Eric Berger:

All right. Well, we're all reconfigured now. And the way I look at these two panels is Lori was kind of like the Princess Leia, the Light Side of commercial space. Now we're going to turn our attention to the Darth Vader side of commercial space. We're going to talk about space debris, which they're playing a role in. Very excited to have a distinguished panel to talk about Space Situational Awareness, space junk, and identify the problem and then find some solutions. And so first up is Caleb Henry. He's a senior analyst at Quilty Analytics, and he previously worked at Space News. Excellent journalist there. We have Therese Jones, senior director of policy at the Satellite Industry Association, where she supports work on regulatory, legislative, defense-based sustainability, cyber security, and more. And then Charity Weeden could not be with us today. She had last minute issues. So stepping in very ably for her is David Hebert, the vice president of global marketing communications at Astroscale. He came to Astroscale from the Aerospace Corporation, where he's expertised in space policy, civil and commercial space systems. So thank you all three for being with us.

Eric Berger:

We have about 30 minutes to talk about a problem that encompasses the entire planet and beyond. So we'll do our best, I guess. And so I guess the first thing, there are people in this audience who aren't deeply interested in the space industry, like we all are. And so I'd love to first identify what is the space junk problem, what's out there and why should we be concerned? And maybe we'll start with you Caleb.

Caleb Henry:

Sure. So I'll try to give a high-level overview-

Eric Berger:

Pun intended.

Caleb Henry:

Yeah. I was just thinking about your intro. I'm like, ''How many times can you say the problem is bigger than earth?'' Not often. So in short, when you put things in space, they don't just disappear. Same as most trash. Trash that's in space is not biodegradable. And so we end up with this situation where early on in the space race, we as humanity put a lot of rocket stages and satellites and objects in space without realizing that they would stay there for hundreds or thousands of years. That some of them would detonate because they were never depleted fully of their fuel. That some would collide because when nobody's at the controls and you just leave them there, that happens. And the result is that we have tens of thousands of large pieces of debris, 10 centimeters or above. And then depending on who you ask, millions of pieces that are below 10 centimeters in size. A lot of it being in low Earth orbit, which is a very popular destination these days. But also debris in higher orbits, where the spacecraft actually tend to increase in value as you go up.

Eric Berger:

And Therese, what's happening now that's making that problem even worse?

Therese Jones:

So one of the major concerns is that we have tens, if not hundreds of thousands of satellites being launched over the next decade or so. For reference, right now there are around 5,000 satellites on orbit.

So exponential explosion in the number of satellites. And the vast majority of them want to be in a 400 to 600 kilometer range above Earth. So that area is becoming increasingly congested.

Therese Jones:

There's also a problem in that not all satellites are maneuverable. So one, you can have two dead satellites potentially colliding. You can have them potentially collide with pieces of debris. But even of the stuff that's being launched, some of it can maneuver, but some of the smaller satellites don't have propulsion on board. So should you be able to launch a satellite into space if it can't move?

Therese Jones:

And with an increasing number of people trying to get into space, there are just so many more people that you have to coordinate with. It used to be just the major space powers that were talking amongst each other to try and deconflict these issues. But now, not only diplomatic issues with for instance, Russia and China and coordinating, but we've got many smaller companies that are not experienced with this deconfliction process that have to be on board with the same space sustainability goals and communication that everyone else is working on.

Eric Berger:

And Dave, maybe you could talk a little bit about the challenge of working in this environment. Because, as Caleb and Therese said, some satellites don't have their own propulsive control. But even going up there to try to remove this junk, you can't just send a garbage truck up there right?

Dave Hebert:

Right, although maybe you can. So human space activity turned 65 in October, since the launch of Sputnik. So we're approaching retirement age in terms of human space activity. But if we ask ourselves how much have we grown? We're probably still learning to clean up after ourselves, like at kindergarten age. And there is a challenge here, not just with the technical obstacles of removing debris, but there are policy and economic challenges as well right? Who's responsible? Who pays? How much do they pay? How are we going to hold people accountable? What business models are going to support a market that includes a debris removal component, a debris mitigation and remediation component. And these questions have to be answered, but as Caleb and Therese have ably illustrated, we're reaching a critical point where if decisions aren't made and actions aren't taken, we may be facing catastrophe.

Eric Berger:

So I want to drill down a little bit further and understand where we are on the issues of rocket bodies, dispent upper stages, ASAT tests, antisatellite tests, which of course Russia unexpectedly blew up its own satellite toward the end of last year. And then the coming mega-constellations, Starlink, Project Hyper. Tell us that. OneWeb. And China is going to do something as well. So, first of all, in terms of second stages and making sure that we dispose of rockets, by and large is the United States, China, Russia, are all of those countries operating responsibly with regard to second stages?

Caleb Henry:

I think I'll probably defer to my colleagues here on that.

Therese Jones:

So there was a list of the top 50 most dangerous pieces of debris on orbit that a researcher Darren McKnight put out a couple of years ago. And out of those, almost all 50 were spent Russian upper stages. So major issues. So not even talking about all the satellites that are coming out of orbit that might collide with things. These objects are quite dangerous. There was a near collision with a Russian upper stage that wasn't even in the top 50, I think within the past year or so. And if you're running at collision risk with something that's not even in the top 50, that's probably not going to be the first thing you remove on orbit. Major problem that exists there. But it's also a diplomatic issue. I have heard people say, ''Hey Russia, all these dangerous pieces of debris are yours and you're going to take responsibility for them.'' And they were like, ''Oh, actually they were launched when we were still the USSR. And we're actually not the USSR. Russia is a different country. So we're not liable.''

Dave Hebert:

Under new management.

Therese Jones:

Yeah, pretty much. Under new management. So many diplomatic issues to work out there.

Dave Hebert:

I think the other issue, we have to sort of step back and look at space operations in general, we have historically and almost entirely built and launched rockets and satellites as if we never would or never could touch them again or do anything else with them again. Now to be fair to the space sector, technologically that hasn't really been a possibility until recently. But we have also operated I think a bit with our heads in the sand about the long term implications of leaving a three- or four-story object in orbit, without a plan for how to get rid of it. And I think now what we need to shift is our thinking about backup plans, contingency plans. How do we get rid of this thing after we've put it up there? Especially as we add tens of thousands of more satellites in orbit.

Eric Berger:

Yeah. The second stages, oftentimes, you would struggle to fit it inside this room. These are big pieces of hardware. But would you say that launches today are more responsible, more cognizant of that? Or are we still seeing some bad actors with Russian Proton launches or things like that?

Caleb Henry:

You're definitely seeing some improvement. I know Europe, for example, I don't remember exactly when they implemented this, but has made it a goal, made it a priority, a regulation even, that the launch companies have to make sure the second stage deorbits. So you see that a lot now with Vega launches and other rockets there. And I think the European Space Agency is even paying a company there, to bring down an upper stage of a Vega rocket this decade. So you're seeing that there. Some of the deployments that are happening in low Earth orbit, something that SpaceX has emphasized a lot with Starlink is they're deploying the satellites at around 200 kilometers. So we know that if you're close to the atmosphere, you can deorbit much more quickly. I made the quip about space junk not being biodegradable, but if you're below 600 kilometers, you will come back down within 25 years roughly. And so that's the closest to biodegradable that we get in the industry, globally I will have to defer to our other panelists.

Dave Hebert:

I think the congestion that's beginning to become a reality is forcing an awareness. And if that's what it takes, that's fine, but you're starting to see launch companies have to think about, ''Where's my rocket going? And where are my payloads being deployed with existing congestion, both active and dead in mind?'' And again, if that's what it takes for people to say, for operators to say, ''Wait a minute, this isn't sustainable.'' Then let's take advantage of that and turn that reactive mindset into a proactive one.

Eric Berger:

So let's talk about the mega-constellations for just a minute, because that's... Therese talked about how we're talking about going from 5,000 satellites, half of which now are Starling satellites or more, and taking that number to like 30,000 satellites. Do we have any of the frameworks necessary in place to manage the addition of 25,000 satellites in low Earth orbit with any kind of conference? Or should we be really concerned about it being bumper cars up there?

Therese Jones:

So there have been some proposed policy solutions and a lot of work is being done in this area. One thing that Starlink has implemented is automated collision avoidance. So they detect they're getting too close to something, they automatically maneuver the satellite. Generally great concept, but if the other operator doesn't know where you're going and also simultaneously moves, there could obviously be issues there.

Therese Jones:

There's a lot of effort being done, both in the U.S. and to some extent in an international level, on what's called space traffic coordination and management. So trying to develop not only better data tracking all these satellites so that companies know what the risks of collision are. Right now, commonly satellites will maneuver if they've got a 1/10000 risk of hitting each other. But that's not a set in stone rule. The operators can choose, so if an operator wants to be risky and move when there's only a 1/100 risk, there's nothing that says that they can't. So there's a lot of work on trying to define what these norms are and get operators to talk to each other about these issues. So that if there is a potential collision, the communication is much better.

Eric Berger:

What happens if a Starlink satellite is projected to hit the new Chinese space station Tiangong? Is there a hotline from Hawthorne, California to Beijing, or what happens?

Therese Jones:

So that was in the news recently, which is probably why you're asking, that there was a major diplomatic issue with a Starlink satellite coming close to the Chinese space station and China condemned both the U.S. Government and SpaceX on international level for this. And what I have heard is it turns out the Chinese and the U.S. And SpaceX were operating on two different sets of data. So the Chinese said oh, we've got a, I don't know what the number was, but like a 1/1000 chance of being hit by this Starlink satellite. But the U.S. Government and SpaceX said, ''No, our data shows that we have a much less than 1/10,000 chance of hitting the Tiangong space station. So we don't have to do anything.''.

Therese Jones:

So different sets of data, issues there, with two operators having different sets of data. But also SpaceX has to go through State Department to reach out to China, to deconflict in any of these issues. And I've heard that when the State Department reaches out to China and says, ''Hey, we have a potential conjunction.'' China just says, ''Go ahead and move.'' In one line, in an email. So there's a lot to be done on the communication side too.

Dave Hebert:

So I think this illustrates the incredible importance of norms of behavior, of everyone having a collective understanding and data to share with each other about what is happening in orbit and having some clarity on how are we communicating with each other and how quickly can we do it? Space is inherently a borderless environment. But it's one where things are moving up to 17,000 miles per hour. And so the consequences of a small misstep can be drastic for everyone else operating in that environment. In that reality, you have to have ways to communicate with each other and you have to have a common set of accepted behaviors.

Eric Berger:

So, just for your edification, we've worried about space collisions almost from the beginning. It calls to mind a story. I was told to me by a former NASA flight director, who was directing a space shuttle mission on Thanksgiving in the 1980s, and one of his controllers said, ''Hey, we got a call from space command saying there's a potential collision with Turksat 1 and we're concerned about it hitting the shuttle, and we've got to potentially do some debris avoidance maneuvers.'' And that sets off this chain reaction to do the debris avoidance maneuvers, and the flight director calls his boss and they're about ready to call up the crew. And then like, ''It's a joke, okay? Thanksgiving. Turkey doesn't have a satellite.'' And as the flight director is scrambling to make these calls, there's a big turkey up on the big board, moving across the satellite. But he doesn't see it. He doesn't get it. He's still working out. And he was not happy about that. There were consequences. But anyway-

Caleb Henry:

I think just to add there, one, modern day Turkey does have their own satellites.

Eric Berger:

Yes. This was the eighties.

Caleb Henry:

But this whole conversation highlights how limited the data is around where things are in space. Because this whole, is it 1/1000, 1/10,000? That's not how we live our lives. ''Oh, I have a 1/5,682 chance of getting hit by a bike today.'' You don't do that, but we have these large error bubbles around vehicles and space. And those can be a few kilometers in size because we don't have really precise definitions of where things are or if one company does, others don't. And so you just have to play it as safe as possible. And I think, to your original question, looking at a world where there will not just be 5,000 satellites, but 25,000 satellites or more, we need to have better data on where exactly things are in space so that we can refine those measurements. And only be calling or emailing each other when there's actually a risk of a collision, not a risk of a risk of a collision.

Dave Hebert:

And if I could add to that, we've talked about situational awareness, having the data, we've talked about traffic management and coordination. The increase in congestion that we're talking about. There's a third leg of the stool that needs to be added and that is space environmental management. We have to proactively remediate and mitigate old debris respectively and prevent the creation of new debris. And while also looking, again, at satellites and upper stages as things that we can go back up and touch and move and get out of harm's way.

Eric Berger:

Yeah. And I want to come to that, we talked about rocket buys, we've talked about mega-constellations and then the third major issue I think is debris created by anti-satellite tests, where a country basically wants to demonstrate to its adversaries that, ''Look, I can shoot down your satellites at will.'' And so they'll fire off a surface-based missile, rocket, and shoot down their own satellite as a demonstration and say, ''Hey, look what we can do. And don't mess with us.'' The United States recently called for a ban on this kind of testing, because there have been some recent tests by China, well China's test was more than a decade ago, but India more recently and Russia that have all created some debris issues, some pretty severe debris issues. I'm wondering what each of you... It seems like in this country and our allies there's been a pretty much universal support for the idea. This is an idea whose time has long come and the White House push for this is very welcome. But what kind of reaction, beyond our allies, have you guys seen to this call for a band?

Caleb Henry:

The tests that we've seen so far, it's a great power politics move. If you can demonstrate that you can shoot something down in space, it's a move to say, ''Hey world, take us seriously.'' I think a lot of times these decisions, you see the anti-satellite tests, I think Modi was praising it in India. This is something that goes all the way to the top.

Caleb Henry:

The industry side of things, the space industry is never happy about things getting shot at or blown up in space. Anytime you create debris, it's now everyone's problem. So I think there's a pretty universal acceptance within the industry that there needs to be bans on ASAT tests. But it's also not super straightforward, how you prevent those kinds of things. The ASAT, I don't even know if test is the right word, but the U.S., the Operation Burnt Frost wasn't an ASAT per se. If you have an intercept vehicle, which there's a lot of talk about today because of heightened concerns about missile defense and hypersonics, an intercept vehicle can function as an anti-satellite vehicle or weapon. So combating the proliferation of ASAT tests is not the same as combating the proliferation of ASAT technology.

Eric Berger:

And Therese or Dave, if you guys have heard, where's China, where's Russia, some of the two big partners you would really need to bring on board, with India as well.

Therese Jones:

Yeah. Russia and China for years have tried to push this Prevention of the Placement of Weapons in Outer Space Treaty. The issue with that, and why the U.S. and Europeans haven't signed on board with that, has been because there's no actual definition of what a space weapon is. Things could be dual use, so you can have something go inspect a satellite that could also end up being a space weapon depending on how you use it. So the U.S. hasn't backed that and that's why they came up with this

destructive kinetic direct-assent anti-satellite test ban, because they wanted something that was verifiable on an international level. Now are there still potential loopholes in that? Well, sure. You could have something that's co-orbital that could destroy a satellite, but they saw this as a first step. Russia, with the whole Ukraine situation, is absolutely not on board. I'm told there might be a little bit of diplomatic room with China to keep working on this, even though they still are pushing the PPWT, but we'll see,

Dave Hebert:

I will echo some of the comments Caleb made about the private sector. I think in general, ASAT tests are viewed as a zero-sum action. There's just nothing good to come from them. It's limiting of commerce, of space's infrastructure, of exploration, of security, predictability. And so Astroscale, it will probably not surprise you, thinks that the deliberate and unnecessary destruction of things in orbit is dangerous and irresponsible.

Eric Berger:

Yeah. So let's talk about now, we've got about 10 minutes left, about we've identified the problem pretty clearly, and it's serious. What are some steps that we could be taking to solve it? And Dave, let's start with you, you work for Astroscale whose business is the remediation of low Earth orbit. So just tell us very briefly about what you're doing in the most important thing on Astroscale's front burner.

Dave Hebert:

Sure. For us, particularly as it relates to government, it's switching from a passive mindset to an active one. That's that environmental management that I talked about, of not hoping that congestion will work out, but doing something about it. And I want to say there's an opportunity here that Astroscale really wants to emphasize and is hoping to help capitalize on. Yes, debris is a burning platform that has to be dealt with, but there's so much to be gained from creating a sustainable infrastructure for the growth of the space economy, through a variety of on-orbit services, being able to move things and refuel things and get them out of harm's way and extend their lives. And that's what's on the front burner for us, is how do we create a sustainable foundation on which the future space economy, which is projected at a trillion dollars plus, can be built?

Eric Berger:

And Therese, you represent the satellite industry. What from their perspective is, if you're an operator, if you're SpaceX, having a low Earth orbit preserved is just as important as it is to Amazon? Is it just as important to the Chinese government? What are the priorities for the satellite operators?

Therese Jones:

Yeah. So one of the biggest priorities is, right now there's Space Situational Awareness, attracting the space debris, has traditionally been run by the Air Force, now Space Force, for not just U.S. government and military, but that's where the commercial providers for the most part get their data too, not just in the U.S., but a lot of international actors get it from there as well. And there's this desire from the U.S. government to shift this effort. So the civil commercial front, over to the Department of Commerce, there's an Office of Space Commerce there, and they're creating what's called an Open Architecture Data Repository.

Therese Jones:

They not only want to get this data from the DOD, but they want to make it a platform where others can input data. And so you get better fidelity on potential collisions. You can input things, if you're planning on maneuvering your space object, you can input that into this new Data Repository. And just to ensure transparency internationally, I think it's going to be a big deal. And the U.S. has signed data sharing agreements with other countries that will hopefully help kickstart conversations on this problem. But it's really the coordination and management part that really needs to be focused on, I think broadly, in addition to this data piece. So working on norms of behavior internationally, because there's no international entity that can regulate this problem.

Eric Berger:

So roughly speaking, it costs about $10,000 to put a kilogram from here into space, into orbit. It probably costs more than that to get a kilogram from space back to Earth, unless it's falling through the atmosphere, and do so in a controlled manner. So what I'm saying is that it's going to be enormously expensive, well maybe not enormously expensive, it's going to cost a fair amount of money to take some of these remedial steps. And I guess Caleb, I would ask you, has the government stepped forward and said, ''We want to have a robust space remediation or space cleanup plan.'' Do we have anything like that in the works?

Caleb Henry:

They want to. There's this gap between them wanting it and doing it. So I'll actually use Europe as an example here. About 10 years ago there's a massive European satellite called Envisat, 8,000 kilograms, I think that's like 20,000 pounds, that just stopped working one day. And the European Space Agency went to Industry and said, ''We will pay you to take this thing out of orbit.'' But it was so technologically complicated and it would've cost so much that even the Industry there said, ''What do you want us to do?'' It was literally too big of a problem. And it's still there to this day, just orbiting the earth. And I think the challenge to getting the debris down, you're right, we need active debris removal, but the way government has interacted with the private sector, hasn't always worked well.

Caleb Henry:

In the U.S., we had the DARPA and the RSGS program and that program is over a year, excuse me, over 10 years old. And Maxar backed out of it at one point, saying basically the costs were not aligned. Not only do you have this tragedy of the commons, but you get these situations where the negotiations between the government and the private sector keep breaking down, in the pursuit of actually bringing down space junk. I'm optimistic that is changing. We have one such company here that I believe is working with the Japanese government on the-

Dave Hebert:

Indeed we are.

Caleb Henry:

-Mission. And so there's optimism that this will change, but there's been an impasse that has prevented wishes from being actualized.

Eric Berger:

So in the last couple of years we've actually seen Northrop Grumman for the first time go up and attached to and move satellites. So what the European Space Agency or Industry said was difficult a decade ago has now been done. But Dave, I'm wondering, are there breakthroughs in your technology that are bringing the cost go down or making this idea more affordable? Because it just does seem way too expensive and very difficult.

Dave Hebert:

So it depends on the problem. If you look across on-orbit servicing, for example, you were talking about Northrop Grumman's. I think MEV, this life extension mission, there you have, in geostationary orbit, satellites that cost hundreds of millions, in some cases over a billion dollars to build and launch. And you're balancing the question of should I build and launch another one of those, or should I pay a few million dollars a year to extend the life of that satellite when it's still perfectly capable of doing its job and driving revenue, but it's just run out of fuel. I think the market's there, the value proposition is there. The question is really just the fine tuning of who has got capabilities that companies feel confident in paying for and is the price right?

Dave Hebert:

Debris is a little different because you have this responsibility challenge in a lot of cases. We're a different country now, that's not us anymore. So it's not our responsibility. And then you have different levels of technical challenge, the large objects, which is what Astroscale has focused on, which is what Darren McKnight's list of 50 has really focused on. We have near term, and in many cases existing technologies, to grab those things and take them out of orbit. The smaller stuff is a very different technical challenge. And there has not been a widespread credible solution yet, with a reasonable price point presented to say, ''How would you go up and scoop up pieces of debris that are this big?'' Which seems somewhat innocuous until you realize a piece of debris that big can knock a spacecraft out of commission, can crack windows on the International Space Station, can present all kinds of problems. So there are layers of economic and technical challenge at play here.

Eric Berger:

So we've got two minutes left. I want an elevator pitch from each of you on something that the U.S. government ought to be doing soon, as a first step to tackle one of the problems that we've identified here today. So Dave maybe start.

Dave Hebert:

Sure. Right now congestion and debris are holding the future hostage, in terms of what is possible. So I talked about technology policy economics. I think the U.S. government needs to be looking at those three factors and identifying some real targets, ''Hey, let's take five of those objects that are on that list of 50 that belong to us and get them out of space in the next five to 10 years.'' Identify a real target and go after it. And I'll give them credit for things like Orbital Prime. There's a Space Force contract vehicle that's engaging the private sector and coming up with on-orbit servicing solutions. But we need to take those three pillars, economics policy and technology, and at a policy level incorporate those into proactive solutions for space environmental management, in addition to traffic management and situational awareness.

Therese Jones:

The issue with regulating on an international level is this is broadly under the purview of the UN Committee on the Peaceful Uses of Outer Space, but there are consensus based organizations, so Russia or China says no, nothing happens. So they have some non-binding guidelines that are very high level on long-term sustainability. But I think the work really has to be done by the U.S. government on bilateral and multilateral basis, on the coordination and management piece, with like-minded countries to get anywhere. And once we start getting other countries to sign up, then it becomes a normal behavior in space that then Russia and China are implicitly bound to, even if they don't sign off. So I think that's where we need to go.

Caleb Henry:

I'll echo Dave's point of Japan and Europe have both contracted with companies to clean up space junk. I would like to see the U.S. government do the same thing and the Open Data Repository, or the Centralized Repository, has been talked about for a few years now. And it's annoying to talk about things forever and not see them done so.

Eric Berger:

Well, I agree. On that note, let's wrap up this panel. Thank you so much, Dave, Theresa and Caleb.