Transcript: Day 1 - September 9, 2020

Panel 1: Space Sustainability in Review: What Progress Have We Made and What Remains?

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- **Natália Archinard**, Deputy Head of Education, Science, Transport and Space Section, Federal Department of Foreign Affairs, Switzerland
- **Joe Anderson**, Vice President of Business Development and Operations,Space Logistics LLC
- **Daniel Ceperley**, CEO, LeoLabs
- **Diane Howard**, Chief Counsel for Space Commerce, U.S. Department of Commerce

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MIKE: Our panel today really is looking at the kind of progress that we're attempting to make and hopefully are making in the area of space sustainability. And to continue the work of last year's summit in--in looking at the large volume of work that remains to be done. Natália, what is the status of the discussions on space sustainability at the U.N. Committee of the Peaceful Uses of Outer Space?

NATÁLIA: Thank you, sorry about that. And thank you, Michael, for having me here on this panel. Just before I start, um ah--Just to say that I'm speaking here on my own behalf and that my views may not engage my government. Thank you.

Well, the stages of the discussion on the long term sustainability at COPUOS is the following.
We had, last year, a milestone moment as the COPUOS agreed on 21 guidelines on the long term sustainability of the space activities, um, that it had been working on for 10 years. And you can imagine, 97 member-states having to agree per consensus on every single word of those 21 guidelines and the preamble, by the way.

So it was a great achievement also because at the same time, COPUOS decided to pursue work on the long term sustainability by establishing a new working group to--with a five year mandate, to work, ah, on three elements. And the first is the implementation of those just agreed 21 guidelines.

The second is capacity building, which will help in the implementation of the guidelines.
And the third element is addressing new challenges to outer space activities. So that was last year.

Those decisions were endorsed by the General Assembly of the United Nations, and this year the scientific and technical subcommittee started addressing--started, actually did an attempt to launch the work of this new working group. But unfortunately, member states could not agree on the

composition of the bureau leading this group. So that is unfortunately, the status. And then of course the COVID pandemia broke out around the world and the sessions of the legal subcommittee of COPUOS and of COPUOS itself in June had to be canceled.

So unfortunately, the multilateral discussions have been stopped since February. That is the status for now, Michael.

MIKE: Oh, thank you, Natália. I think it would be interesting to hear from Dan about the work that they're doing in trying to provide private sources of data about what's going on in orbit that could be part of these discussions. What's your update, Dan?

DAN: Yeah, Michael. Thank you. And thank you and good morning. I'd like to take just a minute and thank the Secure World Foundation for hosting this event. So--the space industry is going through a once in a lifetime change and focusing on sustainability. Keeping the focus there is absolutely critical. So it's an honor to participate here.

Um, you know, as kind of, a way of getting into LeoLabs' activities, I want to start by saying one of the most impressive aspects of this conference is really the breadth of interested parties.
You know, we have UN policymakers. We have regulatory leads. We have space agencies, scientific entities, and commercial firms like LeoLabs and the defense community too. And we're all here to talk about sustainability. And the big question is why?

And I'd say that the two reasons are: first, we all sense we're on the verge of something big, something unprecedented. It's really, it's kind of nothing less than the expansion of human civilization and infrastructure into space. Starting with LEO. And the second is, we're here because we know there are risks that come with this change, and we know they're not well understood. And 2020 looks to be the tipping point for all of these activities.

So you know, at LeoLabs, the big thing that we're doing is addressing the lack of data about all of these risks. So LeoLabs is the commercial space situational awareness and space traffic safety platform for LEO. We've developed radar technology that we can deploy very quickly, in effect, our latest radar showing here in the background. It's the Kiwi space radar that we opened up last year in New Zealand.

We have, a radar, a similar radar in Costa Rica that's underway. We're in the middle of construction and we expect to get the number up to six over the next year or so. So we're on building number four, right now. So this is truly a unique data source, and it's designed to track small debris down to two centimeters in size because that debris is a critical element of space sustainability.

And on top of that, the other aspect we're doing is a software platform and using that to report on important events in space. So, you know, simply generating radar measurements isn't enough. So satellite operators, regulators, defense organizations, insurance underwriters they all need to know what's actually going on in LEO. They need to know the risks.

So we operate a cloud-based platform that turns the radar measurements into alerts and analytics and real time reports. So in terms of us, kind of milestones we had earlier this year, we launched our commercial collision avoidance service.

It's responsive. It supports reporting to all stakeholders. We also completed a rendezvous and proximity operations service, and we're supporting some of these new launches, some of these rideshare launches.

Um, we've used this, these capabilities to publicly report on a few events, including a risky conjunction involving two derelict satellites. Ah, a break up of an H-2A rocket body, a new debris from the Resurs-O1 satellite and some rapid tracking of some of these rideshare launches.
So you know, we--what we see in the market is there's a lack of data about what's going on in space. We're there to fix that on. So that's, that's what LeoLabs has been up to.

MIKE: Well, thanks a lot. And that I think of, of what your work is doing to contribute to space sustainability.

KRYSTAL: You're on mute, Joe.

JOE: And uncover my mute button, sorry about that. So thanks, Mike. Appreciate that. And yeah, absolutely. We started a new industry in space and satellite servicing this year. In February our Northrop Grumman built Mission Extension Vehicle One successfully docked with Intelsat 901 satellite just outside of geosynchronous orbit, starting a five year or more life extension service for, for the Intelsat 901. The Intelsat 901 satellite was actually launched back in 2001 so it's over 19 years old at the time we docked to it.

It had been operating in GEO orbit up until about December of last year. It had entered inclined orbit operations starting in 2018 so it had about a 1.7 degree inclination by the time we docked to it. It had completed that mission. So it's successfully operating, you know, in GEO orbit.

They raised the orbit up to the graveyard to intentionally rendezvous and dock with our Mission Extension Vehicle One. And our Mission Extension Vehicle One, it launched in October of last year. Used electric propulsion to raise its orbit out to GEO, arrived out in the GEO graveyard orbit in late January of this year, where it began the rendezvous mission with the 901 satellite.

So over a period of, ah, a few weeks, we rendezvous-ed and successfully docked to the Intelsat 901 satellite. Intelsat 901 of course, being launched 19 years ago, wasn't designed, didn't have features designed to be docked to. So we were able to take advantage of existing features on the spacecraft to successfully capture it. Once we docked to it, we, uh, we drifted it towards its new orbital location, which is over the Atlantic Ocean region, and we also reduced the inclination.

So as I mentioned, it had about 1.7 degrees of inclination. We brought that back down to zero in April of this year. We put it back into service and Intelsat transferred over 30 customers onto that

satellite, and it's been operational since that time. I was very happy with that service. So very excited about that. We launched our mission extension vehicle number two just a few weeks ago. It's beginning its long journey out to geosynchronous orbit. This time rather than docking out in the GEO graveyard orbit, since we've demonstrated capability successfully in all of our, all of our various procedures and contingencies, uh, this time we're gonna be docking to them directly in the GEO orbit.

They will maintain service throughout the docking. So we're very excited about that. Should be happening in the February time frame of next year. So, you know, what does this mean for space sustainability? I think, I think really we've demonstrated the fundamentals of satellite servicing. It shows that servicing can be successfully used safely to extend the lives of satellites and thereby reduce the number satellites we need ultimately launch.

I think it's really paving the way for even greater servicing capabilities. It will enable us to extend the lives of satellites again, having to launch, you know, less objects in space to achieve the same capabilities or attain totally new capabilities as well. It will all support sustainability.

MIKE: Well, thanks a lot. And, uh, y'know thanks for managing to not create more debris, as people kept worrying that you would. You pulled it off well. And as you said, I think it's a demonstration that this technology has as a future. Diane, you're in the position of having to try to turn all of these new innovations and developments into policy. What's life like now at Commerce as you try to do that and, and what's your own vision for how we're doing at this point in 2020?

DIANE: Well, I-- I think that we've made a lot of progress, to answer the question that sort of drives this panel. And I think what I like to do is first address the three initiative that Natália brought up with regard to LTS and relate them to the work of our office, the Office of Space Commerce, but also the Department of Commerce writ large.

So, for instance, for implementation we're very, very much involved in working to--with, with the directives, that Space Policy Directive 3, um, and all the tasks that it's given to us but also to the interagency... And this, this brings us right into, you know, dealing with the good work of LeoLabs.

When we--when we talk about SPD-3, we talk about an open architecture data repository, but we also talk about leveraging commercial capabilities, and I think LeoLabs is in-- an excellent, ah poster child and role model for, for how that can develop.

I think--you know something that uh, Dan left out when talking about some of the really innovative work of LeoLabs is--is the role of LeoLabs in some of the regulatory processes down in New Zealand. And I think that's something that this particular group would, If they don't know about it, they should know about it because there is an element of, of compliance with the regulations that LeoLabs is helping that government work with. And I think that's incredibly innovative and something that we were paying attention to.

Um, then another--that the second thing that Natália brought up was capacity building. And certainly my office is very involved in outreach. We work with industry. We work with all bran--all parts of the executive branch and really the entire government. And we put on summits, we are known as conveners.

In fact, recently we were happy to see the results of the National Academy of Public Administration study on space traffic management.And one of the things that was brought out in this report was that our, our office has proven itself to be constructive conveners and collaborators, and I--I think that this, this is part of capacity building for sure.

And the last initiative was dealing with emerging challenges, and I would say that that relates very much to the work that MEV represents, this, this kind of work. Operations like this that challenged the traditional way that first of all, how we deal with the life cycle of a mission, but also how we even deal with the role of government in providing space flight safety support, what different kinds of analytics provided by companies like LeoLabs, but, but others as well.

And how do we how do we serve this, uh, dynamic environment that is, that is changing, really on a weekly basis. And so we're doing all of that while we're advocating for industry in the executive branch. But we're not leaving it at the executive branch. I mentioned before that we're looking at things in a whole of government way. And we are. And I think a very good example of that is, is the interagency working group that my office has chaired with regard to commercial orbital debris.

And that's been constructive. I know that they're--actually Dan was on a, in an event that we held about a week and a half ago, and I'm sure that there were others in the audience that were aware of this. And this is an effort for our office to make sure that everybody is in the discussion. Everybody, that's ah from the regulators standpoint, from the policy makers standpoint, and from those that will be following those regulations when they ultimately get promulgated.

So I think these are all really positive developments. I will say that, although the whole pandemic situation has changed the way that we interact with one another and the way we do business, I think it's really given us a sense of what we have to do.

We have to draw upon one another, and we have to stay connected because it's, it's-- at least for my office, it's meant that this has been an incredibly productive and constructive time.

MIKE: Thank you, thank you, Diane, and y'know, to allow you to sort of move us into the middle of our discussion. You've got a lot of expertise in the area of space traffic management that you've been something of a champion of that discussion. And without, of course, committing the US government or the Department, Congress or Commerce or anyone else--what's your sense of where the gaps are now? In terms of the next steps we need to take to, uh uh, to create a predictable environment in, in Earth orbit.

DIANE: First of all, I think that predictable now might not necessarily mean it's gonna be predictable five years from now or even five months for now. So I think that we need to be aware

that the need for agility and nimble responsiveness in dealing with the space environment. So I think that that's number one. I think we're at a point right now where, um, virtually everybody who is working in space is aware of the fact that we have a situation that must not be kicked down the road, that we must deal with, that there are increasing numbers of conjunctions.

I mean, Dan mentioned one that was, you know, two derelict objects that almost, you know--It came within a frightening, frighteningly close distance from one another back in February of this year. And, and they would have slipped through the processes that are currently in place because those are two inactive--they're debris, and so the CSpoC would not have reported out on that. And so that's that's very concerning.

So what do we need right now? What is the biggest gap? The biggest gap is my office, which has moved out on virtually everything that we could work on in SPD-3 without funding, we now need to--we've all acknowledged that we have an issue. We have all acknowledged that that you know, there's there's work that has been done and it will continue to be done.
But it requires some commitment from Congress.

We need--we need funding to go forward, and I think that, um, that is important now. I don't think, I think it's- it's unrealistic to think that we're going to create something now that's going to address all problems forever and ever amen.

But I think what we can do is create something that is again--agile and responsive, and incorporates the best things that come bubbling up from the academic and research communities and also the commercial communities and is able to leverage those in a, in a system that is constantly bettering itself and self improving.

MIKE: Sort of a constantly dynamic, dynamic system for sure.

DIANE: Correct.

MIKE: It would be nice now for us to turn to a few questions from participants. And the first one I'd like to deal with goes to you Natália. And as background, last year's Space Sustainability Summit, 48% of the participants indicated that, that the United Nations would be a logical place to discuss many of the space sustainability issues. The question is, do you think the General Assembly this year without a report from COPUOS will take up any major space issue?

NATÁLIA: Well, thank you for for that question. I mean, it's, it's clear. I mean, you know, the substantive work is not done at the General Assembly.

The substantive work is done at COPUOS in Vienna, and it's subcommittees and other sub-bodies like the working groups. So most certainly, uh, the COPUOS and it's bodies, we'd get the mandate this year from the General Assembly to pursue its work.

So it's really, I mean, apart from ah, a share of the scientific and technical subcommittee I'm a bit worried that we cannot meet next year physically in Vienna, I mean that all delegations cannot travel to Vienna.

And in this respect that what we have experienced this year is that some countries may be a reluctant to ah, discuss substantive issues or to take political decisions if they cannot be physically in the room. So that is, um, as I see it one of my con-- concern from, from the sessions that next year. But as to the mandate given by the General Assembly that there I'm not too much concerned. I believe COPUOS will get its mandate.

I'm more concerned that member states will agree to work on the substance and will be flexible enough to make progress and to find consensus.

MIKE: Thank you, Natália. Another question that is being submitted by participants really concerns the, um, the question for--really it's a question for Joe Anderson, about how you mitigate the risk of complications when docking at the GEO rather than, um, um say a graveyard, um, at-- altitude or or do you, in fact, have no choice.

JOE: Well, um, address that. So the image over my head here is from MEV-1 as it was approaching the Intelsat 901 satellite. That image is from about 80 m or so behind the client vehicle as we're approaching it. Um, and I'll say we actually, on this first demonstration, both Intelsat and Space Logistics together decided to do this initial docking out in the graveyard orbit.

We were under no obligation to do that without a no, uh uh, extra--extra--you know, risk mitigation, we decided this very first time it would be prudent to do that. And in the process, we actually did multiple approaches to the 901 satellite over many days.

And through that process we demonstrated all of our operating procedures. We calibrated sensors. We, we made sure that, you know, our modeling on the ground matches what's happening in orbit in all of our various levels of safety systems that we have in place were functioning and working. And so through that process, we validated that we have these multi-- this multi layer of safety systems built in that adequately protect us.

And we feel enables us to do these missions safely in the GEO orbit. So it's not that we will be doing anything, anything different when we go to GEO. We will actually be building off what we did in the GEO graveyard orbit. So we believe that we have adequately addressed any, any, any of those.

MIKE: Are there any plans for an MEV-3?

JOE: Right now, Space Logistics does not have planned for an MEV-3. We do have some customers we're talking to that are perhaps interested in owning an MEV to manage within their fleets. But Space Logistics is currently working on our next generation system, which consists of ah, a mission robotic vehicle and mission extension pods.

So they're small propulsion augmentation devices that can be installed on, on existing satellites in GEO to extend their life. So that's our next generation system. We're developing that in partnership with DARPA, who's supplying the robotic arms for that mission. So that's good. That's really our focus for servicing going forward, and it really drives us into the next generation of capabilities for satellite servicing in sustainability.

MIKE: Well, thank you again. There's a question for you, um, about accuracy. And to what extent then, do you think you've got, ah, management of false positives, in particular false alarms?

DAN: Yeah, and you know, that's a really important question, especially when it comes to collision avoidance. So, you know, Diane had mentioned earlier that there were a number of these derelict on derelict conjunctions going on, and I want to point out that um, this isn't something that just started happening.

This has actually been going on in the space environment for a while. It's just been unreported. There's been a focus on only the active satellites and anything that might collide with the active satellites.

But, you know, the guidelines are that after the end of mission, a satellite can stay in orbit for 25 years. So that actually means there's a significant number of payloads in addition to the debris that is up there and might collide with other things, might turn into smaller pieces of debris. So um, you know, this is a situation that we need to make sure it doesn't continue to grow.

And also, it's a situation where the impact of a collision is quite dramatic. You know, in an instant you can have 10%, 50% more debris in LEO, and we need to make sure that that doesn't happen. So, um, you know, when it comes to accuracy and in collision avoidance, that's an incredible topic. Because if you're not very accurate with the tracking solutions, you end up with a whole lot of false positives.

And then if you're a satellite operator, you end up in a really tough situation that either, you can spend all day every day maneuvering to avoid every possible collision or you kind of shut your eyes and just hope for the best and ignore it all. And neither one is a good approach.

So, you know, when we focus on tracking, we're really focusing on making sure we're tracking a satellite or piece of debris to better than 100 meters. Ah, and that really enables us to give satellite operators a good feel for: is this upcoming conjunction high risk? Do I need to move the satellite? Or is it one that I can, I can safely ignore?

And, um, along with that accuracy, I'd say maybe what's even more important is transparency. And specifically letting the operator know how well is that object, is that piece of debris being tracked. No data is perfect. Nobody can promise perfect data. But we can at least promise a really good assessment of how accurate it is. And so we bake transparency into our services from the beginning.

MIKE: Well, you know, I think, is we transition to looking at gaps, we can actually pick up a number

of the themes that are showing up in, in questions. It would appear at at the current time, as if some of the gaps in space sustainability center around, um, a lack of space traffic management consensus around the world, an uncertainty about the technologies and the applications of active debris removal and, and standardization--to what extent do you cripple innovation by standardizing things well enough so that you don't have to invent new approach methods for every, every object that you're, you're approaching?

Let's start off maybe with you, Dan talking about your vision of how we fill these gaps.

DAN: Yeah. Ah, very important topic. And you know, as this, um, this, this new space revolution, this business revolution is moving forward, one thing we can be very certain of is there's just going to continue to be a lot of change. You know, it's a--it's a lot of new launch vehicles and launch locations. It's a lot more advanced capability. So MEV-1 and MEV-2 or great examples of it. Extremely capable, innovative new satellites and just in larger fleets too you know.

So with SpaceX's StarLink constellation, it's the largest fleet of satellites we've ever seen. And I think 2020 is shown to be a tipping point. This is all going to keep going. So you know one big gap that we saw in the market is this lack of data, just understanding what is going on space-- on in space and keeping a very close eye on everything that's going on.

Basically, you know, accountability and deterrence really start with making space transparent. Making sure there's no, there's no place where activities can occur that won't be reported on. And so that's a big part of why we're building out this global rate, our network, to be able to report on satellites, on debris very frequently, many times per day.

You know, the other big thing that I see that's missing, at least in the US, has been a regulatory agency to take the lead on really establishing the new norms and establishing what it means to be a safe operator in space. And I know the NAPA study was mentioned a little bit earlier, and I just wanna ah, foot stomp that one.

I think that's a very critical report. And it really lays the groundwork for moving forwards and, um, in making sure we do have a regulator. And I think the Department of Commerce is, is very well suited for that purpose to take that lead. And it's really taking regulation from being kind of a pre launch licensing activity and turning it into an ongoing thing that follows the entire life cycle of satellites and satellite fleet. So I was really happy to see that that report come out.

And, you know, I'm hopeful that, uh, in the future, the Department of Commerce is going to be given the funding in the mandate to, to run forward with that mission.

MIKE: You know, last year's panelists placed the, um ah, a lot of importance on satellite operators revealing the position of their satellites. That publicly, publicly, publishing that information. How would how would you integrate with that kind of published information? A verification, confirmation? Uh, how would that affect your business?

DAN: Yeah, and actually, the new space community, by and large has been pretty good about that. Getting satellite positions out there. One of the ways that we're actually doing it right now is satellite operators send u--some of the satellite operators send us their ephemerides.

So where their satellite's gonna be, including maneuvers, and we use that to actively look for conjunctions and screen conjunctions. And that's absolutely critical because without knowledge of where the maneuvers are gonna happen, where the satellites are gonna be, you don't--you don't have accurate collision avoidance. And along with that, um, we're able to screen one satellite operator's ephemeras against another.

So basically, if you're planning some maneuvers and another person finding some maneuvers, those can get cross checked against each other. And I think what this really points to is the space industry is rapidly adopting modern computing architectures. So we're able to take these services, so the computer systems, cloud based systems that are flying one satellite constellation can get plugged into our cloud base, uh um, software platform and link up to others and exchange all of this information real time.

This is no longer a process or computing architecture where, you know, it takes eight hours, 12 hours to get an answer. There's manual steps involved. The space industry is moving towards a fully automated architecture, and that's actually a very recent development. That--that, the space industry was kind of slow to make that change.

But we're really now leveraging a lot of the good work that's been done by social media platforms, online mapping platforms. They've all tackled the big data problem. And it's coming to space.
And frankly, really takes down the barriers to doing the sorts of communications and safety of flight systems that you were, you were talking about.

MIKE: Thank you. And now maybe let's shift to Natália. And one of the gaps, obviously that exists, is that we have a very solid set of long term sustainability guidelines. And now we need implementation. And there's been some talk of actually creating a, a bureau--sort of, ah, steering committee within COPUOS to--to follow that implementation. How likely do you think that is? How important is it to reducing the gaps?

NATÁLIA: Well, thank you, Michael, for this question. Well, I mean, indeed--ah, the COPUOS itself decided to establish a new working group, which should--as one among a different task-- help in the implementation of the 21 guidelines. So it is certainly a very important task of this new working group, which will be, hopefully, getting work--getting to work next year.

Um, but suddenly--I mean the guidelines there are available to, uh, I mean, they're publicly available, thankfully, and the old space operators can start, um, implementing them.

So I would really, um, look, I mean, at this--at this--ah, in a way that it is a common effort by all space actors and the government shall be the driving force and work together at multilateral level. So

hopefully we'll make progress next year on this. But as, as I was saying before, it's very difficult to get consensus among all those spacefaring nations which are member of COPUOS because have different use.

So it's,--I really believe that the coordination ah, the collaboration at all levels is very important in the implementation or to foster the implementation of those guidelines.

MIKE: So Natália, last year's participants, over 50% felt that conversations among like minded states and participants in space activity would likely be the most productive in creating new norms, in part because they were concerned that consensus in a body that's approaching 100 members is extremely difficult to obtain.
How would you see integrating this conversation among parts of the world community with this larger conversation that you're a part of that includes the members of COPUOS?

NATÁLIA: There was--thank you, because I think it, it's a very point, and it's a trend that we can see indeed, that there are a group of states working together, and I think it's, it is very good.
But in the end, all--all space actors, they're driving on the same highways up there.
So we really need to talk to work all together with all space actors. And set of standards, which--guidelines or norms--by a group of countries may not be agreeable to another group of countries, so that's why I am saying, at a state level, it's very important that all state--all states work together at multilateral level--global, multilateral level.
So that is at COPUOS.

MIKE: Well, thank you. And now I think maybe turn to, turn to Joe. And one of the gaps, it was pointed out by last year's participants, was the problem of delay and de-orbiting derelicts. To what extent could your technology be used to actually assist in de-orbiting a derelict satellite rather than just, um, refueling it or getting it ready to serve again?

JOE: Sure, absolutely. And so it's sort of two different regimes there to talk about. Of course, one out of GEO, where we today don't actually de-orbit satellites because they're just--physics too far away to make that practical. So we actually push them out further. You know, what we call the graveyard orbit.

So certainly, you know, today's capabilities, our MEV is designed to do that. We demonstrated that, precisely, you know, that capability for satellites that have the features that an MEV docks with. But certainly it is also demonstrating the basic capabilities that could be applied in any orbit. So, so that we could take that same basic rendezvous and approach capabilities to--to capture satellites and de-orbit them.

Our next generation system uses robotics instead of this specialized docking mechanism that the MEV has. So with robotic systems are much more flexible to capture other types of satellites, so with that capability certainly in low earth orbits, you would have the capability to grapple satellites and truly de-orbit them.

So certainly the technologies we're doing today are directly applicable to that. There are still some incremental steps to go, I think, to fully implement it, but it's very, very near term possible to do that and implement those, those solutions. And there are companies out there today that are looking to do that in low earth orbit. That is, you know, their primary mission is to do that type of mission. So that's very near term possibility.

MIKE: Any challenges as you--as you planned your mission that could have been avoided with a more structure space traffic management system or were you able to solve most of your problems independent?

JOE: Um, well, certainly from a licensing perspective, you know, we have several agencies we need to integrate--interact with. So be nice if we had a more consolidated group for that. But from a space traffic management, you know, out at GEO, we don't have, you know, quite the same situation that you have in the low earth orbits.

It's a much more, um, I dunno coordinated is not the right word here, but everything's kind of moving in the same direction. So it's a little bit of a simpler situation in terms of managing debris and managing around other objects out in the GEO orbit. A lot more space out there. It's not quite as congested, of course, as LEO and MEO orbits as well. So we really did not encounter uh, too many issues.

Now, one of the challenges we did encounter is, doing this first mission out in the graveyard orbit, is we're actually drifting relative to the earth, right? So we're drifting across the arc behind other GEO communications satellite. So we had to always be maintaining assurance that we were not causing interference with those communication channels of satellites we would be drifting past. So you know, one of the things that will actually make it simpler at the GEO orbit is the fact that we won't have that constraint that, you know, watching at what time we're communicating with our spacecraft as we're doing the approach.

MIKE: So any plans to eventually try to handle the great gridlock in the sky and polar orbit?

JOE: (Laughter) Today, we don't have any plans. Certainly, you know, it's, it's on our roadmap for developing the capabilities and working in the LEOs and GEOs and other orbits. They--the challenge we're facing there is we're a commercial company. We're doing this, as you know, a service. And so we need paying customers.

And today they're just isn't the economic incentive for us to go to those orbits. That's really one of the real challenges that I think we face and one of the big gaps that we're looking at here between, you know, the desires of of, you know, active debris removal and long term space sustainability and the economic realities of commercial businesses trying to implement those things. There's one of the challenges that we face, I think, in the industry for the long term.

MIKE: So looking at the questions, there's a question for all of the panelists and we'll maybe keep you on here for, ah, for a minute. But, um, what real progress have you seen in space sustainability

in the last year? What--what, uh, advancements or activities drive your optimism that we're making some progress? So, Joe?

JOE: Yeah, so I'll start, I guess, um--didn't know if that was directed to me or to the whole panel. So, you know, I think the two key things I think-- you know, one of the keys, of course, is knowledge. And so things like Dan is doing, and in other businesses like his, increasing our knowledge of what's truly happening in space, I think that's been a big step forward, continues to grow and improve. Of course, I think MEV is another indicator of a path forward to help with sustainability. So I think those to me are two key things that have been happening.

MIKE: Great. How about you, Dan? What do you see?

DAN: Yeah, you know, two things really come to mind. To me, one of the big issues in LEO is the large amount of debris and specifically the untracked debris population, you know.
So the numbers are quite amazing. There's about 14,000, maybe 15,000 objects tracked in LEO today, um, significant--the majority of that's debris. But there's actually 20 times more stuff that smaller down to two centimeters in size.

So a roughly 250,000 objects--they're not track today. So a lot of the space sustainability discussion is really focused on 5% of the risk of large stuff. And one of the big things we've been doing when we founded the company to track the two centimeter debris.

And so when we built the Kiwi space radar, that was the first proof point of the radar technology that we launched the company around, to track the small debris and we're now rolling out more copies of it around the world.

So I'm really excited to see the next radar, the Costa Rica radar, come online and be able to track the two centimeter debris and get--work all that information into space traffic safety. The one other thing I wanted to bring up is we had an interesting--or we have, ah, interesting ongoing work with the New Zealand Space Agency. They're now using the Sustainability and Space Regulatory platform. And I think this is the first example of a regulator really keeping an eye on what's actually occurring in space.

So they're using real time data coming off of our radar network to watch all of the satellites that have been launched out in New Zealand and understand their compliance and understand their activities in space. And that's a really important shift. You know, that's a shift from only looking at pre-launch licensing activities to keeping an eye on the activities in space, and I think that's gonna be a really important direction to keep going with, because we're going to see a lot of innovative new activities.

We're going to see certain orbits get more crowded than others, and that's going to require updating the best practices and the regulations. And all of those are going to be best if they're really based on the realities, if they're based on the data about what's actually occurring in space.

So, so I was really happy to get started with that, um, Space Sustainability and Regulatory platform. And I'm hopeful we, we will see a lot of similar activities around the world over the coming year.

MIKE: Well, Diane you've got the government seat to look at some of these issues. Where, where do you see the progress in the last, last year?

DIANE: I think that there have been more focused conversations but also more focused operations. I think we're saying that in things like the MEV and also LeoLabs. But also there's something called SACT, which I know, LeoLabs was--has had a pretty big role in. That's the Sprint Advanced Concept Training and it's, it's a training initiative that's put on by the DOD. But we've--actually my office has also co-sponsored this and it involves more and more of the commercial sector and, and I think there's been a lot of progress in understanding just how different scenarios could be, um, responded to, how different capabilities, different observational capabilities, um, and then also different analytic capabilities can factor into making the space environment, uh--making better predictions and, and make more actionable information and better decision making ultimately.

And I think you know, that's also revealing some of the things that really require some research right about now. We need to start working on how to fuse some of this data and that, that implicates some of this standards work that you talked about before. And I just want to make the observation that standards don't have to be limiting or encumbering on industry.

Instead, in the US, industry is required to make input into standards development. But standards are great because they're grounded in operations and there's much more progress in the standards development with regard to our sector. And right now there is even in uh ISO there is a standard that's been proposed, I believe that the proposal has been accepted for space traffic coordination and management. So, that's a big development I think needs to be noted.

And you know this understanding about how the data works together, and the kinds of things that are coming out from the SACT events is also something that we're taking into this first phase of our open architecture data repository. So we've been working with the NOAA Big Data Project in much the same way that Dan was mentioning that this is a really big data challenges not really specific to space, but, but they have cropped up in a number of different contexts. And we're starting to understand that some of the things that have been sussed out in other contexts will be very useful to us in space and putting these things together.

So to that end, we've already got the Space Weather Prediction Center data in our big data project--and say hello to my dog Gigi. And we're working right now on incorporating reentry data and other data sets that are available to us and that we can put onto NOAA's Big Data Project and respect the NOAA mission while doing so. So I think all of those things really speak to great progress right now, at least from our perspective. (Dog barks)

MIKE: And Gigi agrees. Excellent. Natália, from your vantage point in Europe--what kinds of issues are you seeing? Switzerland was early in talking about an active debris removal experiment. There's a lot of interesting things going on in Europe, but what, what's given you some sense of optimism about progress?

NATÁLIA: Yeah, I know, thank you…I'm very happy because I had prepared a few things, example from Europe, actually. So maybe the first ah, the first element. I mean, the European Space Agency established a new program on space safety a year ago. I mean, at the ministerial council in November last year and in this--in this new program, you have several elements. One ADR mission. One so called the--a mission for automated collision avoidance services.

Um, and also space weather--on several areas pertaining to improving, ah, the sustainability of space activities. You'll have new missions from ESA side and, by the way, Switzerland is a member state of ESA and is very much involved in the ADR mission as you was-- you were mentioning ah, Michael. So that's--I think, and I also heard recently an example...

You know, close conjunction between the satellites have brought the operations to get in contact to establish a channels of communication, non disclosure agreements so that they can exchange more freely data in case a new case of a close approach ah, arise. And so that they both can better react to avoid a collision. So I think it's, it's ah, progress is being made by a collection off small steps by all actors. And obviously we see also that the new kind of activities being developed by the private sector as we hear from Joe and Daniel.

And it's good to see the private sector arising in, in type of activity, like on-orbit servicing like SSA like also, uh, early warning in case of--of the risk of collision, et cetera. So it's, it's a whole new range of tools which are now being available for space actors. Yeah, and certainly, I mean, since the adoption of the guidelines by COPUOS, awareness is, is increasing at a level. Certainly among governments, but also, uh, the society level.

And that's I think it's, it's very positive because we need to be--there need to be a better awareness of the threats to the space environment. And obviously capacity building exchange between, um, at all levels. I would say with the academia, among governments, with the private sector, and the Secure World Foundation is a very important factor in this respect, in organizing, even around the world to raise awareness in all regions. So I think it's--I see a lot of activity and, and I think it's good to see them. Thank you.

MIKE: You know, keeping on the Europe focus for a moment. Are there particular private sector initiatives going on in Europe related to active debris removal or, ah, space situational awareness that you would call to mind as part of the European use of private sectors?

NATALIA: Yeah. I mean, I recall, especially on SSA and I mean, the two examples given the ADR, I mostly recall are public funded projects, for instance, there was a project by the European Union, to uh, for technology development on ADR and SSA, as you know, is ah, is very--I would say is

more from operated, or promoted from the government side in Europe, both within the European Union and within the European Space Agency, whose membership are different, as you may know.

MIKE: ESA, the European Space Agency, has talked a lot about its interest in eventually de-orbiting Envisat. Is there any progress being made in that, in that direction?

NATALIA: Well, so as I was saying, ESA is putting in place a program to…an ADR mission which is not directed at Envisat. So I think before getting the big piece they try with a smaller piece.

MIKE: Okay. Thank you. Thank you very much….I think there's been a lot of questions popping in about, uh, standards, actually. And, and so, this could be an interesting topic to deal with, and maybe we'll, we'll jump back to Dan. First of all on this, the concern that seems to be in the question panel is how mandatory would standards be? And how important are they to being able to provide data about the satellites in orbit and then eventually we'll turn to Joe about what it would mean to actually service them on orbit. So Dan?

DAN: Yeah, You know. So I think standards actually fit in this kind of broader progression where I think we, in the best case, like to start with best practices, codify the ones that work well into standards and then, if necessary, move those into regulations. I think there's been a lot of good work on the standard side and a lot of good discussion around the regula--regulations in the regulatory side.

But I would actually argue that… the work may have gone about as far as it can without data. And, you know, a lot of the discussion is kind of--is centered around, um, kind of hypotheticals and deciding, you know what, what may happen and ah, you know, I think we really want to ground that in what actually is happening and then also look at the solutions. And there's a lot of companies that are trying new capabilities on orbit.

They're trying new operational procedures, and I really hope we can bring a lot of that through to forums like these, out into the public discussion and try to grab ahold of what space traffic management, uh, kind of satellite management capabilities are being used right now and really being brought to bear on the problem. So, you know, I think that the topic of standards is, is an important one.

But frankly, I think just focusing on what's working and what's occurring in space. Kind of where the risks are, where the risks aren't will, actually bring a lot of the change that's desired. You know, I have to believe that a lot of the satellite operators we know and we talk with, they listen to these public discussions and they automatically start engineering away the risks that are being highlighted, that are being discussed.

So I think regulatory bodies like Department of Commerce and others-- they have a lot of power by just driving the public discussion and focusing it on the critical issues. Uh, and so hopefully all of that leads, leads to good standards, leads to good regulations.

MIKE: But you know, as a follow up --to convert data into information, you need to aggregate it and analyze it. Where should that happen? By what you're saying, no one company is going to have a complete monopoly on that information, though I--who, who should bring that together? What kind of "who" should be used?

DAN: Yeah, you've touched on a really interesting point that, that's actually changed a lot in the last few years, and I don't think it's, it's really been noticed. So in the past, the notion was kind of you had radars, you had telescopes and you got this kind of big pile of data and then--which they really meant measurements.

And then you had to piece together this, this software processing system. Ultimately turned that into alerts and reports and the like. And then eventually you know, somebody would get that and decide how to respond, to decide what to do about it. And unfortunately, it put too much emphasis on kind of the early collection and generation of the data and not enough on the analysis in the response and what needs to be done.

What's really shifted now--what the commercial SSA industry is doing is they're saying data is no longer really the measurement. Data is that kind of end piece that somebody can act upon, that a satellite operator can act upon or regulator or the insurance industry can act upon. It's a collision report or it's a maneuver alert or it's a report about a newly launched batch of rideshare satellites. So companies like Leolabs are taking, going all the way from the sensor, from the radar in the telescope all the way to actionable information, and they're making that happen in real time. And so that actually means these defense organizations, regulators, satellite operators--they can actually get the situation in space around their satellite and react to it.

They don't have to become radar experts. They don't have to become software signal processing experts. That's kind of handled, and that's something that's never been, never been available before. So, you know, I would really argue that the data integration level has shifted and it's not measurements anymore.

It's actually things like conjunction data messages, an industry standard. So you know, LeoLabs produces those, um, the U.S. Space Command produces those, and it's something that satellite operators are already ingesting. And so I would actually argue that we need to focus on that really kind of high level data analytics and integrate at that point. It just makes a lot more logical sense, and it ultimately makes all these space actors a lot more effective.

MIKE: Thank you. Joe, to some extent that your MEV missions have shown that you can get something done even in a world without standards. As you said, the target was a totally uncooperative ah, piece of, piece of hardware. To what extent do you see standards becoming a part of the future of on-orbit servicing? Are they necessary? What's your observation from experience now?

JOE: So currently we probably, we feel they're probably 80% of those--the satellites in GEO are

addressable with the technology that we have for capturing satellites using the liquid apogee engine in their launch adapter ring. But that's not the way forward, right? That's not the way to continue doing things.

And I do believe standards play a very important role in that future for satellite servicing. It is a difficult question, though, how do, how to do standards in this area, right? So standards will help us, help us grow the market. It will help us grow the serviceability and sustainability of space. But on the other hand, if certain standards aren't done right, they can also inhibit innovation.

So it's finding the way to do these standards in the right way that, you know, enable the market to grow, enable the capabilities to grow to enable sustainability while not diminishing that innovation. So that's the real trick.

I do think there are a couple of key areas that, that standards would help in the very near term. And those would be in the area of refueling interfaces for future spacecraft, that after 2024 every new spacecraft, just from a commercial perspective, not a regulatory shouldn't be mandated, right? That should have refueling valves on them. Should have a power and data port like a USB port on your, on your computer. And with those two basic interfaces you can do so much and extend the capability of your satellites and reduce risks tremendously by having those, those two key features.

So if we had standards so that every satellite manufacturer used those same interfaces, you know, it will greatly improve, you know, that sustainability picture. But trying to figure out how to do those standards while not hindering innovation is gonna be the challenge.

MIKE: Well, Diane, probably if this were a physical conference, every eye in the room would be focused on you as a regulator. There's a lot of concern in the comments and in last year's discussions that if standards were incorporated in regulations, it becomes stifling, the whole innovation issue. What's your sense of what role, ah, government and the private sector will play in the standards discussion going forward?

DIANE: Well, first Gigi has been very loud in reminding me that I need to address the international piece of things. She was very, very disturbed that I neglected to bring the international piece. So with regard to standards, let me first say that it's--standards, the best standards, come from operations. They're, they're, they're grounded in practice, but they're also grounded in things that are truly happening.

So they really do represent a bottom up approach. And in determining standards to make, make sure that these are standards that are going to be useful to the community, it's very important that industry have input. And, and this is one way to avoid having cumbersome standards that, that are either not achievable, or not based on--underpinned by, by really well thought out technical analysis.

But in developing standards, one standards development doesn't necessarily cancel out another standards development. They can work. They can develop from the bottom up because they're coming out of different practices.

And one of the wonderful things about our space economy is the ability for all of these innovations to percolate. That's one of the things that my office is very keenly aware of and really wants to support.

So let me bring to your attention two pieces of this bottom up, ah, operations-based standards development approach. One, when you're talking about performance based regulation, you can determine what the outcome is that you want to achieve and then use some sort of identifiable, replicable standards or criterion to get there and, and you're not locked in on just one. So this is why I say being able to develop more than one way to skin the cat can be very useful for the community as it determines. And it fits right in with a light touch, performance based regulatory framework.

Another thing that this kind of bottom up approach does while working on achieving this multilateral communication that Natália addressed, when we have something that's standards that are operationally based and replicable in this way and that are informed by the technical community, those are easily sharable with the international community.

And that's something that you see an SPD-3. You see that you know, some of the standards development work that the interagency is directed to engage in is to inform the international community going forward so that our activities are happening by themselves so that they're integratable and so that some of the things--some of the challenges with regard to the analytics and the messaging and how, you know what, an operator needs to have in place in order to be even be able to take in the information that these things are known, and in a transparent way,
but they're known in the international community. Thanks.

MIKE: Thank--
DIANE: Quieted now, she feels much better. Thank you.
MIKE: Much better. And she was glad you wanted to skin the cat, not the dog.
DIANE: Correct, and this is why that is my metaphor. I know where my bread is buttered.

MIKE: Sounds great…One interesting theme in the questions is the theme of how space situational awareness in particular is treated when you happen to stumble on or discover military assets.
So maybe, maybe we start right off the bat with, with Dan. And how complicating is it to your life that some of what you're going to see is stuff that some people don't want you to see?

DAN: Yeah, good question. And a lot of the, kind of discussion in the industry has focused on that in the past. I actually have to say it's, it's a little bit of a misdirection because, you know, the biggest challenge for space traffic safety and space sustainability is really the debris. Is really the derelict satellites. So you know there are 14,000 closing on 15,000 objects in LEO being tracked today.

Over 12,000, about 12,000 of those are debris--derelict satellites, pieces of debris, fragments of satellites. Um, the portion of objects that you know, may be military in nature is very small compared to that amount. And then on top of that, you add in small debris, that stuff down to two centimeters in size.

And now, rather than looking at 12,000 um, pieces of debris. You're actually looking at about 250,000 pieces of debris. That's the giant issue. Tracking those avoiding collisions with those is kind of mission number one. So, I you know, I'd have to say, we'll tackle that.

We'll get that. We'll figure that out. And, I really don't think we're gonna hit roadblocks with, you know, with the issue of military satellites.

MIKE: Well, Joe, as you wander around the graveyard orbit and GEO, you're going to see a few military assets. What kinds of protocols do you need to have in place to deal with that and then also maybe to recognize when one of those assets may be posing a hazard?

JOE: Yes. So, um, in GEO we got a pretty good sense of where the assets are all located. Um, we don't need tremendous accuracy, because most of these assets are all flying in the same direction, right? So, you know, real precision isn't necessary for us to safely drift by. But we do have limitations in our licensing.

We have limitations, especially on our non-Earth imaging. So our MEV does have imagers onboard that are used to do the rendezvous. That picture behind me here is one of those images. And, you know, we do have restrictions about things that we can image, and what we can do with those images. So there are some restrictions there. Now with our system, these aren't big telescopes.

That image was taken from, from 80 meters away, right? We really can't see much. We can't really resolve images with our spacecraft beyond a few kilometers. So it's not really a risk to, you know, the national defense type of spacecraft because of that. But it exists. It's out there.

And, and I think one of the things that you know in the long term we're gonna have to get used to as a nation, and our national defense and others is that, you know, these systems are going to be, be growing and, you know, and there's gonna be more and more of them. They're not gonna all be based and licensed out of the U.S.

And others are gonna be able to image these satellites. And you know that space is a free place, right? It's, it's like the--in a, on a public street with a camera, and we're gonna have to find a way, I think, uh, took to cope with that in the long term.

MIKE: So, you know, as far as the military side you talked, Diane, about the interagency work. Is DOD involved in those interagency discussions?

DIANE: Of course they are. Definitely. Absolutely. First of all, we worked very, very closely with

DOD, with regard to the transition from the services that the 18th, ah, has tirelessly provided despite the fact that it wasn't, you know, central to their primary mission for many years. And so we work with them.

We have a liaison out at Vandenberg Air Force Base and he works--well, we all are working very closely with them to work on these things, so DOD is part of that. But DOD is part of all of the interagency from, from the international space cooperation through all discussions, DOD is there and and certainly DOD has been a big part of the interagency discussion with regard to some of the, um, remote sensing regulations.

We came up with a new and extremely innovative final rule just a few short months ago and that definitely involved DOD to a very significant degree and still is. For many of the reasons that Joe just touched upon about the availability of, of technologies elsewhere than in the US, and what is the impact of this availability on the IC and the security communities anywhere else in the world. So yes, DOD is part of it.

We all are. At this point, you know, our equities I think are becoming, ah, they're changing in the interagency. And, and certainly there's an awareness of the commercial equities in a much more profound way than there was. But they--they're different, these equities are different.

And we all need each other because we all come at things from different, different perspectives. And this is how you avoid groupthink because, you know, instead of trying to be all things to all entities at once, there are some very deep expertises within and certainly DOD is part of that conversation.

MIKE: All right. Thank you, Diane.
DIANE: Yes.

JOE: I might add from, you know, the satellite operations perspective too. We interface with the DOD. We interface with JSpOC, CSpOC in Colorado, right, we share our orbits with them so they know where we are. But they're also sharing with us, right? So they're doing a lot of the analysis, and they notify satellite operators around the world when these conjunctions happen. So it's a natural part of our standard operations for all of our spacecraft to go through that. So there's a natural sharing that's already happening there. So the Defense Department is aware of where we are and certainly, if something's gonna become an issue, they would let us know.

DAN: And if I could add one other quick comment too, you know, I think there is a very important notion of deterrence here as well, and it's not only deterrence for things like anti-satellite weapons tests, but also for just bad behavior that would lead to collisions or lead to satellite breakup. You know as, Joe pointed out, there's more and more capabilities coming from more and more places around the world, and I think it's really important that space becomes transparent. That all of these activities are reported on, all the sources of debris are reported on. And so there's a new level of accountability.

So it just becomes untenable to create new debris or to take the risks that are going to substantially alter the risk environment. And that's actually a big shift. Space really hasn't been transparent in the past, but I think it's a critical element of making it sustainable.

DIANE: I have one comment to that, Mike, and that is--I like to think of it in terms of mutually assured benefit. I think that transparency puts us all on our best behavior or should.

MIKE: Well, you know, Natália, that sort of sets up the stage for your impressions from Europe because the firewall between defense policy and civil space policy has tended to be higher in Europe. But what's your sense of the sensitivity of the military establishments in Europe, particularly France, which seems to have the largest military satellite constellation, to was some of the space situational awareness work that the civil agencies are attempted?

NATÁLIA: Yep. Well, thank you. Well, I really don't want to, um, to be too affirmative on this. You see, um uh, not to divide, but I mean it seems to be true that SSA in Europe is rather in the hands of the military. Ah, especially I mean, and France is one of this country which splits. Um, but it's not the only one in Europe. Indeed.

I mean, it's ah, it's funny you say that because my impression here from Europe is also it was that actually, in the US, you had also quite a stronger um uh, hand from the military on SSA. Although I'm around the discussion to move it to commerce. But it's--there is, as we understand, it is still a very strong hand on the confidentiality and classification of data, of SSA data.

So and I think it's, it is somehow true in many countries and and it's certainly an elemnt which prevent from making progress in a more open and, um, reliable SSA for all space operators because obviously, if you hide-- if you hide a part, and a big part to 40, 50% of the orbit, orbital information from the rests, and how precise can your evaluation of the risk of the calculation of the orbits be. So I mean, it's, it's certainly, it's a domain where progress would be welcome. And I believe it in many countries. So that, that is a really, as I see it, a challenge for a better SSA, ah, for all space actors.

MIKE: Thank you Natália. And as we approach the end of our time, we have about three minutes left. I'd like us to turn to a brief statement from each of you about what you consider to be the greatest challenge to the future sustainability of space. And since Natália, we have you on the screen, maybe you could, you could start.

NATÁLIA: Well, thank you. I think, I did get a little bit from your question. And I'd like to emphasize, I just heard it this morning from the head of the space safety program of ESA. Ah, I think his words were, I mean, because he said the increase of debris in the LEO is extremely high. But--and that is because the compliance with the space debris mitigation guideline is very low indeed. So we have the guidelines and there are not enough implemented.

So he said, if there were implemented, there would be, ah, the exponential trend would be stopped. So that's a good news, which you just have to implement the guidelines. Thank you.

MIKE: Thank you. So, Joe, what's your, what's your take, the biggest challenge in space sustainability?

JOE: So I think the biggest challenge we face is a gap between in the economics required to foster and grow the space economy and the economics of implementing, you know, the ideal solution for indefinite space sustainability. Any pressures you put on new businesses, commercial businesses trying to grow that new business, that new economy, of course, constrains how fast they can grow. So to me, that's, that's the biggest challenge that we place.

MIKE: Okay, Dan?

DAN: Yeah, I think this revolution that's going on in the space industry is creating extremely rapid and extremely positive changes and getting a lot of new satellites up there. And I think the biggest challenge we have is actually making sure, kind of every other aspect of, of the industry and especially space traffic safety norms and in monitoring and compliance keep up. And we don't get ourselves locked in a very rigid way of implementing say new norms or new regulations, but instead are able to keep an eye on what's going on in space and adapt very rapidly.

So I think it's ah, it's kind of keeping abreast of what all the the engineering firms in the private sector are doing, all that great rapid work is gonna be a challenge. It's gonna be a sprint that's gonna go on for a while.

MIKE: And Diane, if you could wrap up with the minute we have left.

DIANE: Okay, well, I would say that for our office, the biggest challenge is funding. But for all of us, I would say that inaction is the biggest challenge. And that can come from either being overwhelmed. Too many, too many false positives. Or also from complacency. And so I would say that those would be, you know, one would be writ large inaction, and the one that's most immediate to my office would be funding. And thank you so much.

MIKE: Thank you, Diane. And so we've come to the end of our panel. I hope that you carry away a certain amount of optimism about the possibilities and a certain sense of caution about over-complacency.