Keynote: Dr. Bhavya Lal, Senior Advisor to the NASA Administrator, NASA

Moderator: Krystal Azelton, SWF Director of Space Applications Programs

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Krystal: Thank you, Brian. First of all, the speakers, thank you for that invigorating debate about the Space Force. I know that it gave me a lot of insight into where we are.

I'd like to go ahead and welcome Bhavya Lal, who serves as a senior advisor to the NASA Administrator for budget and finance. She was also a member of the Biden Transition Agency Review Teams for both NASA and the Department of Defense. This is going to be one exciting opportunity to hear about space sustainability from the new administration. Welcome, Bhavya.

Bhavya Lal: Thank you, Crystal. Can you hear me?

Krystal: Yeah. You sound great.

Bhavya: Awesome. Thank you for inviting me to join you today. It's been, as you said, an incredible five months at NASA. I know better now than we ever did that we are in a new age of space development full of opportunities.

Constellations that involve tens of thousands of satellites, CubeSats from elementary-school children that have little ability to maneuver, and on-orbit servicing assembly and manufacturing that can upend our current Earth-centric paradigms. What we thought was disruptive before, say, reusable launch vehicles is old news. We are on to the new.

While the news is great for growing the space economy, as you all know, something so close to my heart, it also presents challenges. As I know you've been discussing in this conference and other venues, the orbital debris population follows a power law size distribution, meaning that there is more small debris than large.

There are more than 100 million objects, ranging from dust particles to flecks of paint from satellites, that are too small to be tracked. These are the debris that present the most near-term, mission-ending risks to operational spacecraft. To date, and this is something that is actively under consideration, these are the debris that we have worried the most about at NASA.

While the utmost precautions are taken to reduce the potential for collision, especially with our flagship, International Space Station, impacts with these objects do occur. I'm sure some of you know, just a few weeks ago, during a routine inspection of Canadarm2, experts from NASA and the Canadian Space Agency found orbital debris damage to one of its boom segments.

Luckily, the debris did not affect the arm's functional abilities. The damage is mostly limited to a small section of the thermal blanket. Canadarm is continuing to conduct its planned operations. The strike highlights just how important this issue is and how seriously NASA is taking it, and always has.

NASA is a founding member of the Inter-Agency Space Debris Coordination Committee, IADC. IADC established the first international consensus-based Space Debris Mitigation Guidelines in 2002. The guidelines emphasize that reentry of a spacecraft, orbital debris stage, or orbital stage should not pose an undue risk to people or property.

NASA has also been instrumental in supporting the US delegation to UN COPUOS to develop the COPUOS Space Debris Mitigation Guidelines in 2007 and Guidelines for the Long-Term Sustainability of Outer Space in 2019.

NASA has promoted the US Government Orbital Debris Mitigation Standard Practices with the international community and continues to work with the international community to further improve international orbital debris mitigation best practices, such as these guidelines. We can talk a bit more in Q&A about specific NASA activities underway.

There is so much more to be done, which is why -- I'm so excited to tell you all about it -- we've assembled an orbital debris review team in-house to evaluate how NASA can be a more effective leader in the area of space sustainability.

The reality is that orbital debris is not something NASA or even the United States can take on alone. In my mind, and this is how I'm conceptualizing, our review team as well, orbital debris mitigation has three parts.

Reduce the amount of debris we generate, know where everything is and, obviously, not just the debris but also valuable things that debris would hit, and be able to maneuver so you can avoid getting hit and, of course, remove the debris, the three parts.

Given the speed with which the space sector has grown and is expected to grow, we are facing challenges on all three fronts. To reduce the amount of debris, we need to agree as a community, among other things, not just within the United States, but internationally as well on standards and best practices on how to design, launch, and operate spacecraft so they don't produce debris.

To know where everything is, to understand the space and debris environment, we need more and better sensors, better data analysis and fusion capabilities. Again, global agreement on how we collect and share data is critical.

To be able to maneuver, assuming the quality of the information about potential close approaches or collisions is good, satellites need maneuvering capability which, as we know, not all satellites do.

Last but not least, we need to start to think about how we will remove some of the worst offending objects. This act of debris removal will be expensive. ESA and other funders will pay

the equivalent of well over a million dollars per kilogram to remove a secondary payload adapter left by Arianespace's second Vega mission in 2013.

Again, I'm not implying that we need to remove all the debris out there, but just a little back-of-the-envelope math. Given that there is more than 8,000 metric tons of debris in space, if we extrapolate from this one point calculation alone and there's probably a range of costs, we are talking about trillions of dollars in debris removal.

This is a challenge but, of course, it's also an opportunity. Space is a big, diverse, and innovative sector. Together, we can come up with amazing approaches that don't just involve technology, but also regulatory policy and other kinds of innovations. We're also lucky that we have somewhat of an analogy, not a perfect analogy but nonetheless an analogy that we can learn from, climate change.

Think about it. The orbital debris problem tracks the climate change problem pretty closely. We want to reduce the amount of greenhouse gases we put out. We want to monitor, track, model what we are doing and how much progress we are making. We want to remove greenhouse gases from the atmosphere. Each of the things that earlier I said were issues we want to address in the space debris world as well.

In the climate world, there's all sorts of clever technological policy and regulatory schemes under consideration -- Carbon sequestration technologies, cap and trade schemes, regulatory fees. These are only some of the tools that have been used for environmental management. The space community should really build on these lessons.

Both Congress and the White House have laid out plans that were developed with interagency input -- Space Policy Directive-3, the National Space Policy. Earlier this year, OSTP with input from NASA and other agencies put out an orbital debris R&D plan. It is important that we begin to implement this plan.

I spent about 25 years in Boston before I moved to DC. In Boston, we would call the orbital debris problem a wicked, hard problem. To solve problems like this, we need all hands on deck, and the hands had better be global. It is not a problem Americans can solve alone, but we can and we should be the leaders.

The solutions that government co-creates with the private sector will lead to an even bolder and brighter future in space for all of humanity to enjoy. I want to keep my remarks short. I want to turn it to Crystal for questions. I'm looking forward to a really good discussion.

Krystal: Thank you, Bhavya. That was a great, quick overview of where the agency's at, what they're thinking about, about some really important issues around space sustainability. I know that I immediately took note that there is a new active debris review team at NASA. I look forward to hearing more about that in the future. In fact, I was furiously taking notes.

I do want to turn this over to the audience. If anyone out there, I've seen that some questions have already come in. We will just jump right into these. Bhavya's agreed to take a few questions. We won't probably be able to get to them all, but please go ahead and add those into Mentimeter.

The first question that I wanted to hit on with you, Bhavya, is touching on international community issues. You can see it on screen there. What steps...I'm sorry, that is actually not the correct question. I apologize. I'm going to grab the correct one. Here it is. Are there opportunities for emerging or non-traditional space countries to participate in Artemis?

Bhavya: As you know well, space exploration is neither inexpensive nor easy. We want the world to join us not only for a sustainable presence on and around the Moon, but stay with us as we go on to Mars and beyond.

NASA's Office of International and Interagency Relations, OIIR, interface with NASA's counterparts around the world. Of course, they would be happy to engage in potential collaborations related to Artemis Program.

NASA has publicly available reports on the potential for specific science and technology development activities on the Moon and around the Moon. We would be excited to engage with both current and new partners on the potential for joint activities. There is plenty to be doing together and not enough money to go around. All hands on deck, let's do it.

Krystal: Great. I'm sorry. Returning to the first question that we flashed up, I just put them in the wrong order. My apologies. The Moon is a busy place these days. One of our audience members is wondering, "What steps does the international community need to take to ensure operations can be coordinated and conducted safely?" It's a new set of opportunities. How does NASA see that?

Bhavya: Great question. Thanks, Krystal. As you know, our administrator this morning was in Congress testifying on the Hill. He is moving aggressively forward on the Artemis Program, which includes landing the first woman and the first person of color on the Moon.

Parallel with the program itself, and that relates directly to the question you asked, NASA has also developed a statement of a shared vision to create a safe and transparent environment to facilitate exploration, science, and commercial activities not only on the Moon, but deep space -- Mars, comets, and asteroids.

Artemis Accords, as these principles are called, establish a commitment to ensure transparency, peaceful uses of space, the open and timely sharing of scientific data and compliance with all international obligations. As you may know, the accords have been signed by 12 nations. We hope to be having the rest of the world join us as well.

Just recently, South Korea, New Zealand, and Brazil joined in the past month or so, the first signatories under the Biden administration. The Artemis Program will be the largest and most diverse human spaceflight exploration coalition in history. Note, I underscore the word coalition. We are not going there alone, we are going with partners.

We expect that over the course of the coming months and years, more countries will join the Artemis Program and commit to the principles of the Accords. Obviously, the Accords represent a strong initial start. There is much work to be done to establish responsible norms of behavior in space.

Specifically, along with the Department of State and Defense, NASA will be participating in an interagency process to support the development of norms of behavior in space for all operations, including national security.

The Moon is a busy place in the coming years. There is a lot we need to do together with international community to ensure coordination and safe conduct of operations with Artemis Accords as the center of our strategy to do so.

Krystal: Wonderful. I. I'm sure we're going to be hearing more and more about that in the coming months. The next question I'd like to ask is referencing back to your remarks. It's fairly specific.

One of our audience members would like to know, is the NASA active debris review team the same as the previous year's ODMSP IWG? Got to love acronyms. Specifically, is it government only, or does it include commercial and academia?

Bhavya: The orbital debris review team I'm leading is an internal NASA-only team, and our goal is to better examine how NASA could be a better leader and ensuring space sustainability. Up until now, NASA is focused mainly on protecting our own assets. I talked earlier about making sure ISS is safe.

We have a team at Goddard that looks at our robotic missions. We have an orbital debris program office, which does love the modeling characterization, the data around the space debris environment.

We are looking in this review team on things that NASA could be doing beyond what we do in protecting our own assets and being leaders in the broader community. We hope to be sharing our thoughts with you in the coming months.

Krystal: Great. I know the community is going to be eager to hear from you on that. I'm excited to hear that you're leading the team, so wonderful. Our next question switches topics just a little bit. Specifically, in terms of plans or programs, does NASA have to help mature and field active debris removal technology?

Bhavya: Overall, big picture, NASA is globally recognized for its technical competence and has played a leadership role in promoting orbital debris mitigation best practices with international community and debris removal fund specifically.

NASA is currently focusing...This may change in the in going forward, but we are currently focusing on early stage technology developments as opposed to operational systems. Since 2011,

the NASA Innovative Advanced Concepts, NIAC, Program has funded six early-stage research studies relevant orbital debris mitigation and removal. We can get you the studies if you'd like.

More recently, at the request of Congress, NASA conducted several agency-wide reviews of technologies that support active debris removal. The last such review was 2019 and described 16 different investments. Our Space Technology Mission Directorate, STMD, was funded to remove or otherwise mitigate or build debris.

These reviews continue to identify technology gaps that need to be closed in order to enable active debris removal but have not identified major technology breakthroughs that would warrant another in-depth study at this time, but things change.

More work needs to be done in areas such as proximity operations, sensors of instruments, efficient propulsion, guidance in navigation, autonomy, robotic manipulation, and many of these technologies are being matured through currently funded projects such as our solar electric propulsion, satellite servicing, and other small spacecraft missions, all in the STMD Directorate.

In addition, NASA is funding research through academia with a primary focus on improving algorithms related to de-spinning uncooperative debris and controlling the orbit of large objects.

NASA routinely attracts new orbital debris removal concepts through its annual NIAC, Innovative Advanced Concepts Program, I mentioned earlier, small Business Innovative Research and Small Business Technology Transfer, SBIR and STTR, Programs.

This is something I just recently learned, the Space Technology Research, Development, Demonstration, and Infusion, REDDI, solicitations. These solicitations draw participation from a number of commercial entities interested in pursuing this capability as business venture approaches ranging from debris capture to the use of small spacecraft or sales as rock devices.

We are thinking about the possibility of future public-private partnerships, and these programs demonstrate the potential for commercialization of NASA developed technologies. All throughout, SDMD continues to invest in promising early-stage concepts and technologies that could alter the landscape for identifying technically cost-effective.

Again, I want to underscore the term cost-effective. I was talking earlier about the back of the envelope cost of ADR. We want to be thinking about cost-effective viable, orbital debris removal approaches. Our review team will have more on this, and we look forward to feedback from the community as well.

Krystal: We had another question that really builds on your comments there. They're broadening the scope a little bit, and they're curious, do you think NASA is going to support or would support a new international agreement to remove or reduce orbital debris? How do you see this playing out in the international field?

Bhavya: That's a great question. One, we should probably consider in our internal discussions. If you want to send some more thoughts on potential approaches, please do.

NASA, it is more proponent of doing things internationally. I read somewhere recently that only about 30 percent of everything that's in space is US-owned, and anything that we do in space with respect to orbit debris removal has to be coordinated internationally.

International coordination is critical, and we need to be doing this in that way as opposed to some unilateral approach. Send us ideas, and we are listening.

Krystal: Excellent. We do have another international question, and I understand that the policy is probably still forming. You are a new administration.

We did have someone ask, "If Congress would decide to lift restrictions on cooperation or engagement with China, what is NASA's thoughts on that, and how would you expect NASA to react?"

Bhavya: NASA will continue to follow US law in particular the Wolf Amendment that provides guidance on how and if NASA can engage with China. There is no ifs or buts or thens around that.

In recent years, NASA has engaged in certain cooperative activities with China in full accordance with this law. For example, both NASA and China have spacecraft in orbit around Mars, along with ESA, India, and the UAE.

NASA and CNSA, the Chinese National Space Agency, are sharing data on our respective spacecraft as NASA does with other agencies with spacecraft around other celestial bodies to assure spacecraft safety and collision avoidance.

We will continue to do whatever is in the best interests of the United States. As long as we are in accordance with the law, which is one of our most important criteria, which is the criterion for engaging internationally.

Krystal: Wonderful. Just to close out on one final question for you, you've had this incredible opportunity, and you've been a driving force and the Biden administration and deciding what they're going to do about a lot of topics, and space sustainability obviously being one that we care the most about here at this Summit.

I was wondering if you just have any concluding thoughts or remarks you'd like to make on just your impressions. What is this administration's commitment to this topic? Are there any behind-the-scene insights you can share in terms of where you expect things to go broadly that would be the administration in the next few months and years?

Bhavya: If you look at the 2022 PBR, you will see the funding increases for Earth science for climate change. Sustainability is a pretty strong priority for the administration. Space sustainability is not that different from atmospheric and biosphere sustainability, so it is a clear priority.

We are still developing some of our ideas on how we are wanting to proceed. As we have more now the National Space Council gets in place, an executive secretary is appointed, we will begin to speak about our plans and formulate our plans to greater degrees of specificity, so I hope you will invite me back and others from NASA, and we will have a chance to collaborate more.

Personally, we need to start. We're looking at the OSTP R&D plan on mobile debris mitigation. That is a real clear place to start. There's so much more to do so. Hopefully, we'll have a chance to work together.

Krystal: Absolutely. I know we're thrilled to see the direction that the Space Council takes. NASA, OSTP, everyone in the administration on all of these topics. Thank you so much for your insights today. We were thrilled you were able to join us.

I know this is an incredibly busy week at NASA. Obviously, you guys aren't exactly at 100,000 percent in terms of staffing up. We really appreciate your time and interest in speaking with us today. I look forward to talking again in the future.

Bhavya: Thank you, Krystal. It was a pretty exciting time at NASA. This week, Pam Melroy, our deputy administrator, is here. We have now a full complement of leaders. It's full speed ahead. Thanks again.

Krystal: We love Pam. She was at one of our earlier summits. Enjoy and we'll talk to you soon.

Bhavya: Bye-bye.

Krystal: Bye. All right, everyone. We are about to conclude the summit for space sustainability. I want to welcome on stage our executive director, Peter Martinez, for a few closing thoughts. Peter?

Peter Martinez: Thank you, Krystal, and thank you, Bhavya, for that excellent keynote and for sharing your insights with us. It's really been a fantastic two days.

What's a golden thread that's run through many of the presentations and remarks on the panels is that space sustainability is really a multi-scale problem both on spatial scales, as well as on temporal scales, and that we need both short-term, midterm, and long-term actions to address this issue.

I'd like to look at how we address the issue through the lenses of technology, leadership, and capital, which are three general headings under which you could group many of the excellent comments that were made in the last two days. Of course, these three strands are interwoven. Some of the things I will discuss under one of these strands could equally well be considered part of another.

Beginning with technology, when we refer to technology, particularly as scientists and engineers in the space domain, we tend to think of the hardware and software approaches to address space sustainability issues. We think of things like improved SSA sensors and algorithms, things like

automated collision avoidance systems, and other technical capabilities to support space traffic management.

We think of technical capabilities for things like on-orbit servicing, debris remediation technologies like post-mission disposal and active debris removal. Certainly, we do need to continue developing all these technological capabilities. However, we also need to improve our ability to utilize the data that we already have, and to broaden the access to that data and to the tools to process these data.

Since not all countries have the same level of technical capabilities, one of the areas that we need to pay particular attention to in coming years is that of capacity building. For those of you familiar with the UN Space Sustainability Guidelines, capacity building is indeed one of the elements that runs through many of those guidelines.

I particularly liked the remark yesterday that we need to ask policymakers what information they need to make effective policy. Here, I would like to pause for a moment to reflect on the difference between data for science and information for policymaking.

Scientists and engineers tend to collect data to identify the underlying patterns or cause-and-effect relationships in the physical world, whereas policymakers need information they can use in a way that meets societal, economic, and political objectives.

Where scientists and engineers are normally specialists that drill down into their subject matter often requiring their expertise over decades, policymakers are often generalists that have to address the pressing problems of the day and move from one domain to the next every few years.

We do need to reflect on this remark that was made yesterday about who is really the end user for the kinds of data that we're producing and to recognize that data for science is not necessarily the same thing as information for policymaking. In other words, policymakers need policy-relevant information, not necessarily data. We need to think of ways to better understand the needs of policymakers.

Turning then to the next strand, which is leadership, we've heard a number of speakers indicating that our goal is to move from data to a scientific understanding of the problems of space sustainability, which then are expressed in terms of policy, which is ultimately translated into action.

We heard in several panels about the siloed approach to space governance with different entities being responsible for different aspects of the problem. This is a situation that is true in many countries. We need leadership at national level to overcome this current siloed approach to space governance in many countries and, indeed, in the UN system as well.

Indeed, enhanced collaboration between government, industry, and academia will allow us to overcome these siloed approaches with their inherent gaps and to harness the unique attributes of each of these sectors, namely the agility and innovation of industry, the rigor and multidisciplinarity of academia, and the policy and regulatory experience of government.

Getting these loops going requires leadership. As space activities become more international, perhaps being carried out by actors under several legal jurisdictions, we also need to think of ways to enhance regulator-to-regulator dialogues to avoid fragmented governance and to address chain of custody issues.

Reflecting on international cooperation, a number of the issues we've discussed, whether they're climate change or space debris, are inherently global issues. No single actor or group of like-minded actors has the ability to solve these problems entirely on their own. This requires a coordinated global response or global action in the policy, technical, and regulatory fronts.

We need to strengthen the existing multilateral institutions to ensure that they're fit for purpose in dealing with these intrinsically multilateral issues. For example, yesterday, we heard about the population of large legacy objects that from a scientific point of view, it would make sense to make them a priority for remediation.

This, as we all know, is not a scientific issue, but more of a political and diplomatic issue. We need international cooperation to solve the regulatory, registration, and liability challenges associated with such issues.

Turning then to the third strand, namely capital, several speakers have referred to the need to perform risk and cost-benefit analyses for these new systems that we are developing and deploying into the space environment.

A number of speakers pointed to the need to recognize the complete overall lifetime cost of sustainable space operations. This means looking at the economic aspects holistically and integrating them into the financial plans of operators.

From the investment community perspective that is providing the capital for these space systems, this raises the importance of responsible investment in space activities.

When it comes to promoting investment in responsible and sustainable space activities, government of course has a role to play both in terms of providing incentives and disincentives to promote certain behaviors and discourage others.

Lastly, pulling all of these three strands of technology, capital, and leadership together, perhaps we need to change our perspective and approach the space sustainability from seeing it as a series of necessary actions to avoid the negative consequences of inaction, to seeing it as an opportunity for growth and prosperity to be embraced by the entire space community.

Those are some of my key takeaways from the past two days. I'd now like to bring this conference to a close and thank all of those who made it possible. An event like this, even a virtual one, needs considerable resources.

I would like to begin by thanking our digital content sponsors without whom it would not have been possible to organize this conference. Thank you also to our media partners who are playing

a very important role in covering the developments in space sustainability and promoting greater transparency in space activities.

I'd also like to thank the spotlight speakers for their excellent talks that set the scene for the panel discussions that followed. If you missed any of these excellent talks, you can catch them all on the summit website. I can strongly recommend viewing them all.

I'd also like to thank all the panelists who shared their wisdom, insights, and experience with us. Thank you to all of you and also to congratulate the winners of the essay contest. If you've not had a chance to check out these videos on the conference website, I encourage you to do so.

Lastly, an event of this type takes a lot of planning and preparation over a long time. I would like to thank the summit chair, Krystal Azelton, for her excellent leadership in organizing this conference and to all my Secure World colleagues both seen and unseen for their efforts to organize and deliver this conference.

As well as to the folks from Shik Productions who were the producers for this event, thank you to all of you.

This brings our two-day program to an end, but we still have another segment of the summit aimed at young professionals tomorrow. I'd like to remind all the young professionals about the mentoring sessions tomorrow at 9:00 AM Eastern, and 7:00 pm Eastern.

If you're a young professional, you should have received an email about this. If not and you would like to attend these mentoring events, please feel free to reach out to us.

Lastly, thank you to all of you, the audience, for your attendance and active participation in the discussions. We hope you enjoyed participating in this conference as much as we enjoyed presenting to you. We're looking forward to the next Summit for Space Sustainability as an in-person event in 2022 in a location outside of the United States. Watch our website for more information over the coming months.

With that, I'll close the third Summit for Space Sustainability. We hope to see all of you in-person next year. Thank you.

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