



STM and Enabling Sustainable Commercial Development of Space

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Space Traffic Management and Enabling Sustainable Commercial Development of Space

Opening Remarks: Representative Lamar Smith (R-TX 21), Chair, House Science, Space, and Technology Committee

Panelists:

- **John Giles**, Col, USAF; Senior Policy Advisor, National Space Council
- **Theresa Hitchens**, Senior Research Associate, University of Maryland's Center for International and Security Studies
- **Diane Howard**, Professor of Commercial Space Operations/Spaceflight Ops, Embry-Riddle Aeronautical University
- **Moriba Jah**, Director of Advanced Science and Technology Research in Astronautics Program, University of Texas at Austin
- **Brandt Pasco**, Attorney & Fellow, Hudson Institute
- Moderator: **Brian Weeden**, Director of Program Planning, Secure World Foundation

Brian Weeden: My name is Brian Weeden. I'm with Secure World Foundation. Thank you all for coming this afternoon, or technically still this morning for our event.

A couple of logistical remarks, we do expect Chairman Smith to be here right around noon to give some remarks. We only had the room until 1:30, so we're going to get started with our program. When he shows up, we'll take a break. We'll listen to his remarks, and then we'll go back to where we were in the line-up.

Also a reminder, this event is being recorded and is on the record. Once we get done, we're going to publish an audio recording and a transcript on the website in about a week or so.

The topic for today's discussion is space traffic management, which is a topic everybody likes to talk about but no one can actually define, which I think is OK, probably the reason we're here today.

For the purpose of this event, we're going to go with a working definition that space traffic management is the combination of knowledge of what's going on in the space environment and how that informs oversight of human activities in space.

That includes part of the technical piece of space situation awareness and then also in oversight, licensing, regulatory, however you want to define that piece, which is how we provide oversight of what we're doing in space. It's not a new topic. People in the space world have debated it and talked about it for several decades.

There was a big International Academy of Astronautics report that came out in 2007 talking about space traffic management in general. Here in the US, after the 2010 National Space Policy, the Obama administration started a formal interagency discussion on, "Let's solve space traffic management."

They worked on that for several years and made progress on defining what it means and how they want to approach it. They never came to an agreement on this is our policy position on how we're going to move forward.

Congress has also been working on this issue. It's come up as study the issue in several of the recent bills.

In 2014, they had a hearing on preventing a real-life "Gravity" in space, talking about how to do space traffic management. As of yet, there has not been any official, formal action from Congress, "This is how we're gonna go ahead and tackle."

Over the last year or so, the Trump administration has picked up where the Obama administration left off and has actually started issuing some policy directives that are putting in place some of the points and some of the pieces on space traffic management.

They've talked about how to implement the mission authorization concept that the Obama administration talked about. They're talking about moving as an authority to civil agency.

All of that is what we're going to talk about in detail today. What's going on right now? What decisions have been made? What are the issues and trends that are driving us? What questions still remain to be addressed and how should we address those?

Both from what the administration's doing on the executive branch side but also legislatively and what congress should do then.

To help me tackle that, we have panel of very smart people from a wide variety of different backgrounds. To quickly introduce them, starting at my immediate left is Dr. Moriba Jah.

He's a professor at the University of Texas in Austin. He's the director of the Advance Sciences Technology Research and Astronautics Program and Associate Professor of Aerospace Engineering and Engineering Mechanics.

Next to him is, Colonel John Giles. He currently is the Senior Policy Adviser of the National Space Council. He's also a career space officer with the US Air Force and has a lot of experience in space operations and actually doing SSA from a military perspective.

Next to him is Brandt Pasco with the Hudson Institute. He's an attorney manage member of Pasco and Associates. A professor at Georgetown Law and also a fellow at Hudson.

Next to him is, Dr. Diane Howard. She teaches Space Law and Policy at Embry-Riddle Aeronautical University and is also actively involved in National and International professional legal organizations.

Finally we have, Mrs. Theresa Hitchens. She's the senior research associate of the Center for International Security Studies at the University of Maryland where she focuses on space security, cyber security and government issues on destructive technologies.

Prior to joining the University of Maryland, she was the director of the United Nations Institute for Dismemberment Research in Geneva.

I've asked each of them to have a few minute open remarks talking about some different parts of the puzzle. Then, we're going to have a Q and A for hopefully most of the time.

No further ado, Moriba over to you.

Moriba Jah: Good morning. Thank you all for being here. We live in exciting times. That maybe great, maybe not so much. Maybe a bit scary.

I do say that I feel very confident that the US Government is making great strides moving forward in trying to tackle this problem. When we say space traffic management, what are we talking about? What needs to be managed? I would say that not everything up there is noble.

We can't measure everything that's on orbit for a variety of reasons. We don't have ubiquitous sensors, we don't have ubiquitous observations. The science and technology that goes behind trying to track and quantify all these objects is still not comprehensive, not fully exhausted. The funding to do that sort of research has been very sparse, very disparate.

Some organizations and kind of steel pipes have been doing this sort of thing, but really there is no common agreement as to where all these...How many objects there are, where these objects are in any given point in time, what's the first and last name of these things. We talk about norms of behavior that are needed for space. What would those be?

Where do they come from? Are they evidenced-based and we just sit in a room and go by intuition? Which I would say probably not the thing that we want to do, and so even though there are groups of people coming together around the world to talk about this and to make things better and move forward there is still some evidence that we have a long way to go.

To that point, I'd like to bring up a website and basically, this thing is called Astrograph and you can google it and get to it, but in essence what we've done is we have put together a small lake of information. Every day we bring in all the other information on the public catalog of objects. We also have the Russian opinion on where things are located that we map here.

We have all the data on Planet Labs, a flock of doves, these three key stats in lower orbit, and we also have Leo Labs which tracks these things with a couple of radars in Midland, Texas and also Alaska. We bring those four sources of information together. The sources are growing.

What we're really seeking is some sort of open and easily accessible pot of data that people can put information in and retrieve things, and form their own opinions just to compare, just to see how consistent or how inconsistent these opinions are. What I'm going to ask over there, yeah. If you could just go and search by name and, I don't know, put in flock, space, 2P, flock 2P5.

Yeah, just choose any one. That, for instance, is where the USSTRATCOM believes that satellite is located right now, versus the owner Planet. Clearly, the things on top of each other we shouldn't expect them to be exactly on top of each other. What's the disparity there in the orbits?

Maybe what you're seeing is 50 kilometers or so of disparity, but Planet Lab says they know exactly where their satellite is because they contact it and they communicate with it. STRATCOM does the best that they can with their sensors, but the thing is, they don't necessarily line up.

If I put the uncertainty ellipse around what the owner/operator believes, what the public catalog has is way outside of that. Which is one of the reasons that has led to people trying to develop their own space situational awareness platforms, so that they can come up with their own safety products.

Let's see. Let's choose another flock. Let's go to 2P5, for instance, flock 2P5. Sorry, space after.

Brian: Any of these?

Moriba: Yeah. Go down.

Brian: Sorry.

Moriba: That's fine. Here is an interesting thing. Here you have STRATCOM and Planet are fairly close to each other, and then Leo Labs, which tracks with radars, that's number three. You can see they're way off from what these other people believe and think. Everybody who tries to track something in space has an opinion, and the thing is, these are not all consistent.

We shouldn't be afraid of the inconsistency, the inconsistency says we have work to do. Why is number three so far off from two and one? The thing is, we need to bring all these sources of information together, try to quantify what these inconsistencies are.

I think that's how we start getting to some international collaboration and understanding of what's going on in space to help with orbital safety of operations and long-term sustainability of space activities.¹² I'll leave it at that. Thank you.

Brian: Sorry about that. Thank you and onto Colonel Giles.

[background conversations]

Colonel John Giles: Good morning everybody. As Brian said, I'm Colonel John Giles. I'm a Colonel in the United States Air Force. I'm currently detailed to work for Dr. Pace on the National Space Council. It's great to be here today.

Obviously, a topic that is near and dear to my heart. I look around the room and I see a lot of people who have worked on this mission area who have contributed to a great extent to the work that I'm going to talk a little bit about today and the subject that we're going to talk about.

Thank you all for your interest, and for those of you who have done so much to get us where we are in this dialogue thank you for your efforts. As Brian said, this is not a new topic. This is one that's been bubbling for a while and the water's starting to come to a boil a little bit.

I want to talk for just a couple of minutes about why this is a significant issue and why it's on the radar for the National Space Council and for the administration. This will be a familiar narrative for most of you, but let me run through it.

Space has become embedded and integrated into much of what we do as a society today.

It's part of the way we do national security. It's part of the way our economy works. It's part of the way we do science. It's part of the way we operate daily basis with how we figure out where we are with GPS, with communications, with weather data.

It's hard to find an aspect of our life that isn't touched by space, and this makes this a vital interest to the United States. At the same time, there are several trends, and those of you who work in this area there's pretty good recognition that there are some trends that are significant at the moment.

The first is that space is becoming more congested. You saw the graphic that Moriba put up. As Brian said, I used to work at the JSpOC, and while I was at the JSpOC at one point I came across a space catalog and understood why we call it the space catalog.

At one time it was an actual printed catalog, and the one that I came across was from 1967. It was a printout that was printed out weekly, and you could flip through it, and at that time there were 2,000 objects in the catalog.

As many of you know, today we track in excess of 20,000 objects routinely. There are many more objects that are out there that are either too small to track or in difficult to track orbits.

We think that the actual number of objects dwarfs the number that we actually track. So, congestion is a big deal. At the same time the domain is becoming more contested. We have leveraged the space to support our national security activities. Potential adversaries have taken note of that, and they're taking steps to try to see what they can do to disrupt that.

Other trends. There are many new missions that are emerging, servicing in space, manufacturing in space, tourism in space potentially, a lot of commercial activity. You've seen the talk of very large constellations, proliferation of small satellites. These are all things that are significant.

A rise in capability on the commercial sector for doing space situation awareness and space traffic management. All of these trends are happening, and they affect the interest that we have in space. Here's the connection for why this is a significant issue. In space we all operate together.

Whoever's operating in space, you can't draw a geographical boundary in the same way that you can on perhaps the ground or in the air. The way we leverage orbits there is a we're all in this together thing. The actions of one actor if they're irresponsible have the capability to significantly impact other actors.

Pieces of debris or even man-made objects carry a lot of energy when they're traveling at the speeds that they do in space. Even a very small object when it comes in contact with something else has the potential to do a lot of damage and then create the conditions for even more damage to be done.

Brian referenced the movie "Gravity" something where there's other debris that's created. We're all operating in the same environment, and the impact of collisions is great, so it presents a risk to all that operate in there.

Back in the day when there were only a couple of thousand objects in space, it was probably safe to say, "Hey, it's a really big area. There's not that many things. The risk is kind of low. We'll just kick this problem down the road."

I think we're moving past the area where big space is OK, and there has to be more active management of what goes in the domain to manage the risk and to enable a lot of the missions that are emerging and that we're on the verge of seeing realized. All of these things come together.

Whatever area you talk about in space policy, the space traffic management and space situational awareness that I just raised touch those aspects. That's why it's something that the administration decided needs to be dealt with now.

This builds on a lot of the work that Brian referenced has been done in the past, but as the vice president announced that the space symposium in April we're ready to present a set of policy recommendations, a comprehensive national space traffic management policy to the president for his approval.

At this point I'm going to have to say that the policy itself has been presented but has not been signed by the president. As it relates to detailed discussion of what's in the policy I'm probably going to have to stop and focus just on what has already been announced either by the vice president in his remarks or in other public statements that have been made.

We look forward to that policy being approved. We look forward to implementing that policy and having more detailed discussions that follow on. The policy does not solve all of the problems that we talked about today. What it does is lay a policy foundation for a lot of follow on work that needs to happen to address those issues. Thank you. I look forward to discussing further.

Brian: Great. Thank you very much. Perfect sense of timing.

[laughter]

Brian: I'd like to welcome Chairman Smith, who is going to give us some opening remarks. Chairman Smith represents the 21st Congressional District of Texas. He's the chairman of the Science Space Technology Committee which has jurisdiction over many things related to space traffic management, and we were talking about today.

Jurisdiction over NASA, Department of Energy, EPA, Science Foundation, FAA, and National Institute of Science Technology. Under his leadership his committee has been very involved in this issue and making a lot of big changes with how we look at the space domain.

Chairman Lamar Smith: Thank you very much.

[background conversations]

Chairman Smith: We thought you were starting at noon, and you started a little bit early. This may be the first meeting that's ever started early on Capitol Hill.

[laughter]

Chairman Smith: We appreciate y'all being here. Frankly, it's nice to see such a good audience this morning. I was a little bit concerned that when they changed our schedule and we were not in session today and instead we are in session this Friday I thought and probably do feel that we lost some members of Congress who might otherwise be here.

It's nice to look out and see everybody that's here. Not only did we lose members of Congress, but the reason I'm not wearing a suit today is because we're not in session either.

[laughter]

Chairman Smith: It's nice to be in town and nice to be a little bit more relaxed. I really want to do a couple of things. First of all, to acknowledge the people who are participating on my left. Real quickly, they've already introduced themselves. It's nice to have the National Space Council represented. The University of Maryland. And the Aeronautical UT. He's from UT. Good man. Good man.

[laughter]

Chairman Smith: Hudson Institute and Secure World Foundation as well. I know Brian is the moderator. As far as UT goes, I have to tell you at one point I represented the entire campus. Now I just represent, which isn't bad, the administration building, which means that they're going to be nice to me. Also, I had west campus, all the sororities and fraternities.

[laughter]

Chairman Smith: It's a fun campus to represent. Like I say, at one time I represented the whole campus and have a part now. It's nice to have everybody here. Also, the subject at hand, you all wouldn't be here if you interested in space situational awareness or space traffic management.

You know we've already passed one bill, a space commerce bill.

Actually, we passed it on the House floor. We are now waiting for Senate, and the Senate will come through. No reason why they should not. We're already trying to address some of these subjects.

Particularly trying to reduce the regulatory burden and encourage the private sector and some of these innovative companies to get more involved in the space exploration that we all care about so much.

We also have another bill that's coming up on some of the same subjects that you all are going to be discussing here today.

Mike Mineiro, who's with me, is the director of the Space Subcommittee is going to give you a little bit of an update maybe after the panel has finished today on those two bills, the bill that's already passed the House as well as the bill that is really still in process.

Who knows? We might pick up some ideas today, and that might affect what goes into this new bill as well. Thank you all for being here. Thanks for your interest in space.

[applause]

Brian: Thank you very much, Chairman Smith. Brandt, would you like to pick up? I think what you're going to talk about ducktails pretty nice with what he was talking about.

Brandt Pasco: I guess to start, as a point of personal privilege if you would forgive me. I wanted to say what a privilege it is to be back in the House. I worked here in the mid to late '90s for first Congressman Vince Snowbarger and then for Congressman Mark Sanford back before he decided he wanted to be governor and then came back.

I don't get down here as often as I used to, but it's a wonderful privilege to be here today, and I think the Secure World Foundation for hosting and all of you for coming. I was asked to talk a little bit about regulation which is how I earn my living these days and ultimately how the government imposes order on things.

Hopefully this will be an interesting conversation for people here in the room, what flows from all of the wonderful legislation that emanates from the house. This first slide I wanted to throw up here. I was trying to explain the changes that are coming to the system to my wife, who is reasonably smart but doesn't work in these areas.

I walked through who the current regulators are and all of the changes that are coming and who the regulators are going to be. Her reaction to me was, "Really? That's it?" All this going on, and at the end of the day so little is changing.

I put it up here as a straw man because once you get under the hood, there's a lot of change going on, and the superficial things staying the same is not really where things are going. The first thing I'm only going to touch on briefly here, but it would be remiss if we didn't talk about Space Policy Directive Two very quickly.

In particular, looking at the deliverables that are supposed to be coming out over the coming year, and my friend here to my right certainly can talk about these more fluently than I can.

But, to note that this month we're supposed to be looking at what the administration's plans are for consolidating authorities and bringing them to a significant degree under the Commerce Department.

Then this fall, Lord knows streamlining remote sensing rules makes an abundant amount of sense, and I would encourage those in the room who are responsible for policy in this area to consider whether they're performance based criteria so we can get out of the business of issuing licenses for cameras in space.

Draw the regulatory box, and as long as you're within the regulatory box, you have reporting and compliance obligations, but in the norm, we shouldn't be issuing any more licenses for putting cameras on orbit in my view. Moving forward, more remote sensing, rethinking what we're doing with RF policies.

How do we encourage people to be more efficient with their spectrum instead of just hoarding large amounts of spectrum? Changes to export controls, I'll talk about on the next slide.

Streamlining regulations for launch and reentry, terribly important, and it's encouraging to see that this is very much on the table, including the DOD and NASA piece of this where people are launching from federally owned launch ranges.

For the export control piece, I think it's really important that people understand that this is not a new thing.

When I was at the National Security Council at the beginning of the Obama administration, my project was export control reform.

As part of that we brought forward the 1248 Report, for those of you who have been in this business long enough to remember that where we moved commercial satellites off the munitions list and onto the commerce list. A move that was necessarily overdue.

As part of the 1248 Report, if you go back and look at it, we told the Congress that going forward, once we had a comfort level and an understanding of what was happening with the movement of commercial communication satellites from the Munitions List of Commerce.

That we would begin thinking seriously about whether they were other things that we could start to move.

In my view, what is being described in space policy directive tool is really an extension of a process that was begun early in the Obama Administration. That, I think, in a rare spirit of bipartisan compromise, is being continued by the current administration. I really applaud that kind of continuity between the administrations.

We'll be terribly remiss if we didn't talk about the American Space Commerce for Enterprise Act a little bit. I know Mike is in the room somewhere or was. I really applaud the committees work on this and Mike's efforts here.

It's a tremendous step forward trying to look to consolidate authorities under the Department of Commerce to a significant degree even though they are still going to be other regulatory players.

For the purpose of this panel, however, it's worth noting that there's very little in it about space traffic management authorities. We'll talk about that as the day progresses here a little bit. It's an area where there is a little bit in the bill but goodness there is more to be done.

I realized with every piece of legislation the world of the politically possible sometimes is not the world of the perfect. It's an area of continued interest where we'll be looking for more progress.

With respect to the space traffic management piece of this, it's noteworthy that the bill doesn't provide actual authority to regulate orbits. The certification process that's envisioned by the bill, although commendable, doesn't permit the certification to be conditioned on space traffic management concerns.

It's going to have the Secretary of Commerce identify potential conflicts with federal government owned space objects, but not with other commercial satellites, and not with, well, frankly garbage that's flying around up there at 20,000 miles an hour.

There's an open question about whether it would be prudent either in this bill, well it's in the Senate or some future efforts to think about whether those authorities should be expanded in some respect.

My major takeaways here for you today that I want you guys to think about is, first of all, there is a major effort right now in the federal government to streamline regulations. I hope that Congress pays close attention to that as they think through additional statutory authorities and changes that need to be made structurally.

I think it's incredibly important, and frankly, wonderful that the Congress is thinking about elevating Space Commerce to the Assistant Secretary level of the Commerce Department, if only because that would give commerce direct access to the policy coordinating committees at the NSC, instead of being buried multiple offices deep.

Being able to toe-to-toe in the inner agency with the regulatory agencies is a really important piece of making this work. I'm a strong believer that, if you get the organizational chart right, normally the right policies will flow.

I think that's a hugely important piece, that I hope that as we go forward we give significant additional thought to beefing up the space traffic management and space situational awareness legal authorities for the executive branch.

It would be a tremendous step forward for someone to be formally in charge of de-conflicting orbits of things that are being launched, and helping to de-conflict orbits for things that are already up there.

With that, thank you very much.

Diane Howard: Thank you all for coming on a rather a misty Monday.

I'm going to target my comments to some of the academic and operational research that we've been facilitating at my university, which is Embry-Riddle. I'm going to actually try to keep myself on point in the interest of time.

I'm going to look down, and it's not because I'm texting, it's because I'm keeping myself on point for you.

It was mentioned in my brief bio that I teach at Embry-Riddle. I'm also one of the original architects of an undergraduate degree program in commercial space operations, and space flight operations. It's a very interdisciplinary program. I'm responsible for the policy in law track.

As a result of my experience when I first got to the Aeronautical University, which didn't have a whole lot going on in regard to space policy, I am housed on a department floor which has a lot of different disciplines. Many of which actually are touched upon in the issues that we deal with space traffic management.

Largely, in order to help my colleagues unwrap their heads around some of the things that we were dealing with in the space sector, we put together a space management conference. I want to talk about some of the things that have surfaced since 2014, which was the first year that we did this conference.

The way that we do things, not only do we do the conference, we also put together a peer review digital proceedings and an interactive website which includes a Wiki feature. It serves as a record for the entire body of research which has been presented and identified for future works.

I wanted first to let you all know that this resource does exist. In fact, I'm looking out into this very esteemed audience and I see a number of people that have presented over the years.

There is a real value added when you have a forum that goes on year to year so that there's this continuing component. It allows research to be identified, then acted upon and presented. I think that the taglines are very, very...I'm going to focus mainly on the 2018 conference for the bulk of my remarks.

I think that there is some instruction in just knowing what the taglines were for the conference from the very in-session to now because you can see how we got from then to now.

The first one was "Road Map to The Stars", then it was the "Evolving Landscape", and then "Emerging Dynamics". This years was "Seeking Sustainable Solutions", which is, I think, kind of what we're talking about.

I, at the end of this will tell you what we're planning on with regard to the next conference. I think yesterday as I was putting these remarks together I came up with that tagline.

The issues that we've included in our call for papers have been very diverse. In fact, more diverse than some of what is often now considered when we talk about things like space traffic management.

They include range management, human factors, space weather, and on orbit coordination, which does include space situational awareness, modeling and debris related issues, integration of commercial space traffic through the national air space. Which is not something that is always included in this bucket of issues, but it's something that we have definitely included.

That is continuing to evolve, and it evidences a great deal of operational work currently. Always we've included governments as well. We've also evolved and not just in the call for papers and the research that's been presented, but the format and the structure of the conference.

We began layering in poster sections so that we could get a lot more participation from our students, but also faculty. Not just faculty and students from our university, but from all over. We put together a writing competition to bring students in and give them an opportunity to present their research and get them involved in the whole academe.

Round table discussions, which we sort of evolved from simply industry and government to industry, government, and international. In fact, my colleague Theresa is going to talk to you. She moderated the international panel this past year. She'll talk to you about a number of the things that surfaced in that conversation.

This year we also added something else which was pretty revolutionary for us. You just got a feel for the kind of thing that I wish she'd come and show'd this to us at our conference in January.

[laughter]

Diane: That's simulations and a tabletop exercise along the lines of what Moriba was showing you.

The takeaways for this year, I'm going to go through them very, very quickly panel by panel. I'm going to tell you about how many presentations or papers were included. You can see which were popular and which were not as, but I'm not going to talk to you about authors and papers per se.

Those things are available on the website that I mentioned to you. At the very end I'm going to tell you how to find that website. It's so easy. There's also streamed audio and visual on the website. If you are really into these issues, you can really geek out and you can watch them.

We had a user's perspective panel for the first time this year. There were five different papers presented. It included small set operators, high altitude balloon operators, and even a representative of the Association of Space Explorers.

We had a very populated National Airspace Operation panel, which included six papers. These topics included things like using ADSB for space traffic integration. Not just airplanes, but also using this for space traffic. Operations impacts on the national airspace and airlines.

This relied on a lot of data from labs that we have at Embry-Riddle. Then there was also data from another lab that we have at Embry-Riddle, which is a suborbital simulator. This was showing impacts around airports.

We also had an orbital coordination panel. Here we started seeing overlap, which was a new thing. We hadn't seen that in years past to the same degree. There's always a little bit of blurring between topics. This one had four different papers. The overlap that we saw between orbital coordination was with the governance panel, interestingly enough.

There was talk about what was going on at the Office of Commercial Space Transportation -- research efforts there, debris analysis techniques and datasets, some civil space traffic management implementation, excuse me, and different models for what that could look like.

Then lastly, the governance panel, which was four different papers. These included things like the need for uniform standards, using maritime as a model, and extrapolating norms from that context and seeing what fits.

A lot of things don't fit. We're not talking apples to apples, but some things might.

This was rather provocative -- legal implications surrounding debris and whether repurposing debris has any implications for how we define an impact resource utilization in space. I thought that was kind of interesting.

Then the legal status of high-altitude balloons, platforms, and users. The roundtables that we included this year, as I mentioned, were expanded to include a really robust international panel. The simulations that I mentioned were...We had actually two simulations and a tabletop.

Mitre Corporation put on a simulation that -- this is the title, because it's out of my wheelhouse -- "Initial Space Aviation Simulation of Environment Capabilities Which Would Inform Data-Driven Policy and Procedural Decision-Making in Real Time."

That was basically not a video, not a YouTube, but something that was going on in real time. We were patched in to one of their operations centers and could see things.

The next one was done by Aerospace Corporation and it was also a simulation. Amazing, the different kinds of modeling that can be done. "The Risk to Satellites on Orbit Collisions and Explosions."

Then we had a wonderful gal from Integrity Applications -- did I say that right? -- who showed us the logic tree for decisions that could potentially confront somebody who was running a space traffic management center as these things came up in real time. That was pretty amazing.

To close, the next conference is being planned as a collaboration between Embry-Riddle and the University of Texas at Austin with Marie's help. It will likely be physically hosted at UT-Austin but it'll run through the website that we've put together since 2013 so that there's a continuity of the intellectual property.

The tag line that I came up with is "Progress Through Collaboration." I thought that was kind of good. How you find that website, because there's a wealth of information -- there's an interactive map that'll show you how many downloads and where they came from.

If you go in Google and you type in E-R-A-U, space bar, S-T-M, you will get our website. It's the first thing that comes up, and it'll give you all the years from inception. I invite your questions offline and I encourage you to visit and thank you for your time.

Brian: Thank you, Diane. Theresa?

Theresa Hitchens: I also would like to thank everyone for being here. I realize this is technically one of your days off, so I really do appreciate the audience being here and I also appreciated all my fellow panelists and their conversations.

Do look up Diane's website. It's very well-done and useful and the conference is worth your time if you're interested in these subjects. I learned a lot and I work on this stuff. It's important.

I am going to talk a little bit about questions that relate to international cooperation. It is really important as the United States goes forward with setting policies and practices for space traffic management that we don't forget that space is an international domain, where other actors have just as much agency as we do.

Managing space traffic, like managing air and sea traffic, will require international cooperation. That's just how it is, because of the physics of the environment itself. It is also important to remember that the United States has obligations under the Outer Space Treaty.

That includes an obligation to provide authorization and continuing supervision of national space activities that include commercial actors and known governmental organizational actors.

The US has treaty obligations that it has to pay attention to in its own work on regulating and policing space activities.

The US is already involved in several ongoing discussions at the 87 member committee on the Peaceful Uses of Outer Space COPUS in Geneva.

The next meeting of which begins on June 20th and last through the 29th. Several folks here are going to be in attendance of that.

There are two main things that have been going on there. One is negotiations under the scientific and technical subcommittee on voluntary best practice guidelines for the long term sustainability of space activities.

Those discussions, really negotiations have been ongoing for some time. They are supposed to wrap up this June at this session.

There are 21 guidelines that have already been agreed. When I say, "Agreed," I mean agreed by everyone. All 87 countries. [laughs] Including the United States.

I will run through just a couple of them quickly. One is enhancing the registration of space objects. The United Nations keeps a registry. You're supposed to register your satellite with them when you put a satellite up.

Sharing contact information and space situation awareness data about space objects and events.
Performing conjunctions assessment during launch and on orbit operations to figure out potential collisions.

Designing satellites to increase their track ability and strengthening national regulatory and oversight frameworks to implement international treaties.

We've already agreed on those things. We're hoping there will be formal agreement on a couple more things that are outstanding. That the UN will adopt these best practices that are not legally binding but they are politically binding.

When you sign something like this, you have a political obligation to uphold the promises that you make.

The second thing that's going on in COPUS is a more diffuse I think set of discussions under the legal subcommittee about two agenda items.

One is discussions of the legal requirements for small satellites. The other is about legal elements of space traffic management. Just so you know, there are a number of countries that believe that voluntary best practices are not enough.

That there will be a need for some kind of international legal regime to cover on orbit activities that goes beyond what we have now with five or so treaties that govern outer space.

Finally, Russia has proposed the creation of an international space situational awareness database. Where data is gathered and provided for free to all countries.

This is something that is likely to continue to be debated. The United States has opposed the Russian plan for various reasons.

One is cost. The other is manageability or the ability of the UN to actually manage such a thing. Having worked at the UN I can tell you that both of those without concerns. [laughs]

The issue is unlikely to go away. It is something that we are going to have to, not only discuss, but we're going to have to be involved in.

As Colonel John said, what anyone actor does has the potential to affect every other actor in space. Whether that's for good or for bad. If people are operating blind, that is not a good thing.

That's a situation that we, unfortunately have today.

While much of the debate in the United States is centered on deregulation and streamlining of regulatory practices as we've heard today, even the space industry has said, "There will be new regulations required for things that fall between current regulatory cracks."

Industry needs to have regulatory certainty and predictability in order to have stable business models. Regulation isn't always a bad word. Can you remember that? It's not really a four-letter word. It is something that is actually needed.

We are also going to have to realize that it's in US industry's interest to have a level playing field in the international marketplace to avoid a race to the bottom that allows flags of convenience in space.

We really do not want that to happen but also doesn't require industry to have to meet a whole bunch or requirements to operate because space is an international business. It's not a national business. It's an international business.

If there's any doubt about that, go look up or Google the recent launch on an Indian rocket of four small spacecraft by US company Swarm who did so after having a license rejected by the FCC. There isn't any way right now to really coordinate what we say is OK for our people to do and other launching space.

There's no formal process for that which really doesn't make any sense because it shows how something like that can undercut space safety and even your own national regulatory regime.

As Scott Pace, the Executive Secretary of the National Space Counsel has said, "The United States needs to engage with the international community to shape ambiguity that remain in the outer space treaty and the existing international legal regime."

Harmon and I firmly believe that we need to harmonize best practice and regulations so that would promote the responsible use of space to help secure a stable, space, and sustainable environment, and that that would be to the benefit of US industry. Thank you for your time.

Brian: Thank you very much. Mike, did you want to come up and give a short overview of the legislation?

Michael Mineiro: Good afternoon, evening everyone. Thank you for being here today. Thank to the organizers. Thank you to the moderator. Chairman Smith appreciates your presence and attention on this important issue. Chairman Smith was here today because this is important.

As chairman of the committee, he recognizes that. He'd been tracking this issue of space debris and SSA, space tracking management for years. It's something that the committee and its membership have actually voted on in the past. I'll turn you to the free enterprise act, HR2809.

There are two provisions to that act which passed the House floor in the month of April that have related provisions. One has to do with space debris litigation and basically implementing guidelines and standards. The other has to do with a mandatory consultation provision to facilitate this course between a certificate and operator.

The federal government in instances where there's concern there may be safety or flight risks or collision risk of a federal government asset. The membership that I serve recognized during the drafting and development of that bill that there are other issues that needed to be addressed, and the time has come under Chairman Smith's leadership to address those.

At the staff level, I've been directed by the chairman to reach out and listen, to help facilitate events like this, to meet the stakeholders. I have invited my bipartisan colleagues, Pam, Whitney and Alan, Lee from my minority staff to participate in stakeholder meetings. We're here to listen and learn.

Ultimately to provide my chairman and the members with the best recommendations and advice for their consideration on how legislation should be crafted to address this policy area.

I can't speak specifically for the timelines for the chairman, but I do know this is very important to the chairman and the attempt is to get something done during the 115th Congress. With that, I want to

thank you again, and I ask if you have any particular ideas or concerns or thoughts you want to share you can reach out to me.

I have two colleagues here. Sam Amber, Dr. Amber. He's a professional staff member. Ryan Fake, professional staff member. You can reach out to them. Then our minority staff, Pam, Whitney, Alan, Lee and I believe Chief of staff Dick Overman is here today as well.

Brian: Thank you very much. With that, the reason we assembled this panel is it gives the breadth of all the different pieces of this STM question.

As you saw, it ranges from the technical and scientific understanding of what's going on in space through the interagency policy coordination, through talking about legal authorities and regulation, then the international engagement piece.

That's why STM is so difficult to define and wrap up in a nice little bubble because it's a very complex topic that includes all of that.

We've got, roughly, an hour or so for some Q&A. I will get it going by asking the panelists to, basically, give some input to Mike. If you have the chance to speak to a committee work on this topic, what is the one thing you would want to see them address first in the space traffic management setting?

Moribah: The one thing that I would want to see addressed first is this common data lake where people can put in different sources of information and retrieve those that's openly accessible as much as possible to the global community.

Global international data lake where everybody can put in information and retrieve that and that's openly accessible. That's the first thing that I would.

John: I agree with Moriba. I think data sharing is at the beginning of the list. I think we're right at the beginning of this discussion on how you implement policy and how you move forward on space traffic management. There are a lot of issues to tackle.

The other one I think that I would put up there is the authorities to match the roles and responsibilities that different agencies have and making sure that those roles and responsibilities are there and the authorities exist to execute them.

Brandt: Just to amplify on that slightly, the whole game here for space traffic management is, is somebody in charge of assigning and deconflicting orbits and who? What authorities do they need to effectively do that? If that's being done on an ad hoc basis, shoehorned in with other authorities, that creates challenges.

For example, I advise a number of companies that work in this area. One of them is working on some pretty clever things involve optical uplinks and downlinks for satellites, which is nice. That eliminates the FCC as a regulatory layer to a significant degree. That's interesting.

What does that do to the ancillary things that the FCC is doing without particular statutory authority but, nevertheless, somebody has to do it?

We need to make sure that, even if there is an interagency process, that somebody has clear authority to be acting, someone has clear authority to be in the lead.

I'm not going to belabor this too much, but one of the things I learned from doing export-control reform in the early days of the Obama Administration was that you have a whole lot of fiefdoms in these areas across the interagency.

Sometimes, they play nicely with each other, and often, they do not. They don't report to the same person until you get to the President of the United States, and he was always too busy to deal with this.

Having clear lines of authority established by statute, where someone is clearly in charge, others have important supporting roles, but it's possible for the government to move smartly in the direction it needs to go, that's really the message I hope to leave for myself with you here in the room, today.

Only Congress, really, can establish the authorities and who should be in the lead. To the maximum extent possible, if we can consolidate these authorities under a single entity, that would be extraordinarily helpful.

Diane: I have to say I would start with data, making the data accessible but also verifiable, and then building in from there how that data is going to be used and treated.

I would really like to also jump onto what Brandt was just saying about this communication and these fiefdoms. I will share with you Theresa had mentioned that there was this incident that happened back in the beginning of this year with Swarm Technologies.

There was a denial of a license by the FCC. Through a third-party launch provider, they went and they were able to launch from another country.

I gave this dilemma, this fact pattern, if you will, to one of my senior seminar classes and said, "Solve this problem." I gave them [laughs] a few statutes with some enabling authority and said, "How would you deal with it?"

It was very interesting what they came up with. What they said was, "The FCC doesn't have any requirement in the code of federal regulations where they have to actually do some sort of interagency consultation. The Office of Commercial Space Transportation has to. That's part of the whole pre-application consultation process, etc."

They said, "Was there any kind of communication of the denial to the Department of State?" I thought these are really interesting questions because they know all the different reasons why, "Oh, well that can't be done, or that shouldn't be done, or that's just too much trouble, or it takes too long, or it gets stuck on a desk."

Instead, they zeroed right in on things that I thought were simple. Again, these are things that come back down to who has the jurisdiction, who has the authority. I was at a symposium last Thursday. Somebody used a term that I really liked a lot. This isn't a regulatory gap. It's an authority gap.

I think Congress, again, is who needs to step in and fill that vacuum because when there's a lack of communication, mistakes can get made. I think it isn't necessarily just an organizational chart within an agency. It's an organizational chart that's actually somewhat more holistic.

To me, this is an excellent time for us to take a step back, for you all to take a step back. Take a look and decide what exactly is it that we're...Where do we want to get? How do we get there? Because there's usually more than one way to do that. Thank you.

Theresa: What they're all saying. [laughs] I agree with everything. I do want to stress on the Global Access to Data. I did mention that I think it's truly important, again, because we cannot have people operating essentially blind in space.

The issue that's going to have to be dealt with by you all is the question of the relationship between DOD and the Department of Commerce with regards to data and availability of data. While that might sound simple, it's not going to be simple because there are different fiefdoms.

There are national security issues, concerns, some of which are actually legitimate and some of which may not quite be. That's going to be a really difficult problem. It's one that Congress is going to have to fix.

The other thing that I would really like to see legislation to look at is the question of the tractability of small satellites in LEO. We're talking about a tenfold increase in satellites in LEO going from several hundred now to thousands, many thousands, tens of thousands of satellites in five years' time.

These things are going to have short lifespans. They're going to be debris after three to five years. The provisions, the practices that we have out there to both track these things and to deal with their post-mission life are not adequate to the job.

There are going to be problems. There are going to be collisions. All of these things, a lot of them are going to be clumped together like poles that stay in orbit.

We've got to get a handle on this if we don't want to see serious problems involved with orbit. Congress can take a look at what should be done to make sure that we can avoid those problems before we have major incidents and issues. Thanks.

Moriba: Very briefly. I'm glad that you just brought this up, this idea of tractability. You can all say the word. For some, it rolls off their tongue easier than others. But what does that really mean for something to be trackable?

There's no standard definition that everybody accepts on what is trackable, and what is not trackable. I can tell you from a technical perspective, trackability gets to not only can I detect something, but I know what it is.

Those two things have to be hand in hand. It's not just detecting objects. It's being able to put a first and last name to these things to know, "Yes, verily, that's the same thing I saw two weeks ago or three weeks ago." So tracking something is detecting it and knowing what it is.

Brian: Absolutely. I'll join the chorus here and say, "Ditto to all that." I would add one more thing to my own, and that is proper resourcing. At the moment, Department of Transportation, the FAA, Office of Commercial Space, they have on the order of a hundred or so FTEs and about \$20, \$22 million annual budget to do all the launch licensing.

This effort occur in a way to give Department of Commerce a lot of the new authorities to handle a lot of everything else. At the moment, that entire effort is on the order of 10 FTEs and roughly \$2 million a year.

It's an order of magnitude less people and budget to do what's probably going to end up being a much bigger mission because you're talking about FAA does launch, re-entry licensing. Commerce is expected

to do most of everything else and possibly supervision and management functions. That to me is something that needs to be looked at.

It's one great thing to have proper authorities given. It's great. The agencies with those authorities also have to have the proper resources to be able to execute them. That's something that's going to require the authorization committees to work with the appropriations committee to make happen.

A small change of 2 to 3 million, 2 to 4 million, even 5 million, that, I don't think it's probably going to cut it. This is a really big effort that the Department of Commerce is now being asked to take on.

They have to have the resources not only to do it but also do it well so that it's efficient for the commercial companies to be able to deal with it. That would be the one thing that I would have to add on to what Congress is doing.

One more question for everyone and then I'll open it up to the audience. We talked a little bit with the panel about this issue of the national licensing and then the international framework. What comes first?

Do we do the international game at first and then the national mutation or we do the national framework first and then the international coordination? [laughs]

Theresa: I'll go first. I actually think those things need to happen more or less at the same time. I do think we need to know what we're doing before you can coordinate, obviously. [laughs] That makes sense. A lot of the issues that have to be dealt with internationally also involve technology. Technological capabilities.

They involve setting standards. They involve trying to be able to get apples and oranges all into pears, if you will. In data sharing, it's not that simple. It's not just simply calling somebody up, or saying, "Here, look at my website." It's actually quite difficult.

We're going to have to have those conversations at the same time. The second reason is, again, having worked in the international community, as many of us have here, people don't like to feel like the United States is coming in and waving the big stick and telling them what to do.

Even if that may be true. That the US is a leading space power. We are pretty far ahead of lots of other space trying countries in thinking about these issues. About space traffic management and data sharing etc. We're the only country that routinely does share SSA data with others.

We've been doing that for some time. It's not the perfect system. It's by far from the perfect system. We have been thinking about this. It doesn't work to go in and wave the big stick, and say, "OK, we've made all the decisions. Now you have to do what we say." If we go in with that attitude, we're going to fail.

That's going to harm US industry. It's going to harm US national security. It's going to harm US economic interest. That would be a fail not a win.

Diane: I would like to second that emotion. We have an excellent way that we can do this. We're at a time here in the US where we're working on new legislation. We also have been really leaders in the whole long-term sustainability initiative.

We have these 21 agreed to. Whatever the status ends up being with these sustainability guidelines, it's a beginning. We can start with implementation.

I would encourage all of the people that are involved in the drafting of legislation to become familiar -- intimately familiar, if you will -- with what those guidelines that have been agreed to and largely, due to US efforts, what they are.

So that those particular ideas can be captured in our legislation. That's a very good way that we can lead by example. That's not nearly as ham-fisted as saying, "Hey, do it the way we say to do it." Instead, "Hey, this is what the international community came up with."

Because this happens to be a juncture where we are in the process of doing all of this, let's at least look at it and figure out what we can start with. Thank you.

Brian: Brandt.

Brandt: Let me present an alternative view. I don't have as much experience with the UN as some at this table or some in the room. I had the pleasure of being a DOD advisor on a negotiation at the UN some number of years ago, which was an interesting and informative experience.

If we're talking about the UN as the international community, there are not 80-some countries in the world that put things on orbit. There are lot of countries that have interests in space but are not the ones who are actually doing things in space.

Yes, there must be some international dialog. Yes, that's all true. The alternative model that I would suggest is perhaps California in the auto emissions market. If the United States decides what is going to work for it and what's going to work for its industry, and does that in consultation once we know what we think is in our interests.

Does that in consultation with other space fairing nations, other countries that are actually putting things on orbit, we will get to a system that works. Far too often in the UN system, you end up with countries that don't have any skin in the game.

The only thing they're trying to do is extract grants from everybody who does. I encourage us to avoid that result. If the US decides a framework that works for its interests and its industry as it's putting that into motion, it doesn't have to be a finely polished mirror.

Start assigning the authorities. Start working out the policies. After the authorities are more or less in place and the policies are beginning to be refined, that's when it's timely to be reaching out to the Europeans. Who else is putting things in orbit? The Indians.

Now the New Zealanders are getting into the game. Talking with the countries that are actually launching things so that there's some coordination among the community of nations with skin in the game is certainly very helpful.

If we wait until 80-some countries at the UN have come to a common view, we're doing ourselves a profound disservice.

Brian: I'll add in the example. We looked at the air traffic regime. That was a situation where it started on the national end. You had competing national frameworks in the US and UK that cropped up. They created this international body, ICAO, to basically harmonize and try and standardize between those.

That's the example of this national first wave that came forward. If you do that, then yes, the challenge then is you might have conflicting regimes. How do you harmonize those so companies aren't having different things with different countries? Or you end up with this flags of convenience thing where they end up picking one.

That's the challenge with doing national first. As someone who has been participating in the long-term sustainability effort in the UN for the last eight years, the challenge there is...One of the big challenges was actually capacity.

Many of those 87 countries really didn't have the national capacity to think through this issue of space degree and STM and SSA and space security and all those things. We, here in the US have the luxury of hundreds/thousands of people in the government whose job it is to think about those issues.

Most countries, they don't. I used to joke that most countries they have Bob, and Bob does space every third Tuesday. That's his fourth job. A lot of countries, it took a while for them to spin up what their national position would be, so they could then participate in the international dialogues .

That's one of the big challenges with having the international first is that national capacity piece. I'll open it now to questions from the floor. There is a microphone. Please, raise your hand, state your affiliation, and a question clearly to the microphone.

Audience Member: Hi, Mark Skinner, Aerospace Corporation. I want to circle back to orbit deconfliction. It seems to me that if you look at orbit deconfliction, it's really preventing harmful satellite interference. Harmful satellite interference isn't just cyclops affecting somebody's band transmitter, but bumping a satellite definitely falls into there. I think we might agree on that.

I simply think it's appropriate that US national legislation covers continuing supervision of our national. It makes sense that we do that for commercial versus government [inaudible 19:36] of commercial and commercial.

I think that the ITU is perhaps a good governance model for international. It's not just our satellites that need to be deconflicted, it's everyone else's. I want your thoughts on whether that thought about having the ITU maybe be a form for deconflicting non-GEO-stationary orbit satellites is a reasonable way to go or if you think there's some new thinking that would make that better.

Brian: Thoughts on expanding the mission of the ITU.

[laughter]

Theresa: There's something to be said for recognizing that the ITU does deconflict satellites in GEO already. They are in charge of trying to deconflict and make sure there aren't conflicts to start with and radiofrequency interference. In LEO they have less authority to do so.

They give us an experience, and I think that it would be unwise to ignore the capabilities and functions that they have. I'm concerned about the idea of embedding an entire space traffic management regime in the ITU. The ITU, it's really fairly unwieldy, and there...

[crosstalk]

[laughter]

Male Participant: Not the whole thing.

Theresa: OK. I think it would be wise to work with them on. I'm still not sure whether it would be wise to give them that job completely. I'm on the fence about that.

[crosstalk]

[laughter]

Brian: I'll add to that by saying at the moment one of the challenges in the RF harmful interference world is that ITU has no enforcement powers. At best, it can identify that harmful interference is going on, but it really can't do anything about that. That might be a problem in the physical interference realm.

Would you have to then have to give them the ability to resolve or force them. That's something I'm wondering might be a question. The question over here, Josh said [inaudible 21:48] .

[laughter]

Audience Member: I've got a quick question for the panel. Regarding what you mentioned with the resource and the Department of Commerce, and this is an acquisition question. Everyone's favorite subject. Specific to facilities.

The existing ground station infrastructure and many control facilities represent decades of development, a lot of which is dealing with [inaudible 22:14] of computing power and adding a robust network that cover multiple classifications.

I would like your thoughts on as commerce takes on this mission, what kind of analysis alternatives are you thinking about in terms of facilities for this. Would this be something as low cost as asking for co-residence in a facility like Unified Space Vault or possibly building their own facility and the cost that would entail? Thank you.

Moriba: Maybe I'm the least informed of the folks up here to answer that question, but one of the things that I would present is something analogous to the International Global Navigation Satellite System Organization, IGS.

One of the interesting things that IGS has done is they have redundant data centers and redundant analysis centers for all the people who participate. It's not governed by governments per se, but people from different nations participate.

This idea of having a data lake, that's shareable that is in different places, and everybody who wants to participate brings their own resources to the table, is something that might help. It's not a Lord of the Rings one place to rule them all, one system to rule them all.

Everybody around the world is developing their own systems. I think it would be a mistake to force all of planet earth to have command and control of everything. Different people can bring different things to the table, and there's a mix mosh of things, and there's an interplay of things.

Very briefly I would say because one of the concerns that people in the US government have is this idea of, for instance, with catalogues. If you have a certified system and you trust it, how do trust what's coming in from other places, trust their equipment, and that sort of thing?

To that I would say what I say to most people is, how do you know that you have the world's most accurate clock? The answer is you have 350 of them. The thing is the way time is set on planet earth is you have about 350 combinations of cesium fountains, rubidium clocks, hydrogen masers owned by different countries and different organizations.

They all share these things. They look at statistical consistency to figure out what's good and what's not so good. Time is set as the centroid of all 350 clocks worldwide.

I think we need to rely more on the systems and the frameworks that our international partners have, but find a way how to combine that in a way to pull out the salient information for safety and long term sustainability.

Brandt: Can I jump in on that? Just to add a thought to that, I spent six years at the Pentagon and then several years at Homeland Security over various time in my life. One observation that perhaps is relevant to this discussion is how painful it is to take things that are born in a classified environment and port them over into a civilian environment.

Homeland Security struggles with this constantly where they have something that's developed somewhere that's classified and now they want to use it for civil critical infrastructure protection. It's just almost impossible sometimes to figure out how to thread that needle.

I realize that duplicative systems are expensive and hard. I think it's possible that we should consider if there are things the Department of Defense is doing that are highly classified, very sensitive, and need to stay in that classified environment that's great.

When we look at things that are possible in the unclassified environment with companies like LeoLabs and some other interesting innovation that's going on, I think it probably is possible to develop something that would work sell for civilian use that is separate and distinct from very special things that the government is needing to do for the Department of Defense and the intelligence community.

Theresa: Can I just jump in and say I think that if you really look at what industry's doing and you want to bounce the commercial capabilities off of that, you're probably looking at a lot less money than DOD spends on its own facilities, people, and systems? [laughs]

Those are legacy systems. They have some built in difficulties. Their people requirements are quite high. I also would really worry about co-locating things because that gets really messy for the civilians involved.

If you really want this to work, we're going to also need to remember our friends and partners in the international arena many of whom already participate in some ways with the DOD space tracking and the SSA capabilities. I know that resources are always a problem, but I don't think you're going to have to duplicate the kind of spending the DOD is doing now to get a viable commercial system.

Diane: I have just two points to add. One is that I think that probably to not rely on something that's a legacy would be more nimble and we really, at the end of the day, want to be more nimble. We want

things to be more in real time with better information that we can respond to and that all of us can respond to more quickly.

I think also it's important to remember that, if we do things programmatically, the way it starts now isn't necessarily how it has to end up. It's not all or nothing. It's not, we're going to create this, it's going to be this forever. No, perhaps now it's a transition.

You start with the legacy you have as you transition into something that is perhaps takes into what industry is doing. Also, it's tailored to what a government function would be. Recognize that also it's going to involve more.

We don't know what we don't know. If we limit ourselves, [laughs] we fall into another trap. I say, let's look at it, start with this, and then be programmatic in how we evolve.

John: I think this is a really good question. I think there were several really good comments that's were just made. I agree with them.

Kind of at the core of this issue is the capability that's required if you're going to track objects in space and then turn around and do the assessment of which of those are an issue. Forecast that out, contact the folks, make some sort of notification of that, and then orchestrate some sort of response action that heads that off or mitigates it.

I just want to go back to the announcement that the vice president made at the symposium. Again, like I said, my apology. I won't be able to talk about what the policy does or doesn't say. I just want to go back to his comments.

What he said at the symposium was that the Department of Commerce would talk on the role of the public interface, but they would do this in partnership with DOD based on the DOD catalogue. I think it's important to not look at this as a handoff of responsibility from DOD. It's important, I think, for this to be establishing a partnership.

DOD is going to continue to main a catalogue. They need to do that for national securities reasons. It's important to try to leverage some of the aspects of that. The architecture now, a couple people alluded to this. If you have raw data that's collected from a sensor and that data is classified that's not really sharable.

In addition to this partnership and this idea that you can base some of your activities on the DOD catalogue, you also need to have some sort a sharing set up like what Moriba talked about. I think one of the other trends that I talked about earlier is a rise in commercial capability in this area to do SSA and STM stuff.

I think, to the question about how you get after this issue, there's an opportunity to leverage some of that to maybe mitigate this idea that another civil agency has to go out and duplicate that the DOD has built over such a long period of time.

Brian: Just to tease up three points of that that I want to highlight. One is a requirements question. Very good question. To use an example from the GPS era, GPS is a program created and run by the DOD started to do military functions. That's the whole reason we had GPS. Then we realized there's all these civil applications for GPS.

There was a big policy debate in the '90s about how do we have a civil complement with the DOD's involved in. One of the things that came out of that was we started thinking about what requirements there are for GPS coming from the civil domain to do civil missions that may be different than what the DOD is doing.

That took 20 years to work through in that domain. Who has that say? How do you do those civil requirements in a DOD program? Then how do you resource those civil requirements? There was an interesting dissertation by a young woman at MIT a few years ago called, "The Cost of Jointness."

She looked at the history of particularly weather satellite programs, and several cases where doing one joint program that tried to solve the requirements for multiple agencies and multiple missions ended up being more expensive than probably doing different systems to solve different missions.

I would throw that out there as something to consider that the DOD has built a system that solves the military requirements and does the military missions. We need to figure out what the requirements are for the civil SSA, STM mission and then look to see do they match what the DOD system enough.

Is it going to be more expensive to modify and retrofit the DOD acquisition system to do what the civil needs are or go a different direction? On the concept of different direction, the Science Technology Policy Institute did a study I participated in a couple years ago that looked at a couple different...

They basically had a AOA of different options. Then for the Department of Transportation and the FAA if they were to take this mission, the range from being the front door for the DOD data to find commercial data to certifying a private sector entity to do the mission and what the operational and policy implications were.

That study's out there, and it probably addresses some of things you're talking about. The ballpark that we came up with for a purely commercial derived solution was a few tens of millions, something around there. That was based off data two years ago when the commercial SSA world was just starting.

That's probably changed a little bit, but that is something you might want to look at out there. Other questions? Yes?

Audience Member: [inaudible 33:24] . This is an international question ultimately to Theresa, but Brian you mentioned the analogy to ICAO and the air domain. Then when we talk about publicly releasable information that we can all see online, I can go online and see ship tracks with AIS data. I'm interested in the international organizational mechanics.

We're building our US structure. In these other domains, the air domain, the maritime domain and so on, apparently those structures are in place. Are the necessary structures in place for the space domain that would mirror what seems to be working for the maritime and air domain?

Theresa: The short answer is no. there are a number of different forums in the international community if you will, some within the UN, some sideways to the UN like the ITU. There isn't a one stop shop for dealing with space activities at the international level just like there is not at the national level here. That is a big problem.

What is going to be the forum for doing this kind of coordination? Moriba mentioned the IGS, and this is an intergovernmental body. It is not a international treaty entity. It's a bunch of different national space

agencies essentially and other agencies who get together to share data, to share best practices, to try to set standards, to coordinate people's operations.

It seems to me that rather than trying to go straight to creating an ICAO for space that we really ought to do something like that, so we can harmonize ourselves and we can capacity build. We can bring operators up to speed on how to use space situational awareness data, all those things that have to happen to make an international regime.

It did take many years to set up the air traffic regime that we have, and maritime regimes. There's still arguments in the maritime world about who controls what, how far out, and what the rules are. We've made some mistakes because in the maritime regime we do have this flags of convenience problem that we don't seem to have in the air traffic problem.

I think there's a tendency in many other countries, not US countries, to think about development of the process and the organization first, and then to want to do things top down. In this particular situation, I don't think that's the right way to go right now. Eventually, we probably will have to have some kind of international institution. I firmly believe that.

To figure out how to get there, I think we need to do the intergovernmental processes first. Right now, we just don't have proper form.

Audience Member: Hi, thank you so much for your conversation so far. I wanted to follow up on the previous question about...You mentioned GPS which I think is an interesting model here.

What would you guys think about a requirement that there are basic space situational awareness data provided somehow through a civil agency of the United States that would be for peaceful purposes but free and worldwide? What would that look like to you? Does that make sense as you deal with the issues of sensitive data, classified data?

Is there something like a GPS model hidden somewhere in our SSA STM?

John: I think that's a great question, too. Let me just say, Brian mentioned it before, a previous job of mine was working at the Joint Space Operations Center and what you just described, at least at some level, is currently available. If you go to www.space-track.org, that's our website. If you're an operator of a space system, you can register for an account there.

You can provide contact information and then you'll get automatic notifications, at some level, of potential collisions that are upcoming, and things like that.

What I can tell you, from a standpoint of the policy that's proposed, is that at the Space Symposium the vice president also announced that we would continue to provide some level of basic space situational awareness and space traffic management information free of direct user fees.

I think that's a statement of commitment to continue with at least some level. Now, I know that that is not going to meet everybody's needs. That's one of the reasons why we're talking about a sharing architecture and all these kind of things.

I think your point is a valid one, and maybe it was Theresa who made the point earlier, that you can't just have people that say, "Hey, I'm just going to accept the risk. I can't afford to go by the state. I'm just going to accept the risk." That presents a risk for all. Just a couple of comments on that.

Brian: As someone who did his PhD dissertation on comparing GPS to SSA, yes. It's something that started out as a DOD function, as Colonel Giles said, right now the DOD is providing a basic level of free service to the world.

The question is, what you sort of hinted at, there's a set of civil applications that are emerging for SSA that the DOD is not really equipped to provide and to handle. It's not really their mission to provide safety to the world.

The question is, how do we transfer a piece of that to a civil agency with civil authority and civil requirements, and how do they provide that? That's the big question. In the meantime, the air force is going to continue to provide that basic level of service they have been providing for several years now.

Audience Member: I would like to go back to you with the data lake. If development were to stand up a data lake for people, researchers, companies [inaudible 39:46] global benefit of that. I would question on how it could affect domestic SSA, commercial SSA providers.

Could be that be seen, if development were to stand up such a data lake system that it could be seen as being in competition with commercial SSA providers? How would you envision resolving that competition between government [inaudible 40:14] system where everybody contributes, or do you envision development by [inaudible 40:19] and commercial SSA providers?

Moriba: Since I mentioned data lake I may as well be the first to try to answer that, Joseph. Look, I certainly am not proposing for commercial SSA providers to go the way of the dodo when it comes to being able to make money off of their data collections.

For sure, being able to envision the government buying some of those data to put into the data lake, there's no problem with that. There's also a lot to be said about citizen science where people, actually some very good amateur observers have systems that dwarf of what many governments have to observe and track things in space and they'd be happy to donate it.

I think there shouldn't be, again, I'm very much opposed to one ring to rule them all kind of methodologies in something that's hybrid that allows for people to basically buy stuff and put it in there.

People want to donate out of the goodness of their heart. They can put that in there. There's got to be some framework where all these different pieces can come together and be explored. That's my opinion.

Theresa: I would also like to add that a lot of what these companies are doing is not just getting the data. They're not just building databases. They're actually providing analytics. They're analyzing the data. I don't think that function for commercial industries are going to go away.

Each operator has different needs. No one system is going to be able to tailor its analytical information to each individual user of data. That's where it seems to me the real market function and the real business is for those companies. Although, some of them are getting their own data.

As we mentioned, and we skipped around, the data that's provided by the government does not meet users' needs. It just doesn't and for a variety of reasons. Not just national security concerns, but the fact of how the collection system is put together and what its main uses are, etc.

I think there's a way to skin that cat to have a global database where people can donate data or the government can buy some data without actually killing commercial industry.

John: Joseph [inaudible 42:51] , good to see you again. Good question. I think you used the term, "Data lake." There are various terms that I've heard that refer to what a sharing construct might look like.

I think cloud, lake, and lots of different things. I think it could take different forms. On one end of the spectrum, it could just be developing the sharing protocols, the message formats, what data's included as far as what format is it.

What has to have this data point, this data point and this data point. On one end of the spectrum. On the other end of the spectrum, it could be an actual thing. An actual data lake.

I think you could implement it in many ways. The key thing to keep in mind, and I don't think there's really much argument on this. The need for some data sharing to increase.

A quick example on what Theresa was talking about, if you've got an owner operator of a satellite, and they're notified by some free available service of a potential conjunction.

Just going into some kind of data lake may not provide them adequate information. If it's a piece of debris that they have a potential collision with, they may then have the ability to go to some place like a commercial company and say, "Hey, can you increase your collection on this particular debris so I can make a more informed decision?"

There's lot of space in there for the market to provide services, analytics and that kind of thing. I think it's about lots of ways you could implement sharing. The key is, there's got to be a construct for sharing.

Moriba: Let me go back to my website real quick. There's one thing I want to show just so people can get an idea when we talk about lakes and stuff.

That's all these objects. If you go to search data source and you click on JSC [inaudible 44:53] , let's see what happens. Can you scroll out? Can you go to the middle of the screen and try to zoom out? You see some dots there. There should be a way. You started doing something there. Maybe over a mouse button.

Josh: I tried to zoom out.

Moriba: Anyways. The point I want to make is that, at least you can rotate. All those dots you see there, those are all objects tracked by the Russians that are not in the US public catalog.

The thing is, there is about 3,200 of those things that you just don't get by going on to spacetrack.org. For who know which reasons. Some you can hypothesize on, but let's not spend time hypothesizing.

The criticality is, out of all the things of there, you need multiple eye seeing many different things so you can help inform people for orbital safety and long term sustainability. It can't just be one person's or one organization's opinion on what's in space.

It has to be a collection of these opinions, to again, try to maximize the eyes that can see what's going on and start coming to some sort of agreement on what's up there and looking at consistency and inconsistency.

Brandt: Can I jump on that?

Brian: Sure.

Brandt: Maybe a decent analogy to looking up into space and seeing where things are is looking down from space and seeing what's on the earth. There was a time when pretty much any kind of picture you'd be taking from orbit of something on the ground would be considered a very sensitive thing. The resolution that you could see anything. All of it would be classified.

Now, with the American Space Commerce and Free Enterprise Act, thank you very much Mike. One of the provisions that is in there is that we shouldn't be discriminating against orbital imagery when you have aircraft and high-altitude balloons that aren't similarly regulated and give you better resolution.

Why are we saying that the satellite imagery is super, super sensitive when you can get something even better from aircraft that isn't regulated in the same way? Makes a whole lot of sense. If we're going from a situation where we have, someone will correct me on this, but 1500 functioning satellites whizzing around the world and another seven tons of garbage.

We're going to a world where, in the next few years, hopefully, if all of the marvelous plans on the books materialize, 15,000 new satellites and from there just going up. It's not an acceptable answer, DOD sensitivity, to exactly where things are and what they are.

I understand those sensitivities, and it may be just too much to ask DOD to lead the charge in making this kind of information widely available. I think it's more likely that if we have commercial providers and civil entities saying, "Look, if we've got 15, 20, 30,000 satellites on orbit we have to have this level of fidelity of information."

DOD, ultimately, will be dragged along behind, but some years behind. That's OK, right? We shouldn't be forcing things that the national security apparatus sees as extraordinarily sensitive. We shouldn't be making them lead the charge to declassify things. We have to have that kind of fidelity in the data in order to support the level of economic activity that we're trying to unlock.

Theresa: Can I just say yeah verily on that note? We already have amateur observers who track satellites with a fidelity that is very, very fine. It is doable if you wish to do it. There are things that aren't in US catalog because they are classified that can be seen in your backyard with a telescope from Target, OK?

I'm not exaggerating, that is true. That information is out there. I understand the cultural issues that come to bear about declassification of things. That's always a problem, but in reality, the science is there, for the most part.

Audience Member: Good day ladies and gentlemen. I am [inaudible 49:39]. Despite what I look like, and the accent, I am actually working for Secretary of the Air Force here in the Pentagon, in the space office.

My question really gets to, Moriba, your excellent tool up there. A number of the panelists had discussed open architecture and data pools and whatever else. The accuracy of this data.

I would imagine most people sitting on that panel there say it ought to be hyperactive in that your tool is designed to reduce inaccuracies. Just like Brian said, with the commencement of GPS. When we

commenced GPS all those years ago, there was a classified level of GPS that first year and there was a declassified level, or an unclassified level, which kept everybody safe.

It meant that there was no target level data available. I would be interested in the panels opinion about whether significant ubiquitous space situational awareness that is not accurate is an appropriate way to go for national security concerns.

Theresa: We have to have a verifiable system and everyone needs to have a verifiable system. If we refuse to play ball on that, we the United States refuse to play ball, someone else will do it. It is about safety.

There was an incident a few years ago that many of you may have heard of, when an NRO satellite lost functionality and it came very, very close to an INTELSAT functioning bird, a three-billion-dollar satellite.

NRO did not tell the company. The Air Force didn't tell the company. JSpOC didn't tell the company. The company found out because it was in the press. Amateur researchers saw that satellite wobble and go off its normal course and reported it.

This is not a good thing. Something could have been destroyed because of that secrecy issue. I think we have to think hard about what is and is not in national security or what protects our national security because if you think the Russians don't know where our spacecraft are, you're crazy. That's all I have to say. [laughs]

John: I think there are some really good points that are made. The need for transparency in sharing data, I think, is very important, and I think that's something we need to work toward.

I just want a quick point of clarification. The number of dots that you saw on Moriba's thing are not all US-classified satellites that we don't want to share. Some of the things that are not published on space-track.org are not published because the owners of those things have an agreement with the US not to publish that stuff on there.

Just for clarification, those are not all dots whirling around, waiting to run into your satellites.

Moriba: I want to thank Colonel Giles, here, for saying what I wanted to say, but he was the more appropriate person to say it.

Following this idea of the transparency and the accuracy of these things, at first, with GPS, there was selective availability for all of the security reasons that you came up with before.

One of the things that I would say, back to what Theresa said, is that people can track these things, people can start comparing these things, they can say, "There were a hundred opinions on where this one satellite is and that the other one is consistently 10 kilometers off."

People will start being able to see these things the more information that you put together. Then, it'll look a bit silly to purposely try to do this thing.

I definitely stand here with Colonel Giles and say that the sharing's important, but transparency, I think, is a key. I think one of the issues, now, that plagues us is that when an anomaly happens to some object, it's guesswork as to why.

The ability to contribute cause to anomalies, that's still a very hard and salient issue. Because there's a lack of sharing there's a lack of transparency for a variety of reasons. It's more of a he said, she said kind of thing.

If you see some of the stuff that EXOAnalytic, who's in the room, they've tracked a couple of objects here in the past 12 months. You can see that it seems that things are falling apart or you can see what appears to be objects coming apart from parent objects, and that sort of stuff.

Sometimes you talk to the operators and they say, "It's the Jedi mind trick, right? Those aren't the Droids you're looking for."

[laughter]

Moriba: That's not the debris you're looking for. Everything's working on the satellite. You have no idea what these people are showing, but you see things that seem to be evidence that maybe something not so normal took place.

That's only these onesie-twosie people that can say these things. That's because not everybody has access to all this information to start inferring their own things and coming up with their own opinions because of that lack of sharing and transparency. I would say sharing and transparency should go hand in hand.

The idea of what is accurate enough? Different users have different needs. I can tell you right now somebody might say, "I feel unsafe when something is one kilometer away from my satellite." You know what one kilometer is? That's a ways away, man.

[laughter]

Moriba: That's not the room next door. It's very subjective. A lot of what concerns people isn't objective hard-nosed kind of things. It's very subjective. We have to have a variety of information to satisfy a variety of needs depending on who the users are and what their concerns might be.

Oh, by the way, I've shown the whole AstriaGraph a couple of times. I just wanted to say, since George and Steph are here in the room, that's because of support that they provided through the FAA Center of Excellence for Commercial Space Transportation.

Brian: One more note with that GPS example. Yeah, 20 years ago in the Clinton administration there was knock down drag out interagency policy between the FAA and the DOD over exactly that question. Selective availability.

The FAA on one hand saying we need to turn that off so we can use GPS to improve air traffic efficiency and save lives. The DOD saying if we turn it off people are going to start flying bombs into buildings and killing people.

The decision was we'll turn it off in 10 years and meanwhile create a NAVWAR program to come up with an alternative way to deny it to adversaries. The really interesting bit is three and a half years later the DOD puts the turnoff early, not because the threat had changed but because Galileo came along.

[laughter]

Brian: The whole point was, "Ah, if we turn it off early, we can maybe undermine the Europeans and undermine Galileo," which I think says something to maybe the motivation under which those arguments were made. It wasn't necessarily about national security and death. It was more about control, power, and who has what.

I think we have time for one or two more very quick questions. Go ahead

Moriba: I just want to say one thing following up with what Brian said, the last thing on this accuracy piece. I think when people realize that lack of accuracy hinders commerce and space activities, I think that's going to be a big deal.

When GPS has this selective availability, imagine the people trying to put services on top of GPS that are able to do very precise position navigation timing. They'd never be able to make the money and have the business models that they have now. More accuracy, more potential for commerce, and all that.

Brian: In the back?

Audience Member: Hi. Mike [inaudible 57:47]. It seems to me that these systems are going to be build [inaudible 57:52] decades of work [inaudible 57:56] that today [inaudible 57:58] what do you need out there? [inaudible 58:00] systems have to have what [inaudible 58:02] out there for my system.

It's an unfunded mandate when you say, "I expect it to be there. I'm going to launch it. You better have it." It seems to me like the question is who is going to pay for it? Who is going to run it? Who's going to operate it? Who's going to [inaudible 58:17].

It's a very important question for the [inaudible 58:19] to say [inaudible 58:20] this way [inaudible 58:22] this many sensors who need this much money to pay for it and that's how it's going to grow. We can't anticipate their needs until we see the requirements.

Brian: Let's say the US government does remain the primary provider, you get into, how do we pay that? Again, we had the same exact debate with GPS. Should we charge a quarter per GPS chip set which would then fund the GPS constellation?

Ultimately, the decision was made not to do that. Primarily because they wanted people to use it. If you start charging someone might go up and put a free system up.

There's also a huge amount of administrative overhead in trying to do that sort of a system. Ultimately, the government decided it just wasn't worth it. That there is a public good that comes from the US government investing tax payer money and doing the system. That was sort of particularly related to GPS.

So far, we're there with the SSA stuff, but again, there is also room for the private sector to come and do their own thing. I don't think those are necessarily an either/or. I think it's probably a complimentary effort. If you're thinking about how to fund the government funding and SSA, that's a very difficult question to get to.

Brandt: There's again the analogy that we have from overhead imagery. When Digital Globe got started the US government bought most of their stuff. [laughs] We started out with the government having its own imagery capabilities. Industry came along and said we can do that cheaper and better. The governments a great customer. Awesome.

Now, there's so many providers that it's everywhere and it's only getting bigger. It's a bigger and bigger industry. It's being driven increasingly, I wouldn't say principally, but increasingly by commercial requirements.

I don't really see an inherent reason why looking up is going to be a profoundly different market than looking down. Right now, the government is doing it with its own capabilities. We've got some very interesting companies that are trying to get into that space who are probably going to be providers to the government. LeoLabs and others.

As was recognized up here earlier, various operators have their own requirements that are never going to be fully met by the government providing the service. As we go towards 10, 15, 30 thousand satellites on orbit that's only going to accelerate.

To suggest that the government is going to be providing this service for 15 or 30 thousand satellites I don't think will work, but industry would be able to do that. It will just scale in order to take care of the problem. Ultimately, the governments service will probably be secondary to what the market is providing.

Brian: All right. With that, I'm sorry to say we're out of time. Please, join me in thanking all of our panelists. Thank you for coming.

[applause]

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