Summary of the 2016 AMOS Dialogue

Co-hosted by the Secure World Foundation (SWF) and the Maui Economic Development Board (MEDB) at the Advanced Maui Optical and Space Surveillance Technologies (AMOS) Conference in Maui, Hawaii

On Sept. 22, 2016, the fourth annual AMOS Dialogue, a small, invitation-only workshop was co-hosted by the Maui Economic Development Board (MEDB) and Secure World Foundation (SWF) during the 2016 Advanced Maui Optical and Space Surveillance Technologies (AMOS) Conference, held on the Hawaiian island of Maui, Sept. 20-23, 2016.

The goal of the AMOS Dialogue series is to facilitate discussion among key stakeholders in space situational awareness (SSA), thereby promoting greater collaboration and cooperation to enhance SSA for safe and responsible space activities. To accomplish this, the Dialogue brings together representatives from current and future SSA programs and initiatives around the world with a variety of end users and stakeholders so that they may exchange information and views in a not-for-attribution setting.

The topic of the 2016 AMOS Dialogue was a discussion of the SSA challenges posed by small satellites, with the goal of identifying steps that can be taken by both small satellite operators and SSA providers to improve the detection, tracking, and identification of small satellites to enhance conjunction assessment and collision avoidance.

Main takeaways from the discussion include the concern of long-term effects of smallsats on SSA capabilities and analysis, the equal concern about unnecessarily limiting smallsats through onerous regulation, and worries about SSA sharing in general that also apply to smallsats.

SESSION ONE: ASSESSMENT OF SSA CHALLENGES POSED BY SMALLSATS

The 2016 AMOS Dialogue was divided into two main sessions. The first session was an assessment of the SSA challenges posed by the increasing number of small satellites. Participants were asked to consider the following questions: how well do current SSA capabilities and conjunction assessment procedures handle small satellites? Are the gaps technological, procedural, or a mix of both? What are the channels for communication and interaction between the SSA and small satellite communities?

It was noted that there are differences in how smallsats are used and distributed. Smallsats are often, but not always, deployed in large constellations. Additionally, there are often large releases of small satellites at the same time from a launch vehicle or platform. It was commented that while there have been no actual collisions, and only eight collision avoidance maneuvers, done to date because of smallsats, existing satellite operators are concerned it could become a big problem in the future. The U.S. military's Joint Space Operations Center (JSpOC), a main source of SSA data, can track all cubesats now, although it does have challenges in identifying specific cubesats. Since 2000, 425 cubesats have been launched; while the ISS has had several close approaches, it has not had any maneuvers related to cubesats. The real concern is with the big potential cost from a large number of warnings and/or false positives. Smallsats also have launch issues in that they go where the ride goes, which may not necessarily be their first choice.

One participant commented that everything that goes up must come down, which means that eventually successive waves of small sat constellations will all need to come down, which might be a big challenge for human spaceflight in the future, as the decaying smallsats slowly filter though the orbits of the ISS and future space stations.

Others raised the question of whether cubesats should continue to be treated the same way as large satellites, or whether they deserved special rules. Should cubesats be required to follow the same space debris mitigation standards, or should they have their own? If they do have their own standards, should they be more or less strict than those for regular satellites? One participant suggested that instead of creating new standards, existing standards should be clarified. It was noted that for the Department of Transportation, not all planes are jets, not all boats are ships: every other type of transportation has different gradations depending on size. The argument here is not a case of needing stricter regulations, but rather more appropriate ones. It was noted that there is a real timeliness challenge, in that often the time it takes to get a license is longer than the operational lifespan of the smallsat. Finally, the argument was made that we have not scratched the surface of what smallsats can do, so we need to be careful with regulations.

One SSA problem with smallsats is that they tend to be operated by new operators, who may not be entirely aware of all the best practices involved in operating in space. JSpOC has recommendations for cubesat operators on spacetrack.org website, but participants voiced a concern about how to educate the broader smallsat community. Several participants noted that there are no real definitions for what a "megaconstellation" or smallsat is. One participant said that there are smallsats, and then there are smallsats that are too small; they cannot be treated all the same. It was argued that smallsats either need to make themselves trackable, or be limited to altitudes below the ISS. Of course, with the Space Fence, what is trackable will be changing. Another person asserted that size should not be the deciding factor but rather capability of the satellite.

It was suggested that some of the new entrants may not have as big an incentive for self-protection as the existing actors, leading to the question of whether cubesat/smallsat operators can afford to operate responsibly. Alternatively, it was pointed out that while overall compliance

with debris mitigation guidelines for existing satellites is now at about 40%, smallsats are leading compliance today because many are launched from the ISS, which puts them in an orbit with a naturally low lifespan. That may change as smallsat constellations get their own dedicated launches to higher orbits.

One participant raised the question of whether there is enough access to the data and studies to educate countries and operators about why this is a serious challenge, and urged there to be a corpus of data available to everyone to get common understanding. One suggestion was possibly creating a risk index of satellites, similar to indexes that are used to assess risks in many other fields.

It was noted that the increase in smallsats has had some positive effects as well. We are learning commercial off the shelf (COTS) parts do better in space than we had thought. New players can do better than previously thought. As a way of looking at this as a silver lining, learning limits of tracking capabilities now gives us a chance to figure out what to do before the large constellations arrive.

One new space actor asserted that new players in space aren't rogue operators but rather don't really know what to do. It was said that if people are given guidelines for best practices, the vast majority will follow them. Also, there really is not any significant agreement as to what irresponsible behavior in space even means.

The discussion also talked about the challenges with liability. Several participants commented on the shortage of laws for liability in space, or at least how the existing liabilities are enforced. There are mission assurance requirements, and safety requirements. One participant stated that we should let operators be as risky on the first as they want, but the second one is not an option. One speaker broke down the problems smallsats can pose into two categories. The first is collision risk and long-term debris growth/Kessler syndrome, which is not a challenge to operators now, but may be in the future. The second is the short-term impact to other operators, which is a challenge currently and will only become more so in the future.

Different types of regulations were discussed. For ESA, regulations are up to the member states. For the United States, the rule-making process allows interested parties to comment, but it's a very time-consuming and expensive process for international engagement. There also are forum-shopping issues.

The question was raised about whether JSpOC knows all the operators and who to call when problems crop up. Is there a database of contact info for all the smallsat operators? At the moment, there are a total of 2.5 people on the SSA Sharing Team at the JSpOC, with one of those people dedicated to finding and getting in touch with upcoming smallsat/cubesat operators. It was noted that the JSpOC can only give good data if owners/operators work with it; as well, the JSpOC can't give recommendations or tell what to do. Along those lines, it was noted that it is hard for new actors to find who the right people are to talk to in the government, and those people tend to be overworked, raising the question of whether there should be an overall smallsat coordinating office established for the USG.

SESSION TWO: IMPROVING THE DETECTION, TRACKING, AND IDENTIFICATION OF SMALLSATS

The second session of the AMOS Dialogue examined ideas and concepts for improving the detection, tracking, and identification of small satellites. Participants were asked to consider the following questions: What technical and operational measures can be put in place by small satellite operators and SSA providers to improve the detection, tracking, and identification of small satellites? What are the policy, regulatory, and normative options for implementing the measures at the national and international level?

Discussion began with an overview of the University of Arizona's Cyverse initiative, a $100 million National Science Foundation investment which is working to try and create a more public database. The argument was that there is a lack of public data for people to start their analysis, whereas anyone who wants an account on Cyverse can have one. A dozen people already have accounts to share/analyze data.

It was noted that getting more radar tracking sources will be critical to tracking large constellations. Unfortunately, it is hard to make observations via optical telescopes with these large constellations and can be expensive too. (One participant argued that it doesn't necessarily have to be expensive, as both Raytheon and Lockheed Martin have S-band demonstration radars that they are looking to do something with.) Still, low cost does not equal cheap, and deconfliction issues can be tricky (sometimes 25 satellites are released at once).

There is a need for more data on currently untracked space debris. This would validate and calibrate existing models. For example, Astroscale is working on a mission to track particles of debris too small to currently track. The mission is intended to fly in early 2017 and they hope to have good data to share on a free basis.

It was pointed out that while owner/operator contact info is great, a much bigger problem is figuring out each operator's coordinate frames. There is a need for better data exchange standards, but the time it takes to agree on standards is quite long. One exception was Conjunction Data Message (CDM) standards, which started discussions in 2010, and was recently published as an international standard in 2012.

While there is a lot of existing technology concepts to increase the ability to track or identify smallsats, such as beacons, RFID tags, etc., there is no coordinated development of such concepts into something that can be used by smallsat operators. Moreover, there is no clear benefit for small sat operators to do it themselves. Would a smallsat operator need a license for a radiofrequency tag, i.e., are they considered to be transmitting? Who would pay for the RFID tags/beacons – large operators because it could cut down their own costs, governments as part of a public good, or the smallsat operators themselves? It was also pointed out that some things that could help with tracking, like RFIDs, are ITAR-controlled, so that's an added complication.

It was noted that in reality, it can take weeks to track a satellite, and sometimes the satellite won't make it until then. This also complicates tracking the satellites. There is a need to have a large numbers of cubesats deployed in a predictable manner, described by one participant as a

"string of pearls" in that they are released one after the other, in the right velocity direction, perhaps with thrusting during deployment to get into place.

The importance of raising awareness of the importance of SSA for smallsat operators was discussed, with the point being raised that cubesat designers should be educated as well. It was commented that education needs to be about the "why" more than the "what."

Standards/requirements should be enforced through national regulations. Perhaps this could be done through launching states, as they are the choke points? One participant argued that we needed data to show compliance or negligence before making it mandatory. There is some power in the United States going first, in that it is responsible for a large part of space activity, and many countries look to United States as a model for regulation. However, if the United States goes first, we also need to find a way to get international input.

Several participants felt that action was needed now, since commercial people are coming for licenses now and forcing the issue. In the United States, the FAA meets and discusses with a small cadre of launch states and regulates the launch of U.S. spacecraft all over the world. But there is no international counterpoint to ICAO, which has a coordination function for air traffic, for space traffic. Moreover, many countries have yet to identify a national entity has the authority and competence to work on these issues.

The Inter-Agency Space Debris Coordination Committee (IADC) has created a few guidelines, but not all states have participated in its process. It was argued that while the IADC did good work, it is not timely enough for the needs of business. International norms only work if states are interested. It is important to get international buy-in, not just on the what, but the why of an international norm. Then members of the IADC can go back to their countries and then make a law, or do nothing.

Attribution of bad behavior was raised, as it is difficult to identify bad actors without being able to identify actors in general. As such, there is a need for more ability to attribute behavior on orbit. This will likely require data that is public and transparent if it is to be taken seriously. A common framework for assessing impact/risk for a constellation is needed as well.

RECOMMENDATIONS AND NEXT STEPS

There were a few major recommendations from the Dialogue shared by all the participants. The first is that there is a need for more comprehensive studies of the potential space sustainability challenges posed by cubesats and smallsats that clearly identified the risks for collisions and growth of the space debris population. The existing studies are a good start, but lack the fidelity, and balance of costs versus benefits that is needed to inform business plans and government oversight.

The second is the need for a more work on fleshing out concepts for tracking aids (beacons, RFID tags, etc.). There are many ideas and concepts being proposed for how to do this, but no one is coordinating the effort, and no overarching plan to take the most promising ideas and develop them further. The suggestion was made that perhaps the smallsat community could take

a leadership role in this, and perhaps some smallsat operators might help flight test some of the technologies and concepts.

The third major recommendation was for more education and awareness efforts. The smallsat community is gradually recognizing the role it needs to play in space sustainability, but more can still be done. More effort can be made to help educate the smallsat community, and also to build communication and dialogue between the smallsat community, the SSA, community, and traditional satellite operators.