WASHINGTON ROUNDTABLE
ON SCIENCE & PUBLIC POLICY

# Forum on National Security Space

# *Examining Codes and Rules for Space*

By

Lt. Gen. John Campbell USAF (ret.), Kurt Hackmeier, Kenneth Hodgkins, Gerry Jansson, Dr. T.S. Kelso and Robert Reese

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June 27, 2007

***Jeff Kueter:*** Good morning, everyone. I am Jeff Kueter, the President of the George Marshall Institute, and it is my pleasure to welcome you to this latest installation of our Washington Roundtable on Science and Public Policy. This is a continuing series of the Institute designed to bring together the public policy community with scientists, engineers and technologists from around the country to discuss issues of importance. As those of you who have been following our work under the auspices of our National Security Space project over the past year or so know, the central organizing theme for these forums has been helping to identify the actions this Congress or this administration (or the next one) could take to markedly improve the security position of the United States in space. This is the third such forum this year. The first, which occurred just days after the Chinese ASAT test in January, was meant to define the broad spectrum of why space was important. It provided the baseline for the work that followed. The second session, which was held in early March, defined near-term actions which we could take to improve the physical security of the U.S. position in space. Today's forum continues that theme by defining more closely what we mean when we say there is a need for "rules of the road" and codes of conduct in space.

Those of you who follow this debate on a more general basis understand that those two phrases have been used very liberally in the contemporary debate. Aside from signaling the rejection of anarchy in space, however, I don't know what these phrases really mean. What are the rules that we have in space? What are the codes of conduct that govern our actions today? And how do they need to evolve over time?

This forum and the three panels which we have assembled are designed to answer three questions: 1) What are the codes of conduct and rules in space today, and are they adequate? Are they flawed or are they sufficient? 2) How are they likely to evolve? 3) Do we need additional measures to help either accelerate the evolution or to change their course? I thank the six speakers who have given us their time this morning to help elucidate some of these issues on the subject of debris mitigation, collision avoidance and harmful interference resolution. I will turn the discussion over to my colleague Bob Butterworth from Aries Analytics, who will serve as the moderator for the event today.

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## *First Panel – Debris Mitigation*

***Robert Butterworth:*** Thanks a lot, Jeff. Seven years ago, the Rumsfeld Commission called for developing rules of the road for space operations. Recently others have repeated that call, maybe prompted by China's recent progress in space warfare. But what are they talking about? There aren't any roads in space, and satellites don't have drivers or ship captains that can test their mettle by playing "chicken." Our space situational awareness is probably too spotty for us to know whether rules are being followed or broken anyway. We and others have launched satellites for almost fifty years; we have moved them around and have generated lots of debris by intention, carelessness, and accident, all with no fatal collisions, as far as I know. What problems, then, seem to call for additional rules and how could rules, and what kind of rules, help to resolve them? That is what we are here to talk about today. Attention is centered on three topics: debris, traffic management and interference. We will hear from people working in each of those areas, try to understand the nature of the problem and see if there are feasible options for addressing them that so-called rules might provide.

Our first panel deals with debris mitigation. Even without help from the Chinese or anyone else, we would still collide with things in space such as micrometeoroids. Interestingly, the distribution of debris fields is quite similar to the fields of micrometeoroids, at least in large part, ranging from about 1,000 to about 10 million particles per square meter of particles weighing about $10^{-12}$g and so on. The larger ones are distributed otherwise: objects larger than 10 cm tend to be clustered in the 500-1,000 km altitudes. The number of objects in a 10 km altitude band may reach just fewer than 200. There is another cluster at about 1,500 km, where about 100 objects can be found in various 10 km bands, and so on. But our problem is the effects of the impacts that these things might have with our spacecraft. That, of course, depends on the mass of the striking particle and the velocity relative to the spacecraft. The average relative velocity for these things is usually taken to be about 10 km a second.

But human activity certainly adds to the things we might collide with, and because it tends to create trash in orbital regimes that are popular for many purposes, it presumably increases the probability of collisions. I am not sure how far this all might go. Bill Broad reported in the *New York Times* last January on speculation that there might come to be so much debris that one collision generates pieces that generate further collisions that generate additional collisions – a kind of nuclear chain reaction that would blanket the earth with debris. That might help resolve global warming, but it might bring on global cooling; I am not sure how that would go.

The tricky part for our satellites is that we can't simply tell debris to get out of the way. We cannot deter, dissuade or otherwise threaten the debris. Instead we can only try to minimize the amount of it and the hazards that it presents. Actually it seems to me there has been a great deal of very good work and progress that has been under way in this regard. Our first speaker, Ken Hodgkins, from the State Department, is

perfectly positioned to tell us about the progress that we have made, both at home and internationally, on rules of the road for debris mitigation. Our second speaker on this panel, John Campbell, is in just the right place to tell us how these rules and the debris affect the operations of a company that has a lot of small satellites in a very heavily populated orbital regime.

***Ken Hodgkins:*** Thank you. I am with the Office of Space and Advanced Technology at the State Department and I am also the U.S. Representative to the U.N. Committee on the Peaceful Uses of Outer Space. I appreciate the opportunity to speak to you today about what we are doing internationally concerning orbital debris mitigation and the so-called rules of the road. There are three documents that I have provided you: one is a copy of a PowerPoint presentation concerning the various efforts going on, on a multilateral basis, concerning orbital debris mitigation. Then there is a document from the U.N. on debris mitigation guidelines that were recently adopted, just two weeks ago, by the U.N. Committee on the Peaceful Uses of Outer Space (COPUOS). The third document is the Inter-Agency Space Debris Coordination Committee (IADC) Debris Mitigation Guidelines, upon which the U.N. guidelines were structured.

When we talk generally about standards for behavior in space, we have a set of five treaties: the Outer Space Treaty, the Registration Convention, the Moon Treaty, the Agreement on Rescue and Return of Space Astronauts and Space Objects, and the Liability Convention. Those were all negotiated within the U.N. Committee on the Peaceful Uses of Outer Space. Then we have five sets of non-binding guidelines. The two most relevant are the ones dealing with the use of nuclear power sources in space and the other is a set of principles which deal with remote sensing of the earth. The NPS guidelines were adopted in 1992 and Remote Sensing Principles were adopted in 1986. So there are some legal instruments that we have, binding and non-binding, that deal with behavior in space, but nothing as specific as what we now have with the debris mitigation guidelines.

I will run through the basic elements of what we have done at a national level. In the President's recent National Space Policy there is a whole section dealing with debris mitigation which calls for us to implement, at a national level, certain measures for commercial and government activities to mitigate the generation of debris. It also calls on the U.S. to take a leadership role in getting other countries to adopt similar standards that we have already implemented at a national level. The U.S. has, on its own, implemented policies and practices for debris mitigation. Those take the form of NASA and Department of Defense (DoD) policy statements. In the course of licensing remote sensing satellites and the commercial space launch activities, there are in those licenses provisions dealing with orbital debris mitigation. The Federal Communications Commission (FCC) has recently promulgated regulations that require FCC licensees also to demonstrate that they have plans for end-of-life disposal for satellites that the FCC would license.

So the U.S. has done all of this on its own. What we have determined is that that is not enough for the U.S. to do this alone, because there are probably close to sixty countries that either have satellites or have private entities within their jurisdiction operating satellites. We believed that it was in our interest and in the interest generally of preserving the space environment to promote among these countries and space actors internationally the idea that we need guidelines to mitigate debris. In 1993 we established the Inter-Agency Space Debris Coordination Committee, which is made up of the major space agencies: the European Space Agency, the Italian Space Agency, Canada, Russia, Ukraine, China, the United States (represented by NASA) and several others. Since 1993, they have been working on a variety of aspects of debris. The first was to define the debris environment, how we monitor it, what we know is going on up there, and from that information eventually to move toward something of a consensus on what would be good practice to mitigate the generation of orbital debris. Several years ago, the IADC was able to reach an agreement on debris mitigation guidelines. Now this is not a binding agreement; it is only recommendations for the members of IADC, which are, again, a limited number of space agencies, on how they would behave. Those IADC guidelines were based heavily on what we were already doing in the United States.

We recognized that the agreement among the members of the IADC was not sufficient because there were so many other countries and international organizations that are operating satellites, like Intelsat, Inmarsat, Eutelsat, and Arabsat, all who had not been part of the IADC exercise. So they weren't in any way obliged to adopt these guidelines, other than from the standpoint of this being good practice and responsible behavior and just generally being a good world citizen. We also recognized that asking the U.S. private operators, as a function of their licenses, to implement certain measures, either to minimize debris or to dispose properly of a satellite before it ended its useful life, incurred costs and created, in some respects, an un-level playing field. The IADC process was not going to solve that particular policy issue. So we looked around at a variety of mechanisms that could be used to deal with this. We determined that probably on balance the best way to get the type of international consensus that we wanted was to pursue another set of guidelines through the U.N. Committee on the Peaceful Uses of Outer Space. Now the COPUOS, as it is known, had been considering orbital debris for a number of years, but only from the standpoint of countries reporting on what they have done in the debris area in terms of research and mitigation. But we determined that we probably would need a set of guidelines negotiated in the committee that all member states of the committee, and eventually member states of the United Nations, could agree on as being our best practice.

So three years ago, we proposed that the Scientific and Technical Subcommittee of COPUOS should engage in discussions and negotiations on a set of guidelines that were modeled very closely on the IADC guidelines. These could then be pointed to as a consensus among governments – not just space agencies but among governments – as the best practices to mitigate debris. In February of this year, the Scientific

and Technical Subcommittee did reach consensus on the guidelines. The full committee met two weeks ago and we adopted those guidelines and now it will go to the General Assembly as part of the committee's report to the General Assembly. The General Assembly will adopt the full report of the committee and by doing so will also adopt these guidelines. So now we will have a set of non-binding guidelines adopted by the U.N. General Assembly that will urge countries who engage in space activities or who have entities within their jurisdictions that engage in space activities to implement these guidelines as best they can. The guidelines are not as detailed as the IADC guidelines, and the IADCs are not as detailed as the NASA-DoD-FCC policy documents, but they do represent at least a minimum level of behavior in terms of mitigating debris. The other activity under way is within the International Standards Organization (ISO). They have a working group that is looking at debris mitigation standards. I am not directly involved in that; there may be some people here who are. But this activity within the ISO is being undertaken primarily, I think, by private companies to look at what the best practices should be.

As of the end of this year, we will have the IADC guidelines, we will have the U.N. guidelines on debris mitigation, and then within the committee, we will ask that member states report on their efforts to enact national legislation and regulations to give effect to these guidelines. Now this is one of the areas where we have been undertaking a considerable amount of work. There are probably close to sixty countries that have, in one form or another, a space program, whether they actually operate their own satellites or they have entities within their jurisdiction that operate satellites. In the U.S. and a number of other countries like the U.K., Sweden, France and Russia, we have regulations and laws that not only govern what we do at a government level, but also what private entities do in space. Under the space treaties, the state is ultimately responsible and liable for any damage caused by an entity, whether it is governmental or non-governmental. We have chosen to put in place things like the Commercial Remote Sensing Act and the Commercial Space Transportation Act in order for us to properly supervise the activities of non-governmental actors. A lot of other countries don't have that and so there is no clear nexus between the private activity and the state responsibility in that particular country. Of course, the probability of real damage being caused is low, but if something does happen, the consequences could be catastrophic for everybody.

What we want to ensure is that other countries behave the way we do and that the governments have a clear understanding as to what their responsibilities are and what their private entities are doing. It is not a foregone conclusion in the case of some of these countries that there is that connection. This also extends to the whole notion of debris mitigation: we have the guidelines, but how are we going to make sure that other countries give effect to those? For example, take Luxembourg. SES is a huge operation there with a lot of satellites. Luxembourg for many years wasn't a party to any of the treaties and isn't a member of the U.N. Outer Space Committee. That is not necessarily a prerequisite for anything, but this is a very clear example of

where the regulatory and legal structure wasn't necessarily in place to give us the confidence that Luxembourg actually knew what was going on and that if something happened, that they would be in a position to give effect to the rights and privileges under the outer space treaties. With debris, the guidelines are not binding but we want to ensure that other countries understand that we have a minimum standard of what we consider to be good behavior concerning debris, and that they should emulate what we have done at a national level in the United States through policies and regulations.

So with that, I will turn it over to the next speaker and I will answer any questions that you might have.

***Lt. Gen. John Campbell***: Jeff, thanks for inviting me. It is great to be here. This is an important topic and I hope we can contribute on it. What I will do is give you the industry perspective from an operator of a number of small satellites in a place which has got a lot more crowded lately. I will tell you what we do to mitigate the debris, what the effect of the Chinese ASAT test has been on our operations, and then a couple suggestions we have for operational things that we think we could do to help.

I had been with Iridium for about nine months when I found out, when I talked to folks, that when I say Iridium, many people say, "Oh, you are the guys that went bankrupt." Well, not really. We are the company that bought the bankrupt assets of the old Motorola company and brought them back to life and operate them as Iridium Satellite, LLC. It is doing quite well today; it is profitable, healthy and the constellation is in good shape. In fact, we anticipate operating this constellation out to mid-next decade and have recently announced plans to recapitalize the constellation with a new, improved version. I will talk briefly about that later on.

Perhaps a description of what the constellation looks like might help you appreciate the environment that we operate in. We have sixty-six mission satellites in low-earth orbit, around 480 miles. They are in six planes, eleven satellites each, in polar orbit, so they all are crowded over the North and South Poles. In addition to sixty-six mission birds, we have nine online spares parked beneath the mission planes distributed across the planes. They are fairly small satellites, about 1,500 pounds. The satellites are all interlinked so the data and voice traffic goes up from the ground to the satellite and is cross-linked from satellite to satellite until it gets to either the commercial gateway in Tempe, Arizona or the DoD gateway in Hawaii. There is no ground infrastructure associated with the constellation other than the gateways. The satellites were built in the late 1990s. The launch of the mission birds took place between 1997 and 1999, so they are pushing ten years of age now. The design life is only eight years, but because they are only operate about 20 percent of the design capacity, there is less wear and tear on many of their components. We found out a lot of innovative things we can do to extend their life, so right now the mission birds are basically in good shape. We have quite a few spares and we are pretty comfortable that we can operate this constellation out to around 2014 and that will give us time to recapitalize them.

I have to give a lot of credit to the original Motorola engineering of the satellites. They are very robust and have a lot of innovative things. In fact, they were built from the beginning to minimize debris: the use of non-pyrotechnic cool-down devices, release mechanisms. A lot of care went into the selection of the various materials, surfaces and coatings. There was a lot of risk analysis to determine component placement to protect them from debris and there is a fair amount of redundancy and disposal subsystems. Because again it gets crowded at the Poles; they designed the orbits to minimize the conflict so they won't run into each other. Day to day, we do a lot of real-time coordination with the Joint Space Operations Center (JspOC) and STRATCOM. I will talk a bit more about that and how it affects us.

One of the big concerns is what we do at the end of life with these satellites. I will tell you that our end of life plans comply with all of the guidelines that Ken mentioned, the U.S. government debris mitigation guidelines and the IADC guidelines. Additionally in 2005, the FCC published a debris mitigation order. We had then to file a debris mitigation plan with them as a condition of operating communications satellites. It basically follows the same outlines as the IADC guidelines. Our end of life plans call for de-orbiting the satellites or lowering the orbit to a point where decay will take place in not more than twenty-five years. Twenty-five years seems like a long time, but those are the accepted international guidelines and represent a compromise between cost and getting stuff out of the way. In point of fact, at the rate we are consuming fuel, we are pretty confident that at the end of mission life, sometime in 2014, we can de-orbit all but a couple satellites in less than one year. Though that is not a requirement, that is the way that this thing will work out. We do not intend and do not want to leave a lot of dead satellites in space for very long. We will use all of the fuel remaining at the end of life to lower the orbit. At the end of the fuel burn, we will remove all the energy sources from the satellites, discharge the batteries, spin down the momentum wheels, vent the remaining propellant and basically put the satellite in a passive condition, so there is very little chance of a breakup caused by stored energy. Those are our end of life mission procedures.

The Chinese ASAT test got our attention. A lot of that debris is in the place where we operate. Our analysts said there are about 30,000 catalogued items in the low-earth orbit (LEO) space where we operate and probably many times more of that in debris that is too small to catalogue and track, but which can be a problem if it hits our spacecraft. We get a daily conjunction report from JspOC any time something is predicted to pass within five kilometers. The problem for us is that we get about 400 of those in an average week. If you track back, that is about one per satellite per day, so the ability actually to do anything with all the information is pretty limited. The other problem is that with the error bounds associated with those reports, we are not going to be sure what to do. Even if we had a report of an impending direct collision, the error would be such that we might maneuver into a collision as well as move away from one. One of the things we would like to see down the road is the ability to tighten up the orbitology predictions and provide a little bit more useful data.

Now I know that the GEO operators have fewer conjunctions and they, as I understand it, propose a system in which they actually get on the phone and real-time conference with JspOC until that conjunction has concluded. Obviously that is not an option for us because of the space we live in. Of the 400 conjunctions a week, about half are due to spent upper stages, launch vehicles that are flying around in orbit. About a third of them are due to other satellites in orbit, including our own; we track our own, of course. The rest of those are due to space junk and it is significant that about three-quarters of that space junk is due to the Chinese ASAT test. That alone increased our risk due to space junk by a factor of about three and increased the overall risk of collision by about 15 percent. So it was a significant event, when you consider that it was caused by a one-time event.

That said, this isn't aviation; the Big Sky theory works. We figure that the risk of a collision on any individual conjunction is about one in 50 million. However if we have 400 a week for ten years, you can do the math; clearly that risk is something bigger than zero. As I said, our coordination with JspOC is great. We talk to Mission Assurance Working Group folks all the time. In fact, I was at a STRATCOM last week meeting with them. We are actively working with them again just as a practical matter; however the ability to do anything with information is somewhat limited. One of the things that we could do is provide STRATCOM with the best position data we have on our satellites so they are aware of station-keeping maneuvers, etc., and they don't waste their time tracking our birds. We would also like to see more work on the orbitology, enhancing the conjunction prediction, so we might end up with some information we can use. We also think that probably all the operators can help provide situational awareness to STRATCOM and JspOC by providing information back. There may be things which happen with satellites across all the operators that would provide pieces of a bigger puzzle for STRATCOM to worry about. We are certainly willing to do that and in fact we are working on providing the appropriate classified information systems so we can do that.

The Satellite Industry Association has a number of suggestions which I think support the U.N. and the IADC activities and we certainly subscribe to those. For us it is a business proposition. The satellites are valuable assets; that is what our business rides on; that is where our money comes from. So we want to take care of space and keep it a place where we can all operate.

***Robert Butterworth:*** Thanks very much to both of you for that concise and clear and compelling picture of the situation. We will take questions and I would like to claim the privilege of asking the first one. Is there a competitive disadvantage that has come up in the marketplace for our commercial satellite operators and launchers, in respect to the debris mitigation requirements of the U.S. government?

***Campbell:*** I don't think there was for us. I am told that the original design of the satellites took into account the desire to minimize debris just as a good operating and

business practice. Certainly when we build our next generation of satellites, and those are under preliminary design right now, we will continue that practice. For us, it just makes good sense to keep that place clean so we can all operate there.

***Hodgkins:*** We work from the basic assumption that any change in what has been done in the past, whether it is from a launch vehicle operator's perspective or a satellite operator's perspective, would incur some cost that they wouldn't have otherwise incurred. Maybe it is an acceptable cost, but we just felt that if we were asking a satellite operator to use fuel that they would otherwise use for station keeping in order to de-orbit or re-orbit a satellite, it would cut into their revenue stream. So why would we ask our private industry to do that and not ask the rest of the world to do it? I can't give you any real examples other than just generally from a public policy standpoint, we made the basic assumption that there is a cost incurred and let's make everybody incur that cost.

***Butterworth:*** I just wondered whether SES or somebody had actually mentioned these things in marketing pitches or something.

***Hodgkins:*** In the discussions in the United Nations, for example, some delegations made the point – and they didn't get very far – "If you really want us to do these things and implement certain measures for our expendable launch vehicles, then it is only fair that those of you who have the know-how and technology give it to us." We said, "Well, that's not going to work. You should make the changes, because it just makes good sense." Obviously in their own calculations they felt that there was some cost to be incurred.

***Question:*** You talked a little bit about how at the current time the predictions of conjunctions are not sufficiently accurate to allow you to do more than monitor to see if something happens.

***Campbell:*** We grit our teeth and hold our breath; that's our action.

***Question:*** That would seem to complement a military perspective that the U.S. government writ large, both from a commercial perspective in support of our industry as well as from a military perspective, would like to improve space situational awareness. Do you agree with that?

***Campbell:*** I think so. I think if there are things that can be done to fund and resource the ability to tighten up our space surveillance and space situational awareness, we ought to do that.

***Question:*** I wonder who you give the challenge to to make these things happen. Who should get that job?

***Campbell:*** Well, I think in terms of the military, STRATCOM has the mission.

***Question:*** Who is at the end of the food chain to provide significant analysis?

***Campbell:*** My belief is that STRATCOM has the analysts, and probably Air Force Space Command. They have the analysts that can do that work so that is probably where you want to put the effort.

***Hodgkins:*** This is an active topic of discussion within the Department of Defense. The Executive Agent for space is working it; the commander of STRATCOM supported it, and the main thing of being able to improve our space situational awareness will probably be at the Air Force Space Command. We are working on finding how to do that in an appropriate, affordable and technically achievable manner in the next several years.

***Question:*** In the aftermath of the Chinese ASAT test, the Chinese have been involved with debris mitigation activities, as other countries have been. I heard they had a meeting planned on debris mitigation which was suddenly postponed. Can you give us an overview on the post-ASAT test environment relating to China and debris mitigation? In the past the Chinese were very upfront about lecturing us about what we ought to be doing and now they are remarkably reluctant, almost embarrassed, to talk about it. Can you give us your perspective on the Chinese attitude?

***Hodgkins:*** The timing, of course, was interesting, because they had this test in January and then in February the Scientific and Technical Subcommittee, of which China is a member, as well as the IADC, were going to adopt these debris mitigation guidelines. We and six or seven other countries, in statements we made in the Subcommittee, criticized the Chinese specifically for this and the fact that the test was inconsistent with the guidelines. They remained silent for the first week of the Subcommittee. In the second week they finally did have something to say – you have probably seen it in the press – which was, "Sure, we had an experiment that was conducted in January. It wasn't directed at any particular country." That is all they have had to say. But they didn't seek to make any changes to the guidelines; they didn't explain whether their actions were consistent or inconsistent with the guidelines. They basically remained silent. Then in June, when we had the final adoption of the guidelines, they remained silent pretty much about the test. We in our statements did again criticize them for conducting the test and making the point that it was not consistent with the guidelines and we remain concerned about China's intent in the future and hope that this doesn't happen again. We have raised it with them bilaterally and they simply said it was an experiment and wasn't directed at anyone. The biggest problem we have is the lack of transparency on the part of the Chinese. Now in terms of the guidelines, they do allow for intentional destruction of a space system, but you can do that if the debris you create is not long-lived, not of long duration, which is twenty-five years or less. On the one hand, you can conduct experiments or operations that intentionally create debris,

but if you do it, you have to make sure that it doesn't stay up there indefinitely. With the Chinese ASAT test, this stuff is going to be up there for hundreds of years in critical orbits.

***Question:*** They haven't done anything, then, to try to subvert the activities of the international debris community, but they just have been silent?

***Hodgkins:*** Right. The meeting you are talking about, the IADC was supposed to meet in April in Beijing and I think they probably exercised good judgment by not hosting and putting it off. I think it will take place in Paris later this summer.

***Question:*** Just a clarifying question on the guidelines: the twenty-five years is the life of the debris?

***Hodgkins:*** Right, of the debris. One point I did forget to mention. The outgoing chair of the full committee is Gerard Brachet, who is the former president of Centre National d'Etudes Spatiales (CNES) and president of SPOT Image. I think probably almost everybody in the room knows Gerard. He made a proposal in June that the committee and the Scientific and Technical Subcommittee give some serious thought to what could be done within the U.N. structure on rules of the road or good conduct or a code of behavior in space. That particular proposal, typical of how we do business in the Committee, was generally supported, but we have to give it more thought. So in the next year we will be looking at what within the U.N. committee could be done to look at this whole question of good behavior in space. Gerard's idea was that we should bring in private industry and talk about what could be useful to them. We have something on a very preliminary basis in the works, but obviously the framework for the discussions will have to be negotiated and then we get to the real work. But that is something that you should factor into your own consideration of what the future might be for the so-called rules of the road or good behavior. The members of the committee are already thinking of it and Gerard Brachet, who is a well-known personality, has given this some serious thought and thinks there is something that we could do at that level.

## *Panel Two – Harmful Interference Resolution*

***Robert Butterworth:*** Last year in 2006, according to the FAA, there were a total of sixty-six launches that carried 109 payloads. For the first couple of quarters of this year, the numbers are thirty-three launches and sixty-seven payloads, and the forecast for the third quarter says there will be twenty-three launches and thirty-one satellites. As far as I know, they didn't bump into each other or anything else for that matter. And again, as far as I know there has never been a catastrophic unintentional collision between satellites. Our topic on this panel is collision avoidance or, more colloquially, traffic management: what kinds of problems might exist there and what kind of rules-of-the- road type of things might do us some good. But it just seems on a superficial

look, in terms of numbers and the opportunities for potential problems, that some basic procedures and practices might actually have evolved and that they seem to be working. And in fact that is probably true.

The United States government, in a recent letter that our ambassador sent to the Secretary General of the U.N., noted several of these things. For example, under the heading of Transparency and Confidence Building Measures, the U.S. publishes space weather forecasts and unclassified satellite tracking data, provides assistance in collision avoidance analysis for other nations' human spaceflight missions, enforces national regulations to limit the probability of accidental collision in orbit, participates in bilateral exchanges on space policies and strategies, observes agreed procedures for the notification of re-entry of space nuclear power sources, and so on. And going beyond that, the United States has been working toward further assistance in collision avoidance for analysis for commercial and foreign satellite operators and additional work with foreign military space operators. So again, as with the debris, a lot of work has been done and more is continuing.

Our policy issues here center on the responsibilities of corporations and governments. That is not the total the story, of course; there are also some technical capabilities in terms of space surveillance and on and on, but for the policy issues, it is a question of who should be responsible to what degree and how can that work, particularly in a commercial marketplace. For us pilots, for example, flying under visual flight rules, we have the responsibility to see and avoid other traffic. We get advisories from air traffic control, but it is up to us to make sure we know what else is out there and what is happening and to pilot our own airplanes to avoid any close encounters and collisions. But when it comes to commercial space traffic, virtually none of the commercial operators can see what is out there, let alone do the see-and-avoid approach. So maybe we need instrument flight rules, an IFR-type approach, where the air traffic control authority takes over. We file the flight plan to begin with that is the best we can come up with, but then air traffic control tells us where we really are going to go, at what altitude, and so on, and changing vectors. That would be the government in control of all these kinds of operations. Or maybe there has to be some other intermediate approach to try to handle these traffic management issues.

At any rate, the adequacy and the prospects of these approaches, and whether there are grounds for suggesting changes to them, we should learn from our next two speakers on this collision avoidance and traffic management panel. Gerry Jansson is with Intelsat and he can tell us in detail the steps that private or commercial operators take when launching or moving satellites, and what their view is on how to make things better. T. S. Kelso is an astrodynamicist who can help us understand the physics of the problem and some approaches that private industry might try to take in terms of mitigating the possibilities of collision.

***Gerry Jansson:*** Thank you for inviting me here today. I will take a look at and try to give an overview of what we at Intelsat do in the area of collision avoidance and debris

management. We at Intelsat have fifty-two satellites in the GEO orbit, so we are the largest operator today of commercial satellites in that location. We clearly have to be somewhat of a good neighbor to ourselves and to everybody else on the same arc. As we all know, the orbit is highly congested. We have numerous satellites within the geo belt, so collectively we all need to communicate to each other. Without having a real standard that people acknowledge or utilize, we find ourselves operating under an informal good neighbor, help-each-other, if you will basis. That is the best we can do at this point until we find a collective agreement that we all buy into or accept.

As we know from recent events and the ASAT test, we had congestion and now we have even more in these regions of the space environment. There are various items that we have learned through public domain information now, such as how many objects are actually in space and what size they are: about 10,000 are being tracked, the smallest about 10 cm in size. Of those, only a few hundred are actually satellites; a lot of it, as we heard earlier, is space debris. What is not catalogued and what else is out there is what we all need to understand and hopefully try to avoid. We do know that the shuttle had to avoid objects numerous times, as had the space station, and even satellites, as we heard earlier from the Iridium folks. They survive the best way they can; they grin and bear it.

What I would like to do is describe what Intelsat does to get into space as far as notifications and information that we provide to others once on station and when we de-orbit. For the launch campaign, we first notify the Air Force of our intentions so that people know where we are launching from and what our intentions are. We coordinate with operators, both in RF frequency that we are going to operate our spacecraft at and the planned transfer orbit, so that operators in those regions know. We provide the transfer and drift orbit, that is, how we get from our launch stations to where we wind up once we get on station. We coordinate our in-orbit test locations, where we verify the spacecraft capability. Obviously, they may not necessarily be the station that we eventually operate at, but will be a location that we are allowed to operate from. We may need to get approval from the FCC to radiate from specific orbital locations. As a matter of course, we also notify operators we go by, "pass in the night" as we call it, to let them know of our drift plan and our RF frequency of operations. That way if they see this interference come across their spacecraft, they will know who is causing it and the duration it will last. We act appropriately to minimize their impacts, of course; we shut things off when we pass, so as not to interfere with their capability or their traffic or their operations. This is done as a matter of course by Intelsat and other operators within the industry.

When Intelsat gets to space and on station, we do our nominal operation activities. We do nominal station keeping within our control box. While we are there, we, Intelsat, run a background program that monitors the database of debris in our arc to make sure that there is nothing expected into our operating space. This is something that we simply do as means to ensure that "we think we are okay." This is the mini-

mum we can do based upon the database that is "on the street" today as its accuracy is somewhat suspect.

Obviously if we, through this process, find that we do have a proximity issue, we will contact the Air Force and ask them to confirm for us if there is actually something we have to concern ourselves with. Usually they will come back with some level of thumbs-up/thumbs-down type of scenario. We have what we call informal agreements. These are with the operators sitting to the left of us, sitting to the right of us, or co-located with us. We share information about our orbital elements with them as we coexist together. If we do special events at those locations, we make sure that neighbor operators have the latest and most accurate orbital information available. Most of our communication is by phone or email. As we heard earlier, with GEO arc, you have some time as things evolve, so you can operate in a more controlled manner and not necessarily have urgent, fire-drill type of activities.

We also coordinate with Massachusetts Institute of Technology (MIT), where Lincoln Labs (LL) has the responsibility of cataloging debris in orbit. We provide them our satellite data during launch so they know our locations and they can asset it. They'll track its movement and can catalogue movement. MIT(LL) will continue to track during transfer, drift and until we get to our station and permanently park it. During operations MIT(LL) will map our movements against the database and advise on debris status. We communicate in real time. MIT(LL) will confirm location and our coordination with MIT(LL) ends. Once we get to our station position, we cease our discussion with MIT. Now obviously, as people imagine, satellites do have anomalies and sometimes we may drift. If we lose control and drift outside of our box (0.05°), we notify our neighbors. If we stay inside our box, within our controlled area, we manage that amongst ourselves and don't need to notify neighbors.

So that is, briefly, how we do our transfer, drift and on-station notification. As was noted earlier about the policy process that is in place, Intelsat does recognize and acknowledge the need to control the debris that results from putting a satellite in orbit. We do do pyrotechnic control, debris management, outgassing management. Intelsat does these things to ensure not to induce new debris into the space environment during our billed launch mission activities. Debris control is designed into the process to help mitigate the debris throughout transfer and drift orbit and once the satellite gets on-station and to the end of its life (typical spacecraft has about a fifteen-year mission life). Intelsat has satellites in operation today with almost thirty years of lifetime. Intelsat maintains enough fuel on board each spacecraft to de-orbit or decommission it out of its orbital location, so we can boost it beyond the GEO arc. Currently, it is about 300 km above the GEO arc, which is in accordance with the FCC requirements, this is the guideline that we follow.

During the de-orbiting process, Intelsat does maneuvers every twelve hours and then burns the thrusters until the fuel tanks are empty. As we heard earlier, we shut

down all of the expendables, release all of the pressures that may be built up and put the satellite into a safe mode. The spacecraft is a dead object once decommissioned. Intelsat flies every satellite manufacturer's platform. Each spacecraft has its varying set of processes required to de-orbit. It is not necessarily a standard process; it is more of a systematic approach where we deal with each series or manufacturer's spacecraft. Some of the processes are slightly different, so it is a matter of following that process.

I have also included in my handouts some background data on a global warehouse concept, which is to provide better and more accurate data to the population at large and to understand where debris actually is, so that while on-station, the avoidance can happen. We have heard of an occasion where a satellite had to move or was intended to move out of an orbit and debris actually got close to it. There was expected to be a head-on collision, but in reality the debris was approximately seventy meters away. These are things that are uncertain, because of the inaccurate data. Intelsat put together this concept, which is recommended that the industry consider. I am not going to address it here, but it is available for your review and thought. That is all I have and I look forward to your questions.

***T. S. Kelso:*** Good morning. What I will do is take a few minutes of your time to talk about the problem from an engineer's or scientist's perspective and frame objectively what is going on in the environment. I will talk first about the magnitude of the problem, because I don't think a lot of people fully understand just how bad this problem is, particularly in the low-earth orbit (LEO) that we have seen with the Chinese ASAT. Then I will talk about some things that we can do – and do do – today to try and mitigate some of the effects of this. And then I will talk about some of the shortcomings of that approach and ways we can work around that in the future.

On January 11th of this year, the People's Republic of China conducted a test of a direct ascent anti-satellite (ASAT) weapon against one of their own polar-orbiting weather satellites. That test obliterated the FengYun 1C satellite and produced, as of today, over 1,800 pieces of debris large enough to be tracked by the U.S. Space Surveillance Network (SSN). It also produced, by NASA's estimate, over 35,000 pieces larger than 1 centimeter. A single one cubic centimeter piece of this spacecraft with about one-ninth the density of a comparable piece of aluminum and traveling at a typical velocity of 14 kilometers per second relative to other satellites in low-Earth orbit would pack sixteen times more energy than the high-velocity ammunition used in an M-16 rifle. It's not hard to imagine the amount of destruction an object that size or larger would have upon hitting another satellite.

With about 600 of the over 1,800 payloads now in LEO working to perform day-to-day activities, supporting everything from communications and weather monitoring to search and rescue, the global economy depends significantly on these satellites and we are right to be concerned about the risk to these satellites as the result of the Chinese ASAT test. This single event increased the number of orbiting objects in the

public version of the NORAD satellite catalog by 20 percent and is, by far, the worst debris-generating event on record.

But if the Chinese ASAT debris represents 17 percent of the objects currently in the satellite catalog, that means there was already six times as much stuff up in Earth orbit, everything from active payloads to rocket bodies to debris. Those objects were already causing concern for satellite operators. And, contrary to popular belief, nobody is watching to see whether two satellites are about to collide, ready to warn a satellite operator that they might want to move their satellite out of harm's way. Sure, U.S. Air Force Space Command watches for such close approaches to U.S. military satellites, but it is not their job to do this for commercial operators, even if the U.S. Department of Defense uses those satellites for military operations. Satellite operators, whether they know it or not, are on their own to determine if their satellites are at risk.

That's why, in May of 2004, the Center for Space Standards and Innovation undertook a project to show the feasibility of providing a service to warn satellite operators of potential close approaches or conjunctions in enough time to allow them to perform a detailed analysis of the threat and to plan and conduct a maneuver to get out of the way, if they feel it is necessary. This project, Satellite Orbital Conjunction Reports Assessing Threatening Encounters in Space (SOCRATES, for short) takes all the data currently available to the public and generates reports of when any object is predicted to come within five kilometers of any payload in Earth orbit over the next seven days.

In addition to providing satellite operators a quick way to see whether there are any predicted close approaches to their satellites over the coming week, SOCRATES also provides some insight into the magnitude of this problem. For example, for the SOCRATES report for the period from January 11$^{th}$ to the 18$^{th}$, before the Chinese ASAT test was conducted, there were just over 7,000 times when some object was predicted to come within five kilometers of one of the nearly 2,800 payloads in Earth orbit. That's over one thousand times a day. As of the report for June 25$^{th}$, that number is now over 10,000 times a week, an increase of about 45 percent. Just over 2,500 of those close approaches were from pieces of debris from the Chinese ASAT test alone.

Many people will suggest that the risk to our satellites is being exaggerated by these numbers. After all, the conventional wisdom is that there have only been three confirmed collisions on orbit in fifty years of space operations, so what's the fuss? Well, part of the problem lies with the word "confirmed." Satellite conjunctions are not watched as they occur, but have to be gleaned from analysis of hundreds of thousands of observations of tens of thousands of objects when trying to figure out where a new unknown object may have come from. In reality, each object tracked by the U.S. Space Surveillance Network is only observed for about a minute a day and the process of confirming a collision can take many months or years to resolve. Even if a small

piece of debris hit an operating satellite, causing it to fail, determining the cause of such a failure can be difficult or impossible to resolve.

In fact, the operators who maintain the public NORAD satellite catalog are kept pretty busy trying to maintain orbits on the almost 11,000 objects they can currently track in Earth orbit. But even before the Chinese ASAT test, Air Force Space Command and NASA routinely cited another 4,000 to 5,000 objects which they tracked but did not release data for to the public. That in itself is almost three times as much debris as generated by the Chinese ASAT test, none of which is unavailable for satellite operators to use to try to protect their satellites. On top of that, the Russian rocket body used to unsuccessfully launch ARABSAT 4A in 2006, which was seen by observers to explode as it passed over Australia on February 20th, has yet to produce a single entry in the public satellite catalog. This is despite the fact that according to knowledgeable Air Force Space Command and NASA officials, it generated over 1,200 pieces of debris and is the second worst debris-generating event on record.

Running SOCRATES is actually pretty easy. The twice-a-day reports are generated automatically and only take about ninety minutes to calculate. The reports are converted to HTML and loaded onto the CelesTrak web for anyone with Internet access to see, totally without restriction. The top conjunctions are listed separately, often showing predicted close approaches of tens of meters, but the full report is completely searchable. SOCRATES has shown that it is easy to provide satellite operators with the information they need to protect their satellites.

The problem, of course, has more to do with data and data availability. As we just noted, there are thousands of objects which are tracked but for which no data is available to the public to perform the necessary analysis. The data that is available is of low accuracy, with positional uncertainties of hundreds or thousands of meters and the actual uncertainty is unknown. Higher accuracy data, along with the calculated uncertainty, is available within the U.S. government, but is not shared with satellite operators or the public. With access to the observations used to generate this data, current state-of-the-art orbit determination techniques could be used, in lieu of the decades-old legacy techniques from the 1970s and 1980s, to provide even more accurate orbital information. It is likely that this information is also available from the space surveillance programs of other countries, as well. Instead, the U.S. government continues the practice of withholding data for hundreds of satellites deemed important to U.S. national security, despite knowing for decades that amateur observers routinely generate their own data on these satellites as a hobby. The French have just reaffirmed this result in recent weeks, reporting that they are tracking classified U.S. satellites and asking the U.S. to withhold data on classified French satellites. The U.S. action of withholding data on its classified satellites is also encouraging other countries, such as Japan, to follow suit. Japan, a signatory to the UN Convention on Registration of Objects Launched into Outer Space, which requires the registration of all space objects, has openly flouted their obligation for doing so for their own IGS satellites.

It should be obvious to all parties, however, that our collective security and the protection of our orbiting space infrastructure from inadvertent collisions will require a collaborative framework to mitigate risk, much as we do today in civil aviation. Whether this is done through an open sharing of information, which would allow increased opportunity for innovation, or through some trusted international organization, the task is not difficult to accomplish, as shown by SOCRATES. Despite concern to the contrary, similar examples of collaborative data sharing, such as the Global Positioning System or Google Earth, have not undermined national security. We have the opportunity to act now and avoid a future disaster in space. I hope we will not choose to sit back and wait for something serious and totally avoidable to happen before we decide to act.

***Butterworth:*** Well, never let it be said that a Marshall panel speaks with a single voice! Thanks so much, Gerry. I thought that was very clear and very direct and we really appreciate an understanding of what you guys have to go through to work this. T.S., I would have to say that even after re-reading the paper that you sent ahead, I remain totally confused and I will try to identify my sources of confusion.

***Kelso:*** I would be happy to answer any questions.

***Butterworth:*** Well, the confusion that I see is that you are conflating debris with satellites. You are conflating the debris that is in low-earth orbit with options that we really have in geosynchronous orbit, where the debris problem is significantly less, and you are also recommending a solution that involves making public some pretty important national security data. But actually what we really need is more accuracy and better space situational awareness. Publishing more of the catalog of satellites, if there is more to be published, is not going to help us in terms of giving the Iridium guy more time and more knowledge about whether, if he deviates ten meters left or right, he is actually driving into the path of something or driving out of it. I would understand the problem that you set up, I thought quite well, as being really a strong case for doing a better job of space surveillance and getting more precision, which can then feed the kinds of models that I know Analytic Graphics and other companies are putting up. But I do think it is important to maintain the distinction between other peoples' satellites (we have other means of communicating where they are and things to do about it) and debris and again the differences in the debris problems in different orbital regimes.

***Kelso:*** I am not necessarily advocating that we release information on classified satellites, but working with this community for a long time, I am well aware that many people are out there actually tracking satellites. As most of you know, the classified satellites we put up are not small and the amateur observers actually take it as a challenge to go out and find them themselves. I think it is actually rather naïve to assume that if amateur observers can do this as a hobby, that our potential adversaries can't do the same as well and do it equally well. But the point is that there is a lot of data out there currently available through the U.S. Space Surveillance Network and if we had the ob-

servations available to the public where they could actually innovate and use newer techniques, they could process more of the data. Part of the problem right now is that Air Force Space Command actually can't make the associations between the observations and a particular object. If I see you today and I see you tomorrow, I don't necessarily know that that was you both days. So if I am trying to associate a track and figure out where you are going over a particular period of time, I have to be able to say, "When I saw this person one day and I saw him the next day and the next day, those were all the same person and I think he was going from Washington to wherever." If that information was actually released to the public, there are mathematical and astrodynamic techniques available today which could actually process the data quicker. We need to look at what we can do and how we can do things, not by spending hundreds of millions of dollars, but how we can take what we already have and use existing techniques to try to do this better. If we could do that, we could do it more accurately. If I told you your satellite was predicted to have a piece of debris pass within a hundred meters, it would be one hundred meters plus or minus ten meters, which you might not be concerned about, as opposed to one hundred meters plus or minus a kilometer or two, which you would be concerned about because you don't have any idea what that is telling you.

***Question:*** The analysis you cited earlier about collisions and debris being not unlike nuclear fission: where do we stand right now in terms of the density of debris and orbiting objects in comparison when things might start getting really catastrophic? One piece of debris in an unstable situation would generate in a collision more than one piece of debris, which would then multiply catastrophically. Where are we in terms of when we hit some kind of critical density, at least in certain orbits? There are quantitative ways to measure it. Is it five years from now or fifty years from now?

***Kelso:*** I am not sure that I can really answer that question. I am familiar with those theories that we will have a cascading effect of collisions. I am not sure that I necessarily agree with that. It does make a certain amount of sense that you could get to a point where the debris would be high enough that you would end up with some type of cascading effect, but you are actually going to have to look, I think, more specifically at the particular orbits. It would be like trying to do traffic analysis for the United States. You know there are places like Washington where there is lots of traffic and places like Aspen, Colorado where there is not a lot of traffic. You can't apply the same approaches to both. I am not sure I can give you a specific answer to that question.

***Question***: You are right; it is almost meaningless to talk about an average overall. Who is doing work on that subject?

***Kelso:*** I think Dr. Kessler at the NASA Orbital Debris Office is one of the primary advocates of that particular theory and probably would be the best point of contact to go to to ask about that.

***Question:*** Is there a best approach that the Air Force should advocate over the next couple of months, either to improve the quality of the data availability or to improve the system gathering the data, so that there is quantitative improvement of the data?

***Jansson:*** We advocate that. That would be the case that people who provide the data to the database would be more accurate, be more resolved in the accuracy of information provided. The operators have to be prudent and provide clear, accurate data into the database so that when you use it, as you spoke about an impending collision or a close fly-by, you know, within a reasonable tolerance Right now there is no real mechanism or agency that polices the problem. It is done by best commercial practice appropriate to your business and your satellites safety.

***Question:*** So there needs to be organizational center for that?

***Jansson:*** Possibly. Right now there isn't one for the data.

***Kelso:*** One of the things I didn't really address in my remarks: we are doing the predictions through SOCRATES with just the public information from NORAD. In fact, many of the satellite operators actually do use the SOCRATES report to give them a heads-up to say, "Okay, there is a potential problem here. Let's dig into it." They have more accurate information on their own satellites, so if it is a situation where a piece of debris comes close to an operational payload, they can go in and say, "I have more accurate information on part of that equation. Let me put that in, redo the analysis and see if there is still a problem." If we had a mechanism to do that, where multiple satellite operators could share that more accurate information, then at least in instances where you had payloads coming close to each other, you could say, "This was low accuracy data; here is higher accuracy data. We can use that to refine the estimate and decide whether or not there is or isn't a problem that has to be addressed." There may be a need for some clearinghouse or organization to be able to do that.

***Question:*** Would you see such a clearinghouse as being something that is commercially based or more governmental-based? Or would you see that as potentially being some sort of U.N.-sponsored or sanctioned organization?

***Kelso:*** I think the U.N. could play a big role in this. If we really want to do this in a global perspective, you are going to have to have whoever is doing that be something of a trusted agent, be independent. There are going to be certain global groups that are not going to want to, say, trust the United States government, for whatever reason. If you had some type of independent organization that could do that, I think that would be a big help, and the U.N. would seem to be able to play that role.

***Question:*** Has the ASAT test had any impact on the business practices in the satellite industry? Have insurance rates gone up yet?

***Jansson:*** No, we have not seen the ASAT test cause any change in our business practice. Actually, insurance rates have gone down. It is launch vehicle dependent, because most launch vehicles include the launch vehicle plus one year of insurance, traditionally.

***Question:*** I have a question about the scalability of the system that you described. There are two sub-components of that, I guess. Do we see other satellite operators in other countries abiding by the same sets of procedures that you outlined? And as we see more and more satellite operators in the world or satellites in orbit, what is the limit to growth of the system that you have outlined? Where might we begin to see it stressing and how, as external observers of that situation, might we begin to recognize the need for some of the more aggressive things that have been outlined here, such as the United Nations body?

***Jansson:*** To address your first part, there has been a lot of consolidation in the industry, so that helps keep control of satellites in very few hands. We (the satellite operators industry) utilize tools that are commercially available to many users. Even if you are a first-time satellite operator, you will be using a set of tools that are already well proven in the marketplace by others. These tools provide information to the user database with accurate orbital information. Even though a new satellite provider may emerge regionally, their satellites may be operated by experienced entities. Intelsat is an example; we fly other companies' satellites. Americom and SES do the same. The entities that are third party satellites are already engaged in the process of being good neighbors and practicing the policies that we outlined earlier.

***Question:*** Where might you begin to see stresses on the process, either the number of satellites we have to manage or the number of players involved in making decisions?

***Jansson:*** We are seeing more satellites going into the market. Experienced satellite operators who continue "good" policies and procedures do not stress the process. It's maintaining the process, maintaining the communication, maintaining the sharing of that information back and forth, that is what is in place. Until we put down some formalized manner or some control process, it still is completely ad hoc and relies on you relationships.

***Question:*** Could you offer an opinion on what kind of impacts market share and proprietary information have on the ability of industrial or market partners to participate in this information sharing that you thought about? Obviously satellite owners and operators have concerns about that. What kinds of things can you do to overcome some of that reluctance of people or industries to share data when they know that it might represent a loss of competitive edge?

***Kelso:*** Certainly, if you did some type of a clearinghouse to look for these types of events and warn operators**.** One of the ways to set it up would be they would input their information on their particular satellites into that organization. I know Intelsat

does an excellent job of sharing that information. You can go right out to their website and get it. Most satellite operators don't. But if they had a concern, they could stipulate that and say, "Well, we will put the more accurate information in there so you can do the forecast, but we don't want that information to go to our competitors." That would indicate that you would need to have some kind of a trusted organization that could basically safeguard the information, do the calculations and share the results without sharing the actual information that they got from the operators.

***Butterworth:*** I couldn't imagine a better place to put that than in the U.N.!

***Question:*** It seems from all we have heard in the last few months, the biggest concerns from the ASAT tests really would be for manned space operations, at least in the shorter term, in terms of political repercussions. Has there been enough planning attention paid to this aspect of it, or is that so specialized that it is not relevant?

***Kelso:*** I am fully confident that NASA is out there looking at this for any mission that they are doing. As I noted, their prediction of 35,000 pieces of debris 1 cm or larger, that is what the space station is shielded to. So basically any of those 35,000 pieces could do significant damage to the space station, even with the new shielding they just put up a couple of weeks ago. Given that it is primarily the U.S. and the Russians that are doing this stuff, I am sure the Russians are working pretty closely, since most of the activity is around the space station, to look when they do launches. But they are only really tracking that 1,800 pieces of debris that are large enough to do predictions, so they have to do general "where is the orbit plane, where is the debris?" Now a lot of the debris is actually higher than the manned orbital regime, so it is probably not as big of a concern. A lot of that stuff is going to decay out as it gets down to the altitude of the space station. But I am sure that NASA is looking at that pretty closely.

***Question:*** I will just make one point on that, which is that the U.S. has offered for both of the Chinese manned missions similar collision avoidance support. They didn't take us up on the first time, but they did on the second. That offer, as Bob noted earlier, is still on the table for human spaceflight missions. If they want the tech support that we give to the Russians all the time, despite their littering problem, we are happy to help them.

***Butterworth:*** I will indulge myself in one concluding remark for this panel, and that is that if you are the Chinese war planner with a limited stock of ASATs, say eight or ten of them, and you are wondering what to target them on, by all means, please use the lists that are created by amateur astronomers!

## *Panel Three – Harmful Interference Resolution*

***Robert Butterworth:*** For our third panel this morning, we have the topic of harmful interference. We will hear from two people well positioned to give us insights into this: first, from the corporate side of the house, Kurt Hackmeier from Northrop Grumman and then, from the Defense Department, "Bo" Reese. As Bo left home this morning, he didn't know that he would be sitting up here, but he has agreed to do so, essentially channeling for Col. Pat Frakes.

***Kurt Hackmeier:*** I would like to thank the Institute for hosting the Forum. I think it is something that is very timely. Obviously people talk a lot about the Chinese ASAT events and that is clearly something that is on most people's minds when they talk about harmful interference or the results of that kind of thing. But there are other efforts, whether it is interference in signals or other kinds of activities, that can take place that from a policy perspective and from an opportunity to really talk and have a public debate about it, it is good. I will start off by saying that Bo and I used to work together in the Air Force, so we are familiar with this mission area and some of the things that have transpired over the course of many years.

The Cold War, which ended back in the early 1990s, created a peace dividend. And part of that peace dividend frankly is what you are seeing today, that is, that we stopped being so overly concerned about what is going on. Our space surveillance network capability, which was integral back in the Cold War time, was allowed to languish a little bit. So we are now in a position, as a nation, of trying to reconstitute that. And we need to do it quickly, because you don't know what you don't know. Today what we have in terms of space control, space surveillance is for the most part forensics. I know on a certain day that something happened. I have absolutely no idea where that came from. And that is an unfortunate event and it is something that needs to change, but it is not just for debris. It is also for interference on signals that happen to satellites and for a host of other things. So whether or not we will be able to have MIT Lincoln Lab or some other forum try to help, I think there is a problem. There is an opportunity here now to address that. Clearly folks in this room are part of that process. Policy, law, money – all of those things are necessary. They have to come together in a conjunction, in a positive way and that is really what this is all about. So with that, I do think that the Marshall Institute is doing the right thing by having these kinds of forums.

When I was asked by Jeff to talk, I happen to have been to a movie that night, *Pirates of the Caribbean*. Now what does that have to do with space? I look around the room this morning and see all these paintings of ships on the walls. What does that have to do with space? A lot of people have talked about the fact that the issues of space today are somewhat analogous to the issues of free right of passage in the seas in the past and allowing people to use the seas fairly and equitably, not for adverse reasons, was a good thing. Dropping a ship in somebody's harbor entrance was not a

good thing; it created problems. You don't want to do that. There are a lot of laws and policies that exist today that address those kinds of issues. Not so much in space. There are conventions about what you should do in space and I will talk a little bit about that in some brief prepared remarks. But that is really, I think, what this forum can do: talk more and perhaps do some things that specifically address the right of free passage of space assets to do what they need to do and what we can make sure that the policy folks and the financial folks and the DoD and the intelligence community all can do to help contribute to that.

Let me mention another weird thing: where in the world does *Popular Mechanics* come into this? This issue has on the cover "Homebuilt Wonders," and "Mega Spud Gun," but it also talks about China's space threat. I have been in the space business for about thirty years and this is a really excellent article about China's ASAT capabilities – apparently. (I can't confirm or deny it.) But it is something you should look at. It really offers an insightful look at debris, at ASATs and at the kind of things that you need to do for space surveillance. So with that, I will just talk briefly here and turn it over to Bo and take some questions. Again, thanks to the Institute.

The topic of harmful interference to satellites is reminiscent to me of times when the oceans were the new frontier. They offered the future of commerce, trade and exploration. But pirates roamed the seas with impunity disrupting free trade, and pirates didn't follow rules or abide by generally approved conventions. Only with a strong navy guarding the sea-lanes did the ever-present threat posed by pirates subside. Now today it is amazing; there are still pirates. You can go in areas where strong navies don't exist and you are in danger. We still have those and these modern reincarnations of Blackbeard or Captain Jack Sparrow and these new more modern, technologically savvy ones in this information age we live in are looking upward at space. Unfortunately, as in the past, some of these pirates are state-sponsored. They can disrupt commerce and trade and deny important space-based services. They also do not follow rules. This nation relies heavily on space and we have to guard that capability. Your Blackberries are all using GPS-provided time and space. I am not saying that the nation is going to stop if you don't have your Blackberry, but things are going to slow down a lot. You are not going to get gas for your car. Your credit card isn't going to be validated. You aren't going to get money from an ATM. A lot of things happen when things happen to space. So we need to be mindful of that in this new information age. We need to have policies and we need to have conventions that take into account those things. Frankly, I am appalled that China hasn't been more severely criticized. I think it is ridiculous that they got a free pass on this thing. They got a couple criticisms, but other than that, no ramifications that I can discern for what they did.

So interference events happen daily. Ninety-nine percent of them are unintentional. What happens is operators come up on the wrong channel, or polarization. Yet it is difficult to separate potential harmful events from these probing sorts of interference. Those are the things that we also need to be mindful of. It is not just the de-

bris; it is other people coming up and trying to utilize satellites or in some way interfere with them. There is a cooperative effort underway within the industry to minimize these intentional interferences. The Satellite Users Interference Reduction Group is a forum for reporting interference and coordinating responses. I think that is one of the key things. I do believe that collectively we need to start sharing information more about when we do see interruptions or interference of services. And only by having a clear understanding of that can we really understand where that interference is coming from and what we might be able to do.

Satellite interference isn't just a commercial issue. All satellites, with the exception perhaps of some of the EHF protected satcoms, are susceptible to jamming, which make these trends very, very concerning. As I mentioned before, satellites play an important part of the U.S. economy and in our national defense. While our adversaries know this, the United States government needs to do more in protecting what we have in terms of our access to and use of space systems. In January, as we all know, the ASAT test was conducted by China and across the country we have seen that this is causing some concern, not necessarily ramifications, but the debris field which that created is now creating additional problems for us in terms of tracking. It was mentioned before that there is a satellite surveillance network capability. There is a way to share some of this information. Part of the problem is that there aren't sufficient nodes to collect all of that information. Most of those systems are ground-based.

Today there is some effort underway for a space-based space surveillance system, which would be very useful, having a top-looking-down kind of capability or in space-looking-out capability. So things like creating a space surveillance network that has additional nodes, additional processing so that we can collect that information and better understand what is happening. There was discussion earlier about the JspOC, the Joint Space Operations Center, which is really the node that U.S. STRATCOM uses to collect and analyze all this data. There needs to be increases in terms of their capability to do that job for all of us. So in terms of the political and practical steps that need to happen, I think there needs to be a general awareness and understanding of the value that space plays to us as a nation. I think that is growing. I think there needs to be adequate funding put in place to understand what the range of options are that you can pursue as part of U.S. STRATCOM or DoD or NASA. And then that funding needs to be followed through with a commitment over time to continue to upgrade that network and that capability because it is such an integral part of what we do.

So with that, I will turn it over to Bo and let him have his two cents worth.

***Robert "Bo" Reese:*** I want to thank Kurt for hitting on some themes that I am going to hit on as well. I am here today substituting for Col. Pat Frakes, who is the Space Policy Director and Information within the Under Secretary of Defense for Policies Office in the Department of Defense. I will be giving his prepared remarks today.

The title of the panel is "Harmful Interference Resolution." In the Department of Defense, we tend to use the terminology "Purposeful Interference" that has a basis in national space policy. It is what we use to describe deliberate actions taken to deny or disrupt a space systems operation or mission, whether that be the space system itself or space services that we would utilize. "Harmful" would seem to talk about the effects of the purposeful interference; we are more interested in the source and intent of the interference and that is our initial look at this.

Kurt has referred to space situational awareness, the importance to the U.S. government, the Secretary of Defense, and the Secretary of Defense's responsibility to do that for the nation, in terms of a common operating picture in space for the nation, spaceflight safety. Those kinds of things are very important to the Department

Purposeful Interference, as we use the language, is not a new problem, and it is becoming more and more common. The examples that immediately pop to our minds are the events with Telstar 12 in 2003 and 2005. To date, the focus, the seeming intent of the interference, has been to disrupt information transiting on satellites, not necessarily the command, uplink or the telemetry downlink. But the opportunity is open for that kind of mischief as well. We think that the possibility of threat is there and that it encompasses a wide range of potential targets: U.S. government satellites, U.S. commercial satellites, allied government and commercial satellites, things that have an interest to the United States government.

Our National Space Policy is very clear with respect to our view of Purposeful Interference:

> *"The United States considers space systems to have the rights of passage through and operations in space without interference. Consistent with this principle, the United States will view purposeful interference with its space systems as an infringement on its rights."*

While the Policy is very clear, rapidly developing a coordinated response across the U.S. Government can be a difficult task; Kurt talked about it in his remarks just before mine. The Policy goes on to say:

> *"The challenges of the 21st century require a focused and dedicated unity of effort… Departments and agencies shall capitalize on opportunities for dynamic partnerships…"*

We in the Department of Defense think that such an opportunity is available to us on the subject of Purposeful Interference and we have recommended, in the embryonic interagency process, that such an interagency approach to Purposeful Interference is there for us to take advantage of. We have gone off and dialogued with our interagency partners at a working level, at my level, an action officer level, and what we

have discerned is that there are lots of effective processes within government agencies for dealing with areas that have to do with Purposeful Interference, as it pertains to that particular agency. If they have regulatory or contractual responsibilities for a system, if they have ownership, if they are the owner-operator of a particular system, they tend to respond to those, remembering, of course, that 99 percent of interference events are not purposeful. They may be impacting, they may be harmful. That is why we emphasize the purposeful part of this so much – but they are inadvertent, and they can be dealt with by the means of the owner-operator of the system themselves or through other means fairly simply, fairly quickly and fairly responsively. It is that smaller percentage of cases where it is purposeful and it is harmful to U.S. interests that we need to respond in a coherent and integrated fashion. We have lots of effective means within several of the departments, as we have canvassed and talked to them informally. We are recommending, through the interagency process, that we explore the possibility that there be some kind of linkage for information gathering and sharing so that we have a common operating picture when an incident of interference is deemed likely to be purposeful and harmful to U.S. interests.

Because of that, we have started to work on a written product that we can share with the interagency process to recommend to them that this be looked at, to let this carry forward in the interagency process. Obviously there is a lot of work ahead of us and a lot of opportunities for the influence of the departments in the dialogue with their partners, with people that they routinely do business with, the owner-operators out there that are comfortable talking with certain parts of the U.S. government. We need to get this dialogue going and we certainly know that we need to respond to this. Because it is not a new problem; it is growing more common. We are concerned about it and we agree that there is room for collaboration here and a sharing of information. The theme that seems to be carrying across here in today's dialogue across all three panels is the importance of information sharing and cooperating to garner a common operating picture in these mission areas. Again, I beg your indulgence on the part of Col. Frakes, who is much more eloquent. I thought I would be sitting in the back today getting ready to ask questions; I didn't realize I would be on this end of it! But so be it.

***Butterworth:*** Well, maybe I should ask what questions you would have asked yourself.

***Reese:*** Is industry going to contribute to this in a meaningful, fiscal way?

***Butterworth:*** Thanks an awful lot. Help me step through some of this. Say I am working with Gerry and I have a commercial communications satellite up at GEO and I have sold transponders to a number of people or rented them out. Then some foreign entity comes to me and says, "Don't let this particular group transmit on that transponder or we will jam the hell out of your other ones and you will lose clients." Who do I call? Who is my sheriff?

***Reese:*** Who is normally your sheriff? In the normal scheme of things, who has granted your license to operate? Are you providing a service to or are you contractually obligated to that person? Whoever is your normal channel for response, we would envision to be your channel of response here. If you are regulated in any way by a U.S. government agency, you have responsibilities to share that information. If you are contractually bound to provide that information to anybody, we in the Department of Defense do not want to suggest to any other department in the U.S. government that they disrupt or perturbate any kind of relationship that they have that is regulatory or contractual, or even for comfort and precedent. The second part of the question: if that relationship doesn't exist for you, within the Department of Defense it is our assertion that the commander of U.S. Strategic Command has responsibility for space situational awareness. This is a mandated mission; part of the job given to him by the Unified Command Plan is to provide space situational awareness for the nation and to provide support in the mission area of space flight safety.

***Hackmeier:*** I guess I would take the question this way. When I was in the DoD, there were a lot of questions about GPS and whether or not other nations needed to have their own GPS systems and what they were going to do. The concern was that the U.S. government would turn things on and turn things off like a light switch. Frankly, from industry's perspective, that isn't what we want. We want to have a reliable, redundant space-based capability that is going to be there when we need and it isn't going to be at the whim of someone turning it on or off. But the fact of the matter is that they need to be protected systems if they are critical for national security and they need to be there when industry expects them to be there. The way that we do that, I think, is to have some level of prudent protection. I don't leave my car sitting on the driveway running, because when I come out it may not be there. There is a cost element that you are constantly hearing now in terms of resource allocation. If I have a dollar to spend, do I spend it on protecting my system or do I spend it on capability? The answer in the last few years has been capability. There needs to be thoughtful investment in protecting systems that are critical, whether it is a communications system or some ISR system or something that's important for industry or the nation at large. A balanced investment, not one way or the other, is needed.

***Butterworth:*** I appreciate your point, Kurt. But my satellite has only been up there about six years and it will be another six before I get another one. Right now I am dialing General Cartwright.

***Reese:*** What would General Cartwright do? In the current environment, he doesn't have any structured relationship. Knowing the kind of intellect that General Cartwright is, he is probably going to convene quickly several other departments and agencies. The case you cited was an attempt at blackmail to get you to disrupt service that may relate to U.S. interests and try to force you to do something. I have to imagine that in the structure that we are recommending, that we are starting to envision in an embryonic sense that among the collection of people that are sharing the information besides

the Departments of Defense and State would be Justice, Commerce, Transportation and the intelligence agencies. Remember, we have that 99 percent and that 1 percent, with the great likelihood that 99 percent of all interference, regardless of whether it is harmful or impacting or not, is not necessarily intentional or purposeful. One of the things you are going to do is go into this event thinking, "I don't know whether it is purposeful. How am I going to find that out?" Part of that cross-pollination of information between Defense, State, Justice, Transportation and Commerce could be with the intelligence communities as well. Certainly there is a great deal of intelligence community information, Defense and Office of the Director of National Intelligence, the FBI, all of them sharing data. We are hoping that at a departmental level we can spur on a sharing of information, a collaborative effort. Not a controlling effort, because I am sensitive to the fact that any call for sharing of information should not impose financial hardship on our industry and their ability to be competitive in market share and those kinds of things. We would look to put this collaboration on existing processes whereby there are companies every day that report to their regulator or their customer or the person they are contractually obligated to notify.

***Question:*** You talked about the need for situational awareness. What about situation management? Are you considering that as part of the policy in the DoD as well?

***Reese:*** We want to be sensitive to the fact that there are prerogatives that each agency and department has. Given the capabilities that we have right now, it goes back to the earlier question. Our previous investment in knowing what is going on in space has been largely focused on the ability to track and maintain an awareness of where something is in orbit, not on having perfect, up-to-date, real-time knowledge of what something is intended to do in space and what threats are occurring, as they are occurring, and not after the fact in a forensics kind of way. Our intent and our desire to do a better job is not matched by our current abilities. The Department knows this and the DoD executive agent knows this in terms of where he is focusing a lot of his intention and in terms of highlighting things we need to invest in in the coming budgetary cycles, the things that we need to do to provide better space situational awareness.

***Hackmeier:*** There are things that you can do now to help answer that. I think the Colonel mentioned before the JspOC. General Shelton and his folks have, from my perspective, the responsibility to be the first responder in terms of understanding what's happening in space and they should be the repository working as the joint forces component commander for space for General Cartwright to understand what the situation is. There are tools that can help them in terms of decision support. There are ways to connect existing databases, existing networks of information in the intelligence community and across the DoD; what the Air Force would have is a combined air operation center kind of perspective. All of the data comes in that you are aware of and you can make informed decisions on questions like "Was that an intentional event? How come every time I go over Cuba, I get this problem?" You are looking at a way to bring that together, to have the tools in place as soon as you can to allow these folks to have bet-

ter situational awareness. It happens that Northrop is trying to help them with some of that and I am sure that other companies are as well. But that is something that I would say needs to happen first and foremost. The guys at the 14th need to have the tools to understand and to communicate to important folks what appears to be happening.

***Question:*** You mentioned that one of the problems is knowing why a satellite has stopped functioning. Very little happened after the Chinese ASAT test. What could there be done as some sort of action against this? In the old days, when they captured pirates, what they did was simply to hang them from the yardarm.

***Hackmeier:*** I am not ruling that out! First of all, I can't respond. That is really a question for Bo's group, in terms of the policy aspect. I know what I would do: it would be more than cancel a meeting in Beijing. It would be something more than that, but from a policy perspective, I am not sure what is going to happen.

***Reese:*** A couple thoughts to consider. I know that the ASAT event in January is a significant emotional event, but it is a single event of a single capability in a broad range of capabilities which the Chinese are pursuing in a general military modernization. Rather than becoming myopic about the single capability, the single event, understand that any U.S. government response is larger than a DoD response and larger than a military-to-military kind of response. We are mindful of that and sensitive to that because that is the right way to pursue it. We are asking the Chinese repeatedly in multiple forums in which we are engaging with them, such as a State Department-Ministry of Foreign Affairs kind of engagement, to be more transparent. Certainly as a government we are very transparent in terms of what we invest in and where we are focusing dollars in any particular budgetary cycle, such as for weapons system acquisition. When we talk about space, we are very open and focused on the fact that we want to have better space situational awareness to ensure space flight safety and the free right of passage. This is not only for us but for other like-minded entities that want to have freedom of access in the space commons, just like your reference to freedom of access and transit and passage through the maritime commons. We understand that this is part of a larger movement by the Chinese. There needs to be more frank dialogue about what it is that they are seeking to do and what the purpose of this is, and that they need to have a lot more transparency. We are trying to encourage that across a number of forums. I know a strong reaction is attractive to a lot of us, and to me personally as someone who has been in the business for thirty years; you immediately go into some processes on what we should do and what we could have done and those kinds of things. But we probably need to look at the broader picture.

***Question:*** I agree with and support everything you said. But if we think about the future, are there any emergent thoughts at OSD policy that you and your team are looking at for what a regime might be, say ten or fifteen years from now, for responding to a clearly militarily originated interference event, whether it is an ASAT, RF or some other regime? Are there any thoughts that can be shared in this forum?

***Hackmeier:*** I think that you need to be absolutely clear as to what the response will be. I am not a history major, but somebody told me we forgot to tell the North Koreans that the 53rd Parallel was going to be an issue if they came across it. Maybe we forgot to tell Saddam Hussein that if he came into Kuwait, there was going to be a problem. There needs to be absolute clear lines of demarcation. Bo mentioned the policy; policy is written and stated by the President. I think it is clear, but they need to know it is clear.

***Reese:*** It is in our policy. You are right. I am suggesting that one of the possible things for us today to think about is transparency of Chinese programs and Chinese intentions and having more understanding of what they are doing, we need to be transparent and clear about our intentions as well and our policy. I will restate it:

> *"The United States considers space systems to have the rights of passage through and operations in space without interference. Consistent with this principle, the United States will view purposeful interference with its space systems as an infringement on its rights."*

Now I want to make the distinction, and I may not have been abundantly clear when I went through it the first time: we view purposeful interference as deliberate acts taken to deny or disrupt space systems operations or services. Not disabling or destroying; that is an attack and we have a different view of that. That goes into a different set of responses. In the context of purposeful interference, the reason that we are suggesting that there be integration of a cross-U.S. government, all-agency, all-resources response that shares a common operating picture and as much information as we can bring to bear, is because within the inter-agency process, as it comes back into the administration, say within the National Security Council, there are going to be suggestions on courses of action, whether that be diplomatic – the full range of power available to the U.S. in its response. It is not necessarily going to be military, although if the determination is that the interference was purposeful, it is contrary to U.S. interests and it was conducted by a nation-state – understanding that many of the instances of the past have all too often been an individual engaged in something as simple as a criminal act (criminal in our jurisprudence. Maybe I need to reserve my judgment about what it might be in that individual's nation of origin), if it indeed represents a nation-state sponsored attack, then it ratchets up into a different level of response, again, which is going to be recommendations to the President from his administration or his cabinet officers from the various agencies. But in the case of purposeful interference, what we are trying to suggest is that there are a full range of responses and the answer is, "It depends." What if it is an act of piracy or criminal possession – theft – of signal or theft of utilization of a channel? The act is purposeful, the move to steal that particular channel for ones' own personal and selfish use impacts U.S. government use of that channel and impacts our communications in some way, shape or form important to government business or U.S. interests. It is an individual. It may be a situation where the individual resides, that nation-state, when made aware of this particular instance, is

more than cooperative, so it doesn't represent a true and dramatic and compelling reason for us to be responding militarily.

***Butterworth***: What about international components on this, given the effort that is going on to try to get us organized internally, as you described? Is there an international aspect to that, for example, with allies and companies operating satellites and so on?

***Reese:*** Our thoughts are that the U.S. government, obviously where it is utilizing other nations' systems, has an interest. Where we are benefiting from service from international systems, regardless of whether they are government, military, civil or commercial, we have an interest. And we have thought this through, that we will have an interest in incidents of purposeful interference, regardless of whether or not they impact our interest, if for nothing more than we would suggest that we need to understand the environment and the space situational awareness better. Remember, this is a collaborative, data-sharing information. We might determine that something is not purposeful and it is not in U.S. interest, but we want to understand what it is, the environment that is out there and what the trend analysis might be. That might be useful, in the spirit of collaboration.

***Question:*** I just want to make sure I understand the purpose of this new inter-agency effort. Are you talking about managing the response or managing the data sharing?

***Reese:*** The data sharing.

***Hackmeier:*** A caution or caveat: we are at the discussion level right now. The existence of any organization is premature. Please don't run down the street and yell out, "Hey, there is a new group of guys meeting and let's go over and hang out with them."

***Reese:*** Yes, this is an existing problem and a growing problem. Is there something purposeful that can be done about it? Is it in the interest of the U.S. and does it represent good government for us to think about how we might share information? I would say that in our initial thought, we were very careful to make sure that as we went around and talked to other action officers, that we talked about the fact that this is information sharing and not trying to superimpose a controlling body on top of everybody. Remember my earlier remarks, when I said interference goes on every day and people respond to it in a very meaningful and effective way. Let's not monkey with that. What we want to do is if Transportation knows something that State doesn't know and if Defense Intelligence Agency knows something that Commerce doesn't know, isn't it in the interest of the U.S. to share that kind of information? That is what we are trying to get at. If in the future, as we start to envision resolution and courses of action, we want to stay within the prerogatives of the agencies, and there are other mechanisms for doing that. There are inter-agency mechanisms for resolving differences of opinion about courses of action between the various agencies and that already

exists in the National Security Council process. Quite frankly, that is not what our intention or focus is in any way.

***Question:*** Can I ask a quick hypothetical question to make sure this is clear? Let's say that the SGSG transponder that we are using for comms in SWA is jammed, and we are not exactly sure who is jamming it, but we know where it is being jammed from. Under the current setup, how would the information flow?

***Reese:*** Who is the owner-operator?

***Question:*** It is the SGSG, so it could be any of dozens of operators. Let's say it is a European satellite.

***Reese:*** They are the owner-operator. Are they owning and operating it for any particular customer that you had in mind?

***Question:*** For the U.S. government, through the SGSG.

***Reese:*** And which agency has oversight of that?

***Question:*** DISA, the same overseer as the customer and STRATCOM through the JspOC has some degree of oversight in coordination with DISA of that utilization.

***Reese:*** First of all, they are very capable; they have been in business for a while. They have established a mechanism for responding to this. They respond to the interference in your vignette. I assume that what you want to get to is that they are not able to solve it. So now they have a situation where they can't solve it, they are not sure at this point in time whether it is purposeful, but it is having an impact on U.S. government interests because it is impacting services utilized by the U.S. government. If their normal reporting change would be to DISA, that would be where we would expect them to report, and then it would come into the Department. What we are suggesting is that at that point, there should be a sharing of information between the other departments. In other words, are there sources of information that have important bearing on this situation? If you have this sharing of information and it is not meant to be a hierarchical kind of mission grab that says "you are going to do this and you are going to do this," if it is a sharing of information, whatever mechanism, regardless of whether it comes in from Department X, Department Y or Department Z, if there is sharing of information, that is the kind of thing that we would like to see and facilitate.

***Question:*** You were talking about the common understanding of what is responsible behavior for space-faring nations and what is not. Are there similar rules of the road, perhaps incorporating language on purposeful interference that might be discussed, not at the level of a treaty, but as a code of conduct that might help make very clear and

explicit to space-faring nations what behavior is responsible and what behavior is irresponsible?

***Hackmeier:*** I think the way it was described to me in the past by attorneys was, "Everything is okay unless it is ruled out." So what they say is, you can't interfere with another person's satellite, so don't do that. But I am not going to tell you what you can do. So you have to operate under the notion that responsible nations – the sixty-some-odd nations including Viet Nam and Iran – are going to act responsibly. The problem or the concern is how do you monitor that? Without some sort of space surveillance network capability that knows that someone is poaching trees out of your back yard, you just don't know. Today we don't know. We can't point the finger at what is out there. We have historically done space tracking, watching objects move across the sky. The reality is that we need to understand what those objects are, what they are used for, how they are operated, who is interfering with them, where did that happen, when did it happen? He is to blame; we are going to go talk to his boss. All of those things need to be part of an integrated network and understanding and that is what I think the JspOC offers and that is why I think it is an important element to help in this overall network. You can't say somebody did something if you can't prove it. You have to prove it.

***Butterworth:*** That is a perfect ending for a great morning here. Thank you, gentlemen. There are a couple of big messages that came from all three panels. One is that there is a great deal of activity that is of terrific benefit to the U.S. and other space operators and the world at large that is already underway. Second, it is clear that we need better information and better space surveillance and better space situational awareness. Third, we need more developed planning. It seems as though the prospects are pretty good for getting that and that there seems to be a willingness on the part of commercial entities to work with the government and willingness on the part of the government to work with other parts of the government, as well as the commercial entities and a pretty significant international component as well. So thank you all so much.

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Anthony R. Lupo – *Drought in the Midwest* (June 27, 2006) (published to web only)

Harvey Rubin – *Pandemics and National Security* (May 30, 2006)

Daniel Greenberg, Michael Gough, Richard Rowberg – *Science Advice to Congress* (May 22, 2006)

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