so important. And it very much relates to sustainability of Earth.

So how do we stop depleting the natural resources on Earth? We actually achieve that by moving some of our activities to space. And as we move activities to space, we wanna make sure that we do so in a thoughtful manner so that we don't just start depleting the resources out there and that we create sustainable projects as we're moving off of the Earth's surface. So this idea of sustainability, both on Earth and in outer space, is something that was very foundational to the beginning of Blue Origin and kind of keeps coming up in all of the programs that we develop.

So if you look at our launch vehicle programs, from the very beginning reusability was just a core principle of what Blue Origin developed as far as launch vehicles. We very much see that in our Blue Moon program too. So we're looking at architectures with our partners that--and really studying the best ways to reuse these elements so that they're not just--this is not just a one and done type initiative.

So to Mike's point, how do we really establish a permanent presence in space? So the first time we land on the moon, we land this descent element on the moon, it's going to be used as infrastructure for surface operations. It's not just going to be forgotten about and discarded, and we can't use it anymore. So we've really engaged with our, with our partners on the national team to figure out, you know, Lockheed Martin developing the ascent element which will transport crew--how do we make sure that's reusable? Same thing with the descent elements. So this idea of reusability kind of permeates everything that Blue Origin does.

I think that the administrator made some really good points this morning, and I should, full disclosure--I have spent many, many hours working with Mike Gold on the NASA Regulatory and Policy Committee focused on some of these issues. So, space resource extraction and utilization, we made a series of recommendations to NASA. And a lot of those really show up in the Artemis Accords and the principles that the administrator spoke about this morning, this idea of a global perspective and really being a leader in getting everybody on the same page for how we're going to approach things like, you know, due regard and harmful interference and coordination of activities.

We, I've spent many, many hours with the NASA Advisory Council, on this regulatory policy committee figuring out what we want to recommend to NASA as far as engaging with private actors to try to further some of the leadership in these areas. And the administrator made reference to this idea of soft power and, you know, with soft power, I think, comes really strong leadership. And the initiative that he announced this morning, this idea of extracting resource, and selling it to NASA--I think that shows really strong leadership in this, in this area, as does the Artemis Accords.

You know things like, you know, signing up to the Registration Convention if you want to be engaged in in the Artemis Accords there, there's really a nod to some of those important international tenets that they're furthering through the Artemis Accords, and I think NASA and the, and the larger US industry that's connected to NASA shows really great leadership in this area. That's my, my brief overview. I'll let you move on to everyone else. Thanks.

**CHRIS JOHNSON:** Yeah, definitely, thank you for that. I would like to discuss some of the, kind of, policy and, international implications of, you know, recent American initiatives. And I think I would first start with--as the administrator mentioned that 2015 CSLCA creating, you know, private property rights over space resources, but really beginning with earlier this year, the Executive Order on Space Resources and then Artemis Accords and the international reception and interpretation of those Artemis Accords. And now today's announcement that a state would like to procure and purchase space resources. And this may be a harder question, but I want to field it to you, Mike.

There has been a, let's say, a diversity of opinions at the international level as to these ambitious American initiatives on space resources. So, while the US does this international engagement piece, what's the strategy? And I'm really asking you a strategy question, Mike,

what is the strategy to engage the rest of the world, you know, with Artemis and with space resource utilization?

**MIKE GOLD:** Generally, Chris, I can tell you the strategy is to lead. It's to engage--

**CHRIS JOHNSON:** Oh, turn your, turn your camera on if you've got it. Okay, good.

**MIKE GOLD:** Should be on.

**CHRIS JOHNSON:** Yeah, you're good. Go ahead.

**MIKE GOLD:** You can see how terrific I look now, the strategy again is to lead. The strategy is to engage whether that's on a bilateral basis or in multilateral forums like COPUOS or The Hague International Space Resources Governance Working Group and, you know, per the presence of Blue Origin and Audrey and--I think I just noticed that Audrey got a promotion, so congratulations, Audrey. Well deserved.

She mentioned she and I have spent a lot of time working at the NAC Regulatory Policy Committee, and I was always grateful for all that free time that Audrey would donate and grateful for all of her thoughts. So you know, we need to--first of all, it's important to have a program that can drive this. And without Artemis and the return to the moon and the direction that we've received, none of these conversations or possible.

So I think it's important to begin with an ambitious, a practical vision for space exploration. We're very fortunate to have that with Artemis. Beyond that, as we mentioned before, the problem with Apollo is that it ended. And if you want to have sustainable exploration, not only in space but anywhere else in Earth, you've got to be able to leverage resources.

I grew up in Montana, so I have a great fondness for the Lewis and Clark expedition. And what I would ask people is, imagine what would have occurred with the journey of discovery if Lewis and Clark had had to bring all of their food, all of their air, all of their fuel with them. That would not have been a successful exploration program and, while we can at least go to the moon without leveraging resources, we can't do so sustainably.

So what we need from a broad perspective is a consensus to be able to leverage resources as the fuel for sustainable exploration, as the foundation to allow us to make new scientific discoveries that will challenge the very boundaries of our imagination. And not only on the moon but on Mars, where the ability to leverage ISRU is going to be arguably even more important, given the distances and the challenges that we've got on Mars.

But as I said before, we need to practice on the moon, to learn on the moon in order to go to Mars and even beyond that. Relative to, again, the global strategy, we must establish norms of behavior. And this is what the Artemis Accords are. Coming together with nations to reinforce, to implement the Outer Space Treaty. I am a huge fan of the Outer Space Treaty, over 50 years

old, doesn't look a day over 35. That's the foundation that we need to agree upon and implement and then take our experiences via the Artemis program and bring those to multilateral forums to have discussions in terms of what comes next and to gain more fidelity on topics like space resources, space heritage, orbital debris to build a better future in space than we have on Earth. Let's learn from our mistakes and go forward together. But it's important that that path that the world take be one based on openness, on transparency, on safety, on the public release of scientific information. Transparency, hope, optimism, scientific discovery--these are powerful tools that we have and we must leverage them to ensure that when humanity goes forward, not only to the moon and Mars but into the solar system, those are the values that we take with us. We're not just taking astronauts to the moon. We're taking the Outer Space Treaty to the moon. We're taking the Registration Convention to the moon, we're taking the rule of law. And it's important that we set that as a precedent because there are alternatives out there that are opaque, that are dangerous. So we need to embrace our values, embrace our multilateral agreements and our obligations under those, and help engage with the international community to create a bright and harmonious future, not just for ourselves, but for our children because I'm too old to go, that will hopefully have that peaceful and prosperous future on the Moon and Mars. That's the strategy.

**CHRIS JOHNSON:** Great. Thank you for that, Mike. Now, I'd love to turn to Tanja. Tanja, it seems as though you know the rest of the world is beginning to understand that argument that the use of resources in space is critical, is fundamental to any long term presence in space. But, you know, in terms of international perception and reception of these American initiatives, what is your perspective on it from abroad? And how do you think the international context is shaping up?

**TANJA MASSON-ZWAAN:** Thank you, Chris. And thank you for having me on this panel. I think I'm the only non-American, so that question doesn't surprise that I am getting that. And of course, I cannot speak for the global community. But what I personally am seeing is that indeed the United States is taking a leading role, is putting things out there just like they started doing in 2015 with the law, the first country to explicitly say space resources can be owned. And that sparked the debate and that immediately led to the United Nations COPUOS putting this item on their agenda. And of course, this year we have seen many next steps, the executive order, the Artemis Accords, and the announcement by the administrator just an hour ago. And that will, of course, creates a lot of reactions and debates.

But if anything, I think what it does is it puts the topic on the agenda, and that is necessary. And I am, like I think everybody in this panel, convinced that we have to go to the Moon and onwards to Mars. And we will need resources, so we do need clarity and we're not going to do this only with governments, we will have to involve private enterprise which is more able to, with more agility, to put in the finance and the technology. So that clarity in terms of rules is needed. We do have basic norms. We have the Outer Space Treaty which Mike loves so much. Not a day older. I mean the great majority of UN members is adhering to those principles. So but they do not give all the answers.

And so putting things on the table like the Artemis Accords do, of course, does not solve all the questions. And I think that NASA also agrees. And Michael agree that in the end we will need multilateral discussions, and I see Mike nodding. So I can only hope that that this again, this impetus will create more leverage at the UN level. So I'm very curious what's happening.

Of course, we have the legal subcommittee of UN COPUOS that could not take place this year because of the covid-19 situation. Let's hope that there is not a further delay and that it can take place next spring, which is where also, the scheduled informal consultations, as it is called, are currently taking place.

And so the COPUOS members were not yet ready to accept a formal working group in the legal subcommittee. And I would be curious to hear perhaps Mike's view on whether the US would support that, or any other all of you Americans on the panel. I think that would be very important because there you can really involve the other states.

And I think everybody agrees that just having the Artemis Accords, just having a national law, whether it's Luxembourg or the UAE or the US is not enough. It does give us ideas. We've had also all these other non-governmental initiatives, no formal initiatives like the Hague working group, which I've seen working very hard, but also the Vancouver recommendations, the Moon Village Association, which has been working on it. So a lot of input has been prepared, a lot of food for thought is on the table. And so I think the next step must be that the multilateral discussions continue and that also other parts of the world which are worried, and I think they have a right to be worried, should be involved and should be reassured that their interests will be taken into account as well. So we have that basic framework, but we need, we need to take the next step.

**CHRIS JOHNSON:** Great. Thank you for that.

**MIKE GOLD:** Chris, do you mind if I respond?

**CHRIS JOHNSON:** Yeah, go ahead.

**MIKE GOLD:** Yeah, just a bit of that. Because, you know, Tanja is so correct in what she says. She's always been a good professor, I consider myself a student of Tanja's, although I've never paid tuition. So apologies for that.

But per my thumbs up and violent head nodding, you know, I just want to agree that the Artemis Accords are a beginning to these discussions, not an ending. That the Artemis Accords again reinforce and implement our obligations under the Outer Space Treaty. And the Outer Space Treaty, unfortunately, as much as I like it, it doesn't have the solutions for everything. Nor will the Artemis Accords. Nor do I believe we ever will, that this is inherently an organic process as we go and learn.



Again, I don't think we even understand the unknown unknowns that we're going to be dealing with on the moon. Which is why, with the Artemis Accords, we tried to keep them at the principles level to ensure that they were broad and general enough to accommodate whatever situations that we run into. Relative to the COPUOS legal subcommittee on space resources, we absolutely look forward to engaging, engaging in a robust fashion with that discussion, as Tanja's saying that these are ultimately, you know, issues that we look forward to, hopefully resolving in a multilateral manner.

But the important thing is that we have the discussion and that we have the discussion now. And that's what the Artemis Accords and many other of our activities are meant to do. I do want to quickly, though, distinguish the Artemis Accords from the executive order and other actions. That the Artemis Accords is, I think people know, that's a consensus--it's going to be a consensus agreement among the partners that are joining us with Artemis relative to those principles, held not just by the US, but by the partners.

I can tell you that we have received excellent feedback from our partner nations that Artemis Accords are a far better document now, having received that international input, than they were before. And again making it a document that belongs as much to the partners as to ourselves and therefore again, very different from you know, the executive order et cetera because of just the inherent nature of what it is.

But what the Artemis Accords do is, as Tanja pointed out, we're bringing attention to these issues of space heritage, of interoperability, of transparency. How do we actually implement the Outer Space Treaty to create the safe and peaceful future that we all need, and ultimately will be taking that into the international forums to have those discussions. So the accords were really intended to spur and to push forward that global international dialogue with all countries.

And again, fundamentally, the accords are partners that are working with us on Artemis. So not everyone is going to be involved in that. As much as we like the whole world with us on Artemis, this is probably not going to happen. But with the nations that do join us, we want to reinforce our commitment to the Outer Space Treaty and describe how we're going to operate in a safe and a transparent manner and then bring that to COPUOS, because in the end, what we're trying to do is avoid conflict, that we need to be transparent, we need to demonstrate what we're going to do and how we're going to do it so that again our children can have the peaceful future in space that we all want and deserve.

**CHRIS JOHNSON:** Great. Thank you for that. I'd like to open up to some of our other panelists.

Jessy Kate, you've heard of this explanation of, you know, the American approach and NASA's initiatives. You've heard Tanja give some international context for it. You know, we have the Outer Space Treaty, but is that enough? And if not, how do we develop new norms or clarify new norms? And what are some of those values? Certainly space sustainability.

But if you have views on other values that we need to incorporate going forward to really have a sustainable and peaceful lunar environment.

**JESSY KATE SCHINGLER:** Yeah. Thanks, Chris and thanks for having me. And thanks for putting on this event.

You know, Open Lunar Foundation works to advance peaceful and cooperative futures on the moon. So certainly, those values are right front and center for us and what we stand for. I think security and sustainability are two other ones as you mentioned, that I don't think many people would actually argue with those values. So if anything, I think really what's interesting to talk about is what are we willing to invest in to achieve those things?

Because at the end of the day, it comes down to making tradeoffs and finding a way, finding ways to cooperate with one another. So, you know, for the sake of having a dialogue, I thought I would throw out a few that probably we haven't heard, in the Outer Space Treaty, or perhaps build on what the Artemis Accords are saying.

The first is from a values perspective, and I want to talk about values first, because those should inform the norms. From a value perspective, I think that participation is a value, and I think we need new forms of participation that that go beyond state representation. We've seen and we've heard people talking about bringing private actors to the table as peers and finding voice for private actors. I think that is gonna be a very important thing as we go forward. It's great to have Blue here on the panel today. But it's not just private actors. It's also civil society on a broader consultative format. So I think there's an opportunity at COPUOS or otherwise to see states talk about how we could carve out domains where we can endorse operators to coordinate amongst themselves.

The second is, is you know what I would call plurality or polycentricity. Mike mentioned diversity. Diversity will be very important. But what are the implications of diversity? I think we're going to need to make room for multiple approaches to the coordination on the moon. And that raises a really big question because there are some things that, of course, will need to have universal acceptance. And we have a form for that, COPUOS is exactly where I would start.

Dust and debris as the global phenomenon definitely need to be coordinated on that in a universal sense. And commitments around land management and occupation, there are real questions coming up about the safety zones and the Artemis Accords. I think we need to talk about that at COPUOS.

But there are other areas that could be regional or topical. And so there's another concept that is called subsidiarity, which is the idea that we can coordinate at the most local level appropriate for a given area of activity. And I'm curious for us on that, to be exploring this as an international community so that we don't only rely on unilateral action on the one hand or kind of wait for consensus on the other. I think there's a middle ground that we're not exploring as much as we could be.

Back to values. I think that another one that's really important that will bring us into norms is learning. The Hague Space Resources Working Group talked about adaptable governance design. You know, I think we need to design learning loops into whatever mechanisms we put in place so that we cannot be terrified to take any action, right?

If we have the confidence that our systems can learn, then we can take these first steps. So, moving into the norms space, I'll just throw out three that I think would be really interesting. Not just interesting, important. And I think that first is access. I would say that to some aspects are of coordination. But by the Outer Space Treaty, different approaches will still need to be open to everyone to participate.

And so how do we do that? It introduces some neat and new constraints. And I think we need to make some space to figure that out. And then the next one is notification and coordination. That is a big part of the Artemis Accords, it's obviously a part of the Registration Convention and the regimes that we are thinking about putting in place around that. But in terms of the norms of behavior within it, I have some questions.

One is around standards for positioning. Positioning will underpin a lot of the other norms that we're talking about. Safety zones and registration. I don't think we have the infrastructure for that. Maybe somebody like John could talk about this a little bit more, or even Blue. I don't think we have the infrastructure or even know what the standards are that we're expecting. Because--  
information and for registration on the--  
norms of transparency--  
I think I might be--

**CHRIS JOHNSON:** I think you may be cutting out just a little bit, so I'm gonna turn to two of our operators. Thank you for that, Jessy Kate. I would like to first go to John and then hopefully to Audrey. You've heard the norms that we do have, but you know, John, first I wanna ask you in terms of actual lunar cislunar operations and activities on the moon, you do space traffic management for the moon.

First off, what is that like? How difficult is that? And then also, you know, how does how does space law inform some of the activities that you do and shape it and provide guide rails?

**JOHN CARRICO:** Sure thank you. And thank you for having me on this panel. This is a really cool topic.

I would just start off with a story. In February of 2014 I was working at NASA Ames in California, in the control center for the NASA LADEE mission, that was a Lunar Atmosphere and Dust Environment Explorer mission. And there were about four spacecraft orbiting the moon, including the Lunar Reconnaissance Orbiter, LRO. And they were at NASA Goddard, here in Maryland. I was out in California.

We both had teams, operation teams and we were predicting that our two spacecraft orbiting the moon were gonna come within a kilometer of each other, and we detected that a couple of days ahead of time. We were working using NASA JPL's MADCAP system.

Believe it or not, MADCAP is an acronym for Multi-mission Automated Deep Space Conjunction Assessment Process and the way that works, it's a very cooperative method, where you show-- you give your predicted orbit to the system, and it will calculate for everybody who gives their orbit which ones will come close to each other. So it's-- very similar to the Space Data Association that we have for low earth orbit and GEO, which is kind of a cooperative nonprofit effort.

But JPL is doing this for the moon and for other, other celestial bodies. And it took a lot of work. We actually had friends in the other control centers. We were on the phone. We were talking and trying to make sure our two spacecraft weren't gonna hit each other. There's a lot of uncertainty when you're predicting where your orbit is. You're cooperatively tracking your own satellite and the LRO mission decided to modify one of their momentum dump maneuvers and ultimately, our LADEE flight team annex team, we had to waive off one of our station keeping maneuvers and altitude control maneuvers just to avoid hitting. And this took days of work to avoid this, and there were only two spacecraft at the moon at the time. So that's just one example of two cooperative spacecraft, both at NASA needing this.

**CHRIS JOHNSON:** Yeah, so lunar norms are now. I mean, like, you know, these issues are real and in play, I get it.

**JOHN CARRICO:** Absolutely. And as you know, in the Outer Space Treaty, Article VI says that you know, the states have to look and continually surveil what their nationals are doing, what the commercial companies are doing on. But we've already seen a commercial company--we worked with Space IL on their team orbiting the moon.

Article IX says the states have to detect and notify if any other nationals are going to cause harm. So you have to be able to surveil that and then Article XI says, you know, you should let everyone else internationally know as well, so what's happening around the Earth for Earth orbiters, as you know, we have--United States has a space surveillance network. The Europeans have a surveillance framework. Russians have their own surveillance and tracking system. And we use radars and we use telescopes and there is a catalog. And internationally, you can work with the 18th Space Control Squadron. You can give your predicted orbit to the Space Control Squadron and they'll tell you if you're gonna, if you're gonna run into any debris or anybody else. It's still a cooperative thing. But those radars and those telescopes, they don't reach out to the moon.

A couple of years ago, the United States Space Defense Agency had some notional architecture, that maybe they could put 200 satellites in Earth orbit to look space surveillance--you know, space surveillance in the cislunar space. And they said that was too expensive. And just April of

this year, I think it--in one of the journals, it was said that they decided that they're not going to fund that yet. And it's gonna be research.

Just to give you a little kind of grasp of what's going on, if you took the Hubble Space Telescope and pointed it at the moon, which they've done, its resolution is only things about the size of a football field, you know, it is not going to see things very well. The Lunar Reconnaissance Orbiter has a very nice half meter, resolution of half meter camera, but it has to be done in, like, 50 or 30 kilometers to see it. And it's very narrow field of view. It takes several years to look at the entire surface of the moon. So optical is really tricky. Plus, if you look towards the sun when the moon is on the sun side of the Earth, you're not gonna see anything.

First of all, any satellites are lit on the other side, so they're not shining towards us on the earth. And second, the sun's in the way. So this is the same problem we have with tracking asteroids. If anything is on the sunward side, it's hard to see it. So it is possible to track using--you know, Asia's had three used telescopes to track when they went around the moon, it's difficult. And maybe someday we'll have radar.

So right now it's, it's gotta be a cooperative thing. It's gotta be a thing where the satellite operators inform other folks, you might think, well, could we do something like aircraft to--automatic, you know, the ADS-B system, the Automatic Dependent Surveillance Broadcast system, where international aircraft, you know, commercial aircraft--they get their GPS location and then they broadcast it out to everybody and they say, okay, here's where I'm at. May become a surprise to a lot of people, but most satellites that are flying don't know where they're at. The lucky ones in low Earth orbit can use GPS, but beyond that, satellites actually don't know where they're at. It's people on the ground in the control centers who know where they're at. And if they're in a good mood, they might tell the satellite where it's at. But a lot of times they don't need to know that.

Second, even if the satellite knows where it's at, it's not very good at broadcasting. The NASA satellites that we have can only put antennas on a couple sides of the spacecraft. There's solar panels on one side. There's engines on the other. The satellite has to be pointed in a certain way to do its mission, and it can't always talk with the Earth, let alone broadcast to everybody else. So an ADS-B system, that's not really gonna work and plus, try to convince some of these satellite manufacturers, you know they care about size, weight, and power--try to convince them to put on another antenna and another broadcast. They're just not gonna make it through their review system if we're--if the government is forcing them to add mass.

So it's, it's the Russian proverb. You're gonna have to trust but verify. That's gonna be the state of the art for the next 10 years or so. The people who are controlling the satellites are gonna have to be open and transparent. We're gonna have--and we already do--but we're gonna have to use international standards to say this is where I think I'm going.

I did want to mention even if you had some, you know, Star Laboratory system that Mike Gold could probably tell you about, you know, that can track everything in space, a lot of satellites

nowadays don't follow orbital mechanics, they have solar, electric propulsion or they're in a chaotic trajectory where, if--we like to use the equivalent of the biological gaseous outburst from a mouse is actually large enough to move drastically hundreds of thousands of kilometers from one orbit to another. So it's really hard to predict, even if it's your own spacecraft where you're gonna go on some of these chaotic trajectories. And some of them go out 1.5 million kilometers from Earth before they come back to the moon. So it's gonna have to be some sort of cooperation, like the Space Data Association, or, like, MADCAP. And everyone's just gonna have to agree and say, okay, this is what we're planning to do. And then when we do get a chance to take a look of, you know, we might have a center and say, okay, yeah, that's consistent with what they said they're going to do. So it's a huge technical challenge.

**CHRIS JOHNSON:** Okay, great. Yeah, that's certainly one perspective. Thank you for that. I'd like to go to Audrey.

You know, Audrey, as a commercial actor, private actor, you are also, you know, bound by the strictures and obligations of international space law because they're imposed on your regulating country. As you are active on the moon, as Blue Origin is active on the moon, is the current framework enough for Blue Origin to do everything that it wants to do?

It seems as though you know, we've heard that perhaps it isn't--if it is not enough, then how could Blue influence and set precedents and establish norms that that suit its purpose and also suit the other--these other purposes of space sustainability? So how do you see your role, Blue Origin's role, in establishing lunar norms?

**AUDREY POWERS:** I think what's interesting to me about this conversation is many of us on this panel, and I'm sure in the audience, has spent, you know, years of our career, decades of our career, talking in a rather academic way about the Outer Space Treaty, about some of these other international treaties and what will happen when people started doing things.

What does Article VI mean? What does Article II mean? And we've kind of invented these scenarios in an academic setting and attempted to apply these, you know, obligations of these international treaties to those scenarios. Now you have very real scenarios, right?

John just walked us through something that actually happened in space. And the announcement by the administrator this morning is: somebody go and do this for us and we're going to establish the position with respect to this activity and the governing tenets of the Outer Space Treaty. And that is what I think is so fantastic about this time frame right now, is that we're figuring out exactly the point of your question.

We're figuring out whether there is sufficient architecture in place in all of these international norms and treaties to really govern people's behavior. And I do, probably echoing something that Mike touched on earlier, you know, there is an obligation on the actors to buy into this stuff, right? Buy into the obligations that they're bound by and as a private actor, Blue Origin, understanding that we have relationships with NASA and the larger US government, who has

obligations under the space--the Outer Space Treaty, to understand what we're doing and where we're doing it, and that the obligation is not just on us, but it's a collective obligation as US actors to abide by these by these norms.

So I do really enjoy the fact that we're in a situation now where we're actually practically exercising these things, and everybody's interpretation is gonna be put out there for the world to see and say, this is how--I thought the administrator made a great analogy this morning. This fishing analogy which I've heard many times before, someplace, Mike Gold.

You know, when I go out in the ocean and I fish and I collect some fish and I eat it or I sell it, that is not appropriating the ocean for sovereign purposes, right? That is using a resource. And if you draw the same analogy to the moon, for example, you know, Blue Origin's propulsion system based on hydrogen and oxygen, it's gonna be very important for us to be able to extract literal material for propulsion purposes for--to further use the materials available there for in space purposes. And the idea that if we use any of that lunar material, that we would somehow be appropriating the moon, it just doesn't compute if you compare it to behaviors that we're engaged in in everyday life on Earth.

So I think some of these things that as you tease them out, it's really gonna put everyone's opinion on display as to what is the appropriate way to interpret these provisions. So that you know, Article II becomes very important to someone like Blue Origin. We're very much in line with what the administrator said this morning. Go up there. Use those resources, sell them if you want for other folks to use the resources or to not use the resources, as the case may be.

Article VI, the idea that we need to be transparent with our, our government partners, whether it's NASA or is the Department of Commerce or the Department of Transportation, whomever it might be overseeing and authorizing our activities so that they're aware of what we're doing. You know, appropriately giving transparency into what our plans are so that those things can be coordinated with other actors from other countries.

So I'm very excited about the fact that we're now actually practically exercising these things and no longer just sitting around talking about them in an academic--which was always very exciting, but it's way more exciting to be testing them in practical application.

**CHRIS JOHNSON:** Yeah, definitely. I think we're really testing the strength of what is known in the Outer Space Treaty by setting these precedents. To return back to Mike--

**MIKE GOLD:** Can I jump in on that one? You know--I'm just saying it's great that we weren't completely wasting our time during all those hours.

**AUDREY POWERS:** That's right, that's right.

**MIKE GOLD:** And let me say in regard to tuna, that's all Jim Bridenstine, that if it was me, you know it would be all baseball or Star Trek analogies. And when we're on the topic, John--you

know, John, for those who aren't familiar with the Flash lore, that's a DC Comics Flash reference with Star Labs. So I try and go deep cuts, John has absolutely exceeded me. So thank you, John.

You know, I just want to--again, violent agreement, echo everything that Audrey and John had said. And while I'm very excited about operationalizing and getting into this future, I do wanna make just a quick point relative to infrastructure.

You know, I mentioned how important infrastructure is for sustainable space exploration in a physical sense, in a hardware sense relative to Gateway. But that's absolutely true from an institutional perspective as well.

And this is the warning sign or the fear that I've got, that our institutions, be it Committee on Peaceful Uses of Outer Space or even the way we deal with things in the US government, they're set up for a government or government to government orientation, that they weren't structured to be able to accommodate the private sector. And as the space exploration evolves and per the announcement today and for the success of, you know, commercial crew and COTS and like what John is talking about space traffic management, private sector will have a huge role to play there. You know, the private sector is here. This isn't science fiction. This isn't theoretical. Obviously it's arrived, and our institutions have to start reflecting that.

And that's one of the reasons I was so excited to participate at the time I was part of the private sector in The Hague International Space Resources Governance Working Group, the name still rolls off the tongue. And Tanja, I think you were sitting right next to me during those conversations. And what I appreciated about the Hague, was it brought together the private sector with government all around the same table, to have discussions that then fed into COPUOS. And I think that's an interesting system, a good mechanism and we're going to have to have more of these conversations and more institutions or working groups that combine private sector with government. Because if we don't have that conversation in a robust manner with private sector entities, we won't get good policy.

And speaking of not getting good policy, again just following up on Audrey's point, it's so exciting that we're operationalizing because if you try and create too much policy without too much experience, it's not going to be good decisions that we need to learn on the moon. We need to go to Mars to be able to craft the policies, which again, is why, with the Artemis Accords, we're setting up a foundation based on the Outer Space Treaty. And then we'll be taking those experiences to multilateral forums in the future as we learn and operate on the moon in as safe and transparent fashion as we possibly can.

**CHRIS JOHNSON:** Great, yeah, no problem. You know, you mentioned American leadership and America setting the pace on establishing precedents. So I want to turn to that and think about some of the implications and context of setting precedents. Tanja, it seemed--I'd like your context in terms of this resource use and procurement for it, it seems to be in accordance with The Hague working group.



But you know what--we're going to see other--what if we do see other nations, you know, do the same type of things? Do the same type of procurements and assertion of property rights in space? These things certainly could play out, especially if America is going to be the leader on that. What are some of the implications of that? And perhaps Jessy Kate could also chime in after.

**TANJA MASSON-ZWAAN:** Well, you know, I wanted to, just before I do that, chime in on the on the tuna issue. Because, yes, analogy of fishing on the high seas has been made many times. But I think there is one specification that has to be made. It depends also whether resources are scarce or not, and whether they are accessible easily for everybody.

Because even if you, of course, have a plethora of resources water, platinum, whatever and everybody can go there, then it's fine. But if they are scarce or even if they are abundant, but they are difficult to reach, then you do need some governments and you can just not go and fish the tuna.

And I like the fact that it was mentioned that you need to get the industry around the table. And I think that was one of the big success factors of The Hague working group, which was initially met with quite some skepticism. And perhaps still so, I mean, people were saying, what's the mandate and what are you doing here?

But I think that that aspect of it, not only industry and government, but also all parts of the world community countries were sitting around the table. I mean, you were also sitting next to a member of the Mexican Space Agency or the Indonesians or whatever. So that inclusive, inclusivity that Jessy Kate also mentioned is very important.

And I think that we should, perhaps more than looking at a lot of sea analogies, look at the International Telecommunication Union, where you have that aspect of involving industry. And I don't know how we can do this in COPUOS, but I think it would be a very good development if something like that could be done there, where you have sector members as they have in ITU. So they don't vote on the Constitution and things like that, but they have a legitimate voice. They're not just part of a delegation.

Of course, that happens now already. But then those, those industry partners are subject to the instruction of the official delegation. But recognizing the actual players as full-fledged discussion partners is very important.

And I think also another example that I wanted to bring here is, the is the fact of the management of for instance, the geostationary satellite orbit, which is the scarce natural resource, officially, where you have a kind of dual system of ensuring that everybody does get access so that it is not one takes all. But on the other hand, you also have a rational and efficient and effective management requirement. So all those things are, I think, important to ensure also for this manner of this matter of lunar governance.

And now I forgot exactly what your question was I wanted to bring these points down. Can you repeat?

**CHRIS JOHNSON:** Yeah, I mean it's setting a precedent. So if America does this, you know we can predict it is possible, it is likely that other nations may also be asserting property rights and for their own national, you know, space exploration and development goals. That's not to be feared, perhaps, but do you see problems with that happening?

**TANJA MASSON-ZWAAN:** Well, you have already seen that after the United States made their law and ongoing processes, we have had already two states that have gone the same way, Luxembourg and more recently the UAE, who have proclaimed laws about ownership of space resources. And generally these three are more or less aligned in what they do in acknowledging that ownership of resources can be--is legitimate. However, compliance with international treaty obligations has to be ensured.

But of course, the risk is that some other country which does not agree with the way this thing is going, might proclaim another kind of national law, saying we find that this is completely contrary to international law and companies will not be allowed under our jurisdiction to own resources, and then the risk is that you would get some form of patchwork of national regimes that are not in harmony with each other. And I don't think that that is in the interest of everybody.

So I'm going to be a little bit repetitive but saying again, that having these laws puts matter on the table to discuss. But eventually we will have to come together and find some compromise on common principles. And, you know, we had in UN COPUOS, for instance, the resolution on recommendations for national space legislation and that was adopted in I think 2013, that gives eight recommendations to states that want to adopt a national space legislation, to make a legal framework for commercial space activities. Why couldn't we have something like that, the UN resolution that gives recommendations to states some common elements on such national legislation?

Because let's be pragmatic, also, before we get to anything substantive in the UN COPUOS, it may take another 10 years. So I'm not convinced that we will have actually commercial use of resources before then, it might not be, but should it be, I mean, then we do need a Plan B. And then having some kind of agreement on at least the common denominator on the common principles that that I think would be, would be perhaps a good first step.

**CHRIS JOHNSON:** Definitely. And I know that we have about 15 minutes left in our panel, and I know that I do want to get to questions from our over 200 participants, we have a number of questions. But before I take a look at those questions, I want to ask Jessy Kate, based on this announcement today and, you know, based on what Tanja has just said, are--you know, in terms of precedent setting, think 5, 10 years, 15 years, 20 years down the road, is this setting off some type of land rush in space for resources and is the only way around that to actually

then agree that this needs to be discussed at the COPUOS level with some type of COPUOS or internationally deliberated instrument clarifying rights and obligations?

**JESSY KATE SCHINGLER:** Yeah, thanks. I love what Tanja was just saying about the idea of making recommendations to states. So I just wanna reinforce that. Also, I hope I don't drop off again, my apologies for my Internet connection, but let's have a go.

You know, my first thought is that--that the announcement made by the administrator and that we're discussing here, that really this accelerates the conversation about something that is in and of itself, as everybody has been saying necessary for sustained human presence. There's two elements of that: there's resource utilization of some kind and eventually some kind of market activity. And in and of themselves, these are not bad things.

I think the question, as usual, is about the implications. And I think, Jim said earlier, the resources extracted from the moon will be owned by the people who invest their resources, equity, and effort. And you know, that is certainly one way of doing it. But as we're talking about here--the tuna and the high seas, you know there are, there are questions of scarcity. Also, the tuna on the high seas is not just a free for all.

There are regimes that manage how we allocate utilization of those resources and regimes that talk about benefit sharing. And I know these are controversial terms. But I think these are the things that we're gonna have to talk about.

So there are many ways to make something ownable. Owning something can have different rights and obligations associated with it. And that is where I think we need to kind of double click and get into the meat of these conversations. When we make them sort of black and white, it actually makes it quite difficult to have the conversation. So I'm excited for us to have the opportunity to do so. And in that sense, I think what we're seeing here is a sort of first, first move.

I really hope to see the international community respond, not just with a black and white response, but actually nuancing and complicating the conversations so that we don't just see polarization in response to this, but real substance.

**CHRIS JOHNSON:** Alright, great. Alright, so the first question that caught my eye, part of it is from Michael Mealing. He asks, do the panel members see any serious commercial customers on the economic horizon for lunar activity? If not, what could be done to move beyond the 'build it and they will come' perspective?

So this is you know--if NASA's buying a few grams of space resources, how do we go to that next step, you know, version 2.0, and start to actually build that lunar economy? And anyone can, if they have a perspective on that.

**JOHN CARRICO:** So it was mentioned before that there's also the NASA CLPS program, which is buying commercial payload services, so that this is actually kind of a step after that purchase.

So I think there's a trend there for government. Some of the proposals that I've seen have been that, once these commercial companies--it is a build it and they will come--but once these commercial companies have their own infrastructure and capabilities, built for NASA, then other, private companies will take advantage of that.

And you do see that with the CLPS payloads already, where they are going to deliver a NASA payload, but there are several commercial payloads that these companies also have secured that are going to ride with the NASA payload to the moon.

So I think that's to me the very beginnings of this.

**MIKE GOLD:** Yeah, and if I could jump in on that one as well. First of all, let me say I'm a big fan of Field of Dreams. Great film, really believe in it. And that you're right, Chris, to point out the issue. And it's certainly a challenge, frankly, whether it's LEO commercialization or creating the business case on the moon. And that's driving the announcement that was made this morning and will continue to be the fundamental issue that pushes NASA to take action, that we believe that NASA can serve as a catalyst to creating these commercial capabilities, then as a customer for those capabilities.

And the hope is that by being a catalyst, by being the customer, that we can help create what then will be a dynamic business ecosystem where NASA can be just one customer among many. We've got a ways to go, which is why it's important that we get to the moon, operate, and discover what are the business cases that could work.

I don't believe we've even scratched the surface of the business case and capabilities in low earth orbit, much less on the moon. The important thing, just like in baseball, is to get out there, get on the field, and then anything can happen as Field of Dreams showed.

**CHRIS JOHNSON:** Thank you, Mike. There is a very precise question from Marcia Smith, Space Policy Online that was for Mike. What is the total amount of money available? And are any countries excluded from bidding on this RFP?

**MIKE GOLD:** So the total amount of money, and Marcia apologies if I get it wrong, I haven't looked at the RFP this morning, but I believe it's about \$50,000. Please go back and verify the actual document.

I'm bad with numbers, which is why you don't see me touching engineering, just the lawyer policy international specialist here. But I believe it's 50,000, so the dollar figures are relatively low. Also as the administrator described, the amount of resource is going to be similarly small, but we believe that the precedent that the importance of getting us out there on the field as we described, that's what this is intended to do, to act as a catalyst for that.

And as I mentioned before, this is a global effort. We're not going to be the only ones going to the moon. We need to lead the world forward to the moon and beyond into the solar system and that's why it's very appropriate that this solicitation is actually open globally. And I certainly

hope that there will be global participation to help support the simple contention that you can extract resources and enjoy the fruits of your labor.

**CHRIS JOHNSON:** Thank you for that, Mike. You know, I think when we're speaking about developing a commercial infrastructure and commercial economy, a lunar economy, and at the same time building the normative frameworks, the rules and regulations for that, there is this tension and we don't know what should come first.

You know, we don't want to have regulation that stifles innovation and stifles development of the economic sphere. But also, if you wait too late, then it seems as though that type of activity can really get away from you, and it's difficult to set the rules afterwards. So the timing of when we should be really drafting these lunar norms and lunar rules, you know, we don't know whether it's--how much should be done beforehand and how much should be done, you know, as it's happening.

How much should be--we should wait for the activity to happen and then seek to, you know, regulate and foster it. So you know, I'd invite some--any perspectives and reactions to that question.

You know, do we need to do this beforehand or kind of the American approach or the common law approach is wait for the activity to happen, and then and then you can start to come with rules. So it looks like our resident Canadian and other international individual on our panel, Jessy Kate, you have the answer. Go ahead.

**JESSY KATE SCHINGLER:** Thanks. Yeah, well, actually, it sort of speaks to the previous question as well as this question, which is that in some senses, I think you know, these are chicken and the egg. But that's actually why baby steps and incremental capabilities will be really helpful here.

I have to say, you know, at first when I heard the announcement this morning, one of the thoughts that went through my head for a minute was oh geez this is like, this is just so small. Or, you know, I mean, I think there will be a question about is this even just a gimmick? Or is this a real--you know, is this really extracted or these really resources? What makes them resources? So I think there's a whole set of conversations to be had there.

But actually, I think the fact that it's a very small, incremental activity is actually really helpful because it still raises a ton of really big questions that we will need to answer. And in doing so, we can have a tight feedback loop between the regulation and the policy and capabilities. And, you know, I don't think anybody knows, I mean, as evidenced by the silence on the panel when you asked--I don't think anybody knows exactly how we're going to see rich, you know, economic activity in outer space or even you know, what markets in space will look like. But again, emphasizing on the small incremental capabilities is what lets us as Mike said, sort of get into the game and get going.

**CHRIS JOHNSON:** Go ahead, Tanja.

**TANJA MASSON-ZWAAN:** Yeah, I think I would like to issue the magic word of the Hague Working Group again here, the adaptive governance. I think we should--I mean law should not proceed technology, but on the other hand, you have to be ready. So you have to think of what is going to be necessary in the near or medium term future and have rules in place for that. And I think that is important, but you should not try to regulate now, for instance, the use of space resources on Earth, I mean, before we're going to be able to bring them back to Earth, that will be far away.

So incremental regulation going hand in hand with what is expected to be realistic in terms of technology, I think, is the way forward. And you see that also with human spaceflight capability, we have companies that are also receiving funding from NASA to be able to make that step from the space shuttle as a governmental transport system to SpaceX and Boeing doing it on a commercial basis.

It is a stepwise approach, and so this announcement by the administrator I think that that is done in the same sense. NASA will be, even if it's only \$50,000, but is facilitating the step towards commercial use. I think what will be interesting here is that you will have one federal entity in the United States that will have to authorize and supervise this activity, which is in a way commissioned by another administration, institution of the government.

So when there is going to be a foreign company that is going to win this bid, it will be quite interesting how the licensing and the supervision will be done. And I hope that the US government would then also verify that a proper audit has taken place, that the activity can take place in the safe and sustainable manner, taking into account international law.

**MIKE GOLD:** And Chris, if I could jump in on that one too, and rest assured that whenever you get silence from me, it's just me struggling with my mute button. That I always love to jump in on commercialization of the moon conversation. Sorry, I was slow on that one.

Just agree with everything that Jessy and Tanja just said. And in direct response to your question, Chris, I say beware of false dichotomies. That the question isn't to regulate now or later. We really, as Tanja mentioned, need law and technology to be in tandem, to be in partnership and to reinforce each other. So it's not either now or later. It's both.

That we need policies and regulations that will enable, that will empower the commercial activities and safe and sustainable exploration and science that we want to see in the future. Because if you're trying, even before an activity takes place, if you want to raise funding from a venture capital fund or you're an investor yourself and want to put money forward or you're even trying to get insurance, what you don't want to see is unpredictability. What you want is transparent. You want to be able to know what that regulatory environment is going to be. It's a question that investors will ask. So you do need a degree of certainty that you can provide the commercial sector moving forward.

But we also shouldn't be arrogant relative to us having all of the answers at this stage. And this gets back to what Tanja was talking about with The Hague, that we have to be able to update, to modernize, to treat our rules as organic, adaptive governance because we're going to learn along the way. And that's why I say and why we structured the Artemis Accords, taking a page from the Outer Space Treaty, which I love so much, that it's a series of principles because we don't know enough really to go far beyond the principles now. Once we have that information, though, then we will.

And I look forward to those bilateral and multilateral conversations that can take the operational experience that we've gained and create future policies and regulations to further enable growth, development, safety, and sustainability.

**CHRIS JOHNSON:** Great. Thank you so much for that last comment. And I believe we do have to end it there. I want to thank my panelists for this really fascinating discussion about the moon. It's a pleasure to speak with you about it and hear all these comments and perspectives.