The Consequences of a Space War
by Li Bin*

Moves in preparing for Space War

We have seen some explicit moves in the United States in recent years in preparing for space wars. On May 8, 2001, US Defense Secretary Rumsfeld announced the "Space Management and Organization Initiative," directing the military to engage in organization, training and equipment for swift, continuous, offensive and defensive space operations.¹ This plan has apparently gone beyond the approaches of passive defense in space, for example by hardening satellites to survive attacks, and turned to seeking capabilities for offensive approaches. Also, some US defense companies have been making efforts in recent years to develop weapons for offensive space operations. For example, Boeing has the KE-ASAT (Kinetic Energy Anti-Satellite) program to develop weapons that are used to attack hostile satellites and the program has received funding from the US government for more than ten years.²

The incentives behind these moves toward space war preparation in the US seem strange, however, given US dependence on space for both military and civilian uses. More than half of the satellites in space belong to US. American decision makers understand that US security and daily life depend largely on these satellites that are vulnerable to space warfare.³ The US also has the technical and economic potential to expand its presence in space, regardless of whether there is international cooperation or competition in the uses of space, provided the space environment remains a peaceful one. To maintain or strengthen the US dominance in space, it would seem that the US should avoid violent conflicts in space that could hurt US assets there. The US should be eager to ban space warfare, or at least it should encourage international dialogue toward such a goal. The fact is, however, that the US continues to reject proposals aimed at negotiating a ban on space weapons.⁴

Incentives for war preparation
It seems that US decision makers prefer war preparation in space rather than peaceful approaches. Such a choice logically should be based on a belief that a war in space is more preferable to the US than peaceful cooperation or peaceful competition in the use of space. In another words, these decision makers may believe that the US can certainly win a space war that would then allow the US to increase its dominant position in space.

It may help in understanding the incentives of US space war preparation if we recall the dynamics of the nuclear arms race in the 1950s and 1960s. The main motivations that drove the US and the former Soviet Union to pursue quantitative nuclear development stemmed both from the fear of being militarily defeated and from the hope of defeating the other side with nuclear weapons in a preemptive strike. As survivable nuclear weapons were deployed, however, US and Soviet decision makers recognized that a nuclear war could not be won without suffering unacceptable levels of damage through nuclear retaliation. This realization led to a slowing of the quantitative arms race as both sides sought limitations and reductions in their strategic nuclear arsenals.

In addition, the discovery of the global effects of large-scale nuclear war made nuclear war even more undesirable. Even if a country could successfully disarm its enemy with a massive first strike of nuclear weapons, that country itself would be seriously affected by many of the global effects of the war; for example, by world-wide dispersal of radiological products of nuclear explosions, by excessive ozone consumption of nitrides generated in nuclear explosions, and by temperature decreases caused by dust clouds. The realization of the serious consequences of a nuclear war helped reverse the nuclear arms race between the two superpowers.

In similar fashion, if US decision-makers understood the serious consequences of a space war, they might turn to support cooperative approaches in addressing security problems in space. This paper analyzes one such consequence of space warfare by examining the change in the amount of space debris generated by such a conflict.

**The current hazard of space debris**

Satellites in space are not safe even in the absence of war. There are many natural and artificial objects moving through space around the earth that threaten satellites. If a satellite collides with one of these objects, it could be seriously damaged or destroyed; the damage would depend on the mass of the object and its approach velocity. Typically, satellites suffer little or no damage if hit by objects smaller than one centimeter (1 cm). Very large objects in space, larger than ten centimeters (10 cm), are rare, thus the probability of their colliding with a satellite is low and can be
ignored in normal estimates. Accordingly, the major concern of debris collision is with medium-size objects of between $1 \sim 10$ cm.

The total number of medium-size debris objects around the earth is about 360,000\(^5\), of which 120,000 are in Low-Earth Orbit (LEO) of altitudes below 3,000 kilometers (km), 170,000 are in Medium Earth Orbit (MEO) of altitudes between 3,000 km and 30,000 km, and 20,000 are in geostationary (or geosynchronous) orbit (GEO) at an altitude of 36,000 km\(^6\). Despite their numbers, these objects do not yet pose a serious threat to space activities, as the risk of a satellite receiving destructive hits of space debris is still very low. Table One shows the intervals between two destructive debris impacts on a satellite with a size of 100 square meters (m\(^2\)). Given that collisions occur randomly, the time between two impacts can vary widely. Table One provides the maximum, minimum and mean of the possible time intervals between two hits in three different Low Earth Orbits. It shows that a satellite of 100 m\(^2\) would receive one hit in a few hundreds years time in LEO. This time is much longer than the operational life of most satellites, which are usually on the order of a few years. Satellites in higher orbits have less risk of a destructive collision because the debris population density decreases as altitudes increase.

<table>
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**Table One, Time Between Debris (>1 cm) Impacts on a Target Object of 100 m\(^2\) Cross Sectional Area\(^7\)**

**Hazard of Space Debris after a Space War**

Although the number of debris fragments around the earth is enormous, their total mass is not that large; for example, the total mass of all the medium-size debris is estimated to be around 2,000 kilograms (kg)\(^8\). If we assume that the debris have a universal mass distribution around the earth, the mass of debris is estimated as about 700 kilograms in LEO, 1,000 kilograms in MEO, and 100 kilograms in GEO.
However, if an anti-satellite interceptor is destroyed in a war, it’s debris could make a significant contribution to the overall total. For example, a Soviet anti-satellite interceptor, Cosmos, has a mass of 1,400 kilograms\(^9\), which is twice the current debris mass in LEO. If a Cosmos interceptor broke into fragments with sizes of 1~10 cm in LEO, it could triple the population density of the debris there. The new US anti-satellite interceptors could be lighter, on the order of 100 kilograms, which is still not negligible compared to the mass of existing debris. These interceptors, if launched and exploded in a space battle, would significantly increase the debris population and the risk to satellites orbiting the earth.

In addition to the interceptors themselves, those satellites targeted by them will constitute another source of debris. If a two-ton satellite is destroyed and broken into medium-size fragments in a space war, it will double the whole debris population and accordingly double the risk of an innocent satellite being hit by debris. Similarly, a war involving hundreds satellites and interceptors could increase the debris population by hundreds of times. Therefore, the interval between two impacts to any particular satellite in LEO will be reduced to less than one year. In other words, any satellite in LEO will likely receive at least one hit every year. The result is that more and more satellites in LEO that are intact when conflict begins will be damaged or destroyed by debris even after the war ends, with the debris they generate causing more and more debris that places even more satellites at risk. A process of collisional cascading may set in (collisional fragments trigger further collisions) and much more debris will be generated. In short order, a “debris barrier” could result that would prevent the stationing of any new satellites, or other space activities, in Low Earth Orbit.

No matter who launches the war and whose satellites are destroyed in the war, the result will be the same if a few hundred satellites and anti-satellite interceptors are involved: all satellites in LEO will eventually be destroyed and no new satellites can either be deployed in, or transit through, LEO. The result is that no country will be victorious in a space war as no country will be able to use space for tens of years until most of the debris disappears. Such a scenario would constitute a disaster for the entire international community.

**Conclusions and Discussions**

Traditionally, zero-sum assumptions have been used to analyze security issues. For example, a few players try to divide a certain amount of wealth. If one player can dominate the others through force, this player can then obtain a larger fraction or even the whole wealth. This kind of zero-sum thinking has historically been repeated in the competition for territory, regions of control, markets, and so on, however, the zero-
sum approach is counter-productive under some circumstances, especially when the object being sought is itself vulnerable to the competition for it. Such cases, such as the benefits derived from the use of outer space, call for a non-traditional security approach. As described above, the space environment is very vulnerable to a war where debris multiplication and the collisional effect place all space assets in a particular orbit at risk. Even if a country that successfully destroys all the satellites of its enemies will face the risk that its own satellites will be destroyed after the war by mounting space debris.

While the above conclusion applies to all countries, it is especially relevant for the US because of its dominant position in space and its large number of space assets, both military and civilian. If the space remains peaceful, it will continue to provide huge benefits for Americans; the loss of such benefits for the US would be equally consequential.

To maintain space as a peaceful environment, it is important to ban weapons in space and the potential for any conflict in space. Accordingly, proposals for preserving the non-weaponization of space are very much in the US interest. Given America’s strong political influence, its dominant position in space and in aerospace technologies, the US is in a very favorable position to negotiate an agreement on the non-weaponization of space. Compared to other arms control agreements, an agreement on the non-weaponization of space would be easy to monitor and verify. US decision-makers should not have to worry about evasions in implementing a space agreement, as they do for other agreements, for example, the Biological Weapons Convention.

To be sure, an agreement on the non-weaponization of space will also benefit China. While limited compared to the US, China derives many benefits from current uses of space. Similar to the US, however, China would not be able to increase its use of space in the event of a war in space. A ban on space weapons would relieve China’s concern about conflict war in space and thus help shape China’s peaceful development in space.

Most importantly, however, it is in the common interest of all peoples of the world to ban weapons in space and the potential for space conflict.

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Notes:


6. Ibid. p. 1.2.2.

7. Ibid. p. 1.3.3.

