Co-orbital Counterspace Systems
For the OEWG Second Session (September 12-16)
14 September 2022 – 1.30 – 3.30 pm (10.00 – 12.00 CEST)

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Good morning, Chair, members of the Open-Ended Working Group, civil society participants, and the Secretariat! Thank you for the invitation to be part of these deliberations and the opportunity to share my thoughts on the subject of space security.

Competition in space is not new. It has been on since the world's first artificial satellite, Sputnik-1 was launched in 1957. But this competition has changed and intensified over the decades. Militarisation of space is something we spoke in the previous decades – it is true most militaries around the world use space for what they call passive military operations such as the ISR (Intelligence, Surveillance and Reconnaissance). But today, that is not the real worry.

Many state parties are truly weaponising outer space, making outer space extremely fragile. Integration of space into military operations has serious consequences. This is a dangerous path to pursue because if one state decides to pursue such a weaponisation path to secure itself, it is going to push others to do as well. The net result is negative for everyone for several reasons. One, space is finite in nature; the usable orbits are limited in nature. If a large number of states decide to go down this path, one is polluting space beyond the scope of usability. An already crowded and congested space is going to get even more crowded, with both space objects and space debris, which have seen an exponential increase in the past decade. As the recent DIA report stated, the possibilities of collisions in space has increased substantially. The report says that the "probability of collisions of massive derelict objects in low Earth orbit (LEO) is growing and almost certainly will continue through at least 2030 because of rising numbers of space launches—especially those with multiple payloads—and continuing fragmentation from collisions, battery explosions, and further ASAT testing events." Two, these actions will negatively affect the long-term sustainability of space, making space inaccessible possibly even in the medium-term. With such actions, safe, secure, and continued access to space is not a guarantee.

Even as many satellite disruptions can occur due to the crowded nature of space, the growing geopolitical rivalry especially in the Indo-Pacific and globally has increased the likelihood of intentional attacks carried out by states as a way of denying advantages accrued through space especially during conflicts. These could manifest in a number of attacks using counterspace capabilities such as cyber and electronic warfare, but in future, use of ASAT or co-orbital systems appear to be a growing possibility, all of which makes safe, secure and uninterrupted access to outer space a lot more problematic. Driven by the geopolitical rivalry, we are moving to nascent arms race in outer space.

None of this is to suggest that militaries in the past have not used space, but the military use of space was primarily limited to strategic functions like missile warning, arms control verification, and not integrated into conventional military operations.

Let me get to my presentation now, and I will stick to the questions provided by the Secretariat. I was asked to look at the overall trends in the development, testing and deployment of dedicated co-orbital counter-space systems, how they function and what their impact on the space environment are likely to be and on the space-based activities of third parties.

Co-orbital weapons are weapons that are placed into orbit and later manoeuvred to approach and attack a target satellite through different means, including in destructive and non-destructive ways.

Both direct-ascent ASAT weapons and co-orbital systems belong to kinetic physical counterspace category, and can be used to target satellites, resulting in the creation of massive debris, adding to the already crowded space. Whereas direct-ascent ASAT weapons are launched from Earth to space to target a satellite in orbit, co-orbital ASAT weapons are placed into orbit first and later maneuverered to get into close proximity to the target satellite. These manoeuvres are commonly known as rendezvous and proximity operations (RPOs).

The debris generated through these actions can remain in orbit for several decades depending on the altitude in which the ASAT weapons are used. An ASAT test in 2007 at an altitude of 800 kms above the Earth created huge debris cloud, which continues to threaten satellites in nearby orbits till date. But we are not merely talking about things that happened 15 years ago but there have been ASAT missile firing as late as in November 2021 when one state targeted one of its own defunct satellites.

Co-orbital counterspace capabilities are being developed by states today because they want to deny their adversaries any advantage that accrue from the use of space in military affairs. For example, if Country A has made big investments in space and is heavily reliant on space for military functions, with the ability to produce outcomes in its favour, country B and country C see this reliance by country A as a weak spot, a vulnerability that can be exploited, in order to deny country A the benefits it may get from the use of space. This is the competitive dynamics and rivalry that is driving the development of these counterspace systems. The development of direct-ascent ASAT and co-orbital systems have picked up momentum.

There are more than 80 active space players today but thankfully, only a handful have developed co-orbital systems. Countries that have developed these systems include the United States, Russia and China. Let me briefly talk about each:

The US: Going by a number of authoritative reports, the United States has undertaken multiple tests of technologies for close approach, rendezvous and proximity operations (RPO) in both low Earth orbit (LEO) and geostationary Earth orbit (GEO), along with tracking,

targeting, and intercept technologies which could be developed into a co-orbital ASAT capability. These tests and demonstrations were carried out for non-offensive functions including missile defense, on-orbit inspections, and satellite servicing. The US does not have an acknowledged programme for co-orbital ASAT capabilities, but it does possess the technological wherewithal to develop a co-orbital ASAT capability in a short timeframe if there is a decision to develop them.

The US has conducted a number of tests that cause concern. In January 2003 the US Air Force launched the XSS-10 as a secondary payload on Delta-2 rocket. Once released, the XSS-10 conducted a pre-planned series of RPO manoeuvres near the Delta upper stage, eventually closing to within 50 m. In another test, in April 2005 , the US tested XSS-11, which was developed with the goal of exploring a range of future military applications including space servicing, diagnostics, maintenance, space support and efficient space operations. According to the US Air Force, microsatellites, like the XSS-11 offer reasonable platforms to test and validate key capabilities such as rendezvous and proximity operations, autonomous mission planning. Thus the US has successfully demonstrated rendezvous and proximity operations with the expended rocket body first and in the next 1-1.5 years, it undertook rendezvous and proximity manoeuvres with several US-owned, dead or inactive resident space objects near its orbit.

Subsequently, in March 2007, the US DARPA's Orbital Express mission was launched to demonstrate close approach and rendezvous technology for satellite servicing functions, with the ASTRO servicing vehicle and the NEXTSat client vehicle. This demonstrated the ability to autonomously transfer fluid to NEXTSat and use a robotic arm to swap out components. The two spacecraft then separated, and spent the next few months demonstrating multiple rendezvous and capture scenarios, including the first-ever use of a robotic arm to autonomously capture another space object. This was deactivated in 2007.

Earlier, in 1990 a satellite named Prowler was secretly launched from a Space Shuttle mission in 1990. Based on media reports, the satellite had maneuvered close to multiple Russian geosynchronous orbit (GSO) satellites to collect intelligence on their characteristics and capabilities and used stealth technologies in order to stay hidden from the Russian optical space surveillance systems. The Prowler is believed to have been decommissioned in 1998.

In 2006 the US launched two satellites into GSO under the Micro-satellite Technology Experiment (MiTEx) to identify, integrate, test, and evaluate small satellite technologies to support and enhance future US space missions. Experts believe that the MiTEx satellites would be conducting RPO in GSO.

In 2014, 2016, as part of the Geosynchronous Space Situational Awareness Programme (GSSAP), the USAF has launched two pairs of small satellites in near-GEO orbits Technology. Their positioning at altitudes slightly above and below the GSO belt has enabled them to do close inspections of objects in the GEO region. Data from the ISON space surveillance network, managed by the Russian Academy of Sciences, suggests that the GSSAP satellites have undertaken hundreds of manoeuvres since 2014, including close approaches or proximity operations of more than a dozen operational satellites in GEO.

Reportedly, these satellites have undertaken close approaches of several US military satellites as well as many Russian or Chinese military satellites and commercial satellites developed by China and operated by other countries. There is very limited public information on these satellites.
From July 2014 to November 2017, the US launched small satellites as part of another RPO programme, the Automated Navigation and Guidance Experiment for Local Space (ANGELS) to provide a clearer picture of the local area around important US national security satellites in GSO.

In April 2018, the US also launched multiple small satellites in GEO under the EAGLE Experiment. At least one of these satellites, Mycroft, reported to have undertaken rendezvous and proximity operations.

Overall Assessment:
Capability demonstration undertaken by the DART, XSS-10, XSS-11, Orbital Express, Prowler, MiTEx, GSSAP, ANGELS, and Mycroft satellites is for on-orbit satellite servicing functions and close-up inspections. But these could be quickly modified into co-orbital ASAT weapons. China has developed similar capabilities in the past decade and half which will be discussed in the next section.

China:
China has undertaken multiple tests of technologies for rendezvous and proximity operations (RPO) in both Low Earth Orbit (LEO) and Geostationary Earth Orbit (GEO), which, like the US, could lead to a co-orbital capability. So far, China has not conducted an actual destructive intercept of a satellite, and there is no evidence to suggest that China is developing these technologies with counterspace utility as the goal; it is reported that these are being developed for intelligence gathering purposes. China has been undertaking RPOs in LEO since 2010.

Like the US, China has conducted a number of tests. In June-August 2010, China's SJ-12 satellite initiated a series of deliberate changes in its orbital trajectory to approach and rendezvous with the SJ-06F satellite. The purpose was supposedly to measure space environment and conduct space experiments but some experts suggest that the mission was an electronic intelligence (ELINT) collection or signals intelligence effort for the Chinese military.

In July 2013, China placed three satellites into similar orbits around 670 km altitude and 98 degrees inclination from the same launch. The stated purpose was "Scientific experiments on space maintenance technologies" but the satellites were found to be engaged in capture and surveillance activities. One of the satellites, the SY-7, likely had a robotic arm that interacted with the separating subsatellite. Another, the SJ-15, manoeuvred and conducted proximity operations with other space objects. The third, the CX-3, was used to provide optical surveillance of space objects in geostationary and low Earth orbits.

In June 2016. Aolong-1 was launched by China, causing concerns about on-orbit grappling

Technology. The satellite reportedly demonstrated a capability of using a robotic arm to capture a small piece of space debris for removal from orbit; and possibly refuelling experiments. A Chinese researcher from the National Astronomical Observatories in Beijing has hinted at the potential for Aolong-1 to be used as a space weapon.

In November 2016, China lofted the SJ-17 satellite to GEO on the maiden launch of its new Long March 5 space launch vehicle reportedly to test higher-performance solar cells, new structural components, a green propulsion system consuming non-toxic propellants, and debuting a Hall-Effect Thruster system for use on future Chinese GEO satellites, testing an imaging system for the identification of space debris at high altitude. But the satellite is reported to have approached an apparently dead Chinese communication satellite parked in the what is called the graveyard orbit, within "a couple of hundred meters", which is incredibly close by space standards and reportedly undertook "proximity operations" with at least four Chinese satellites.

In December 2018, the Tongxin Jishu Shiyan (TJS)-3 satellite was launched to an elliptical geosynchronous transfer orbit (GTO). According Chinese media, it was a "communications technology test satellites". Experts suggest it was possibly testing missile warning sensors, deployable antennas, or other technology but there is very little open information.

In October 2021, China launched Shijian-21 (SJ-21) satellite to GEO and RPO missions to validate technologies that will remove space debris. A few months later, SJ-21 reportedly performed many advanced tests and maneuvers, including the release of a subsatellite or apogee kick motor (AKM), close approaches with other satellites in GEO, RPOs with SJ-21 AKM and other satellites including the Compass G2 satellite, part of the Chinese Beidou constellation of PNT satellites to a disposal orbit.

Overall Assessment:
There is broad agreement that China's satellites – SJ-12, SJ-15, SJ-17, and TJS-3 AKM – are, in technological terms, consistent with RPO demonstration capabilities for the purposes of on-orbit satellite servicing, space situational awareness, and inspection. DIA reports reach similar conclusions that China is developing capabilities for a range of activities such as repair, inspections, space debris removal although these may be used as a space weapon.

Russia:
After ignoring it for a couple of decades, Russia is seen to be revamping its Cold War-era counterspace technologies. Since 2010, Russia has begun testing many of the technologies required for RPO missions in LEO and GEO that could evolve into or support a co-orbital ASAT capability. It is also reported that Russia is possibly working on a new co-orbital ASAT programme, Burevestnik, possibly supported by a surveillance and tracking program called Nivelir. These technologies could prove to be useful in non-aggressive functions such as surveilling and inspecting foreign satellites as well but that Russia released two sub-satellites at high speed indicate that some of the LEO RPO activities could be of a weapons nature. During the Cold War, Russia conducted Multiple tests, starting from late 1950s, for over three decades. Russia's IS system involved a launch vehicle based on the R-36 missile,

launched from dedicated launch pads at Baikonur Cosmodrome in southern Kazakhstan. Technologically, these were Hit to Kill co-orbital ASATs; once launched into orbit, the interceptor and the booster get separated, the interceptor makes several changes to its orbit in order to gain close proximity to the target and then explode releasing a shrapnel within a range of 50 metres.

Further in 1990 -1994, Russia is thought to have tested the Naryad-V advanced co-orbital systems.

Subsequently, from 2013onwards, Russia launched a series of satellites including Cosmos 2491, 2499, 2504, and 2521to test satellite manoeuvring capabilities through a project conceived in 2011; also for SSA capabilities and providing a supporting role for other counterspace systems.

Beginning in 2011, Russia also tested Active co-orbital ASAT program codenamed Burevestnik ("Petrel") for RPO missions.

Also in 2011 under the Nivelir program, Russia is reported to have launched two satellites - Cosmos 2519, Cosmos 2491. These were inspection satellites but could undertake supportive role for Burevestnik by validating the RPO technology or servicing with tracking and targeting support.

Further in July 2019, Russia launched four military satellites - Cosmos 2535, Cosmos 2536, Cosmos 2537, and Cosmos 2538 which engaged in a series of RPO experiments. Another military satellite, Cosmos 2542 was launched to conduct space surveillance as well as Earth remote sensing. In December 2019, Cosmos 2542 released a small sub-satellite designated by the US as Cosmos 2543 which went on to conduct a series of manoeuvers that would place Cosmos 2543 in an orbit from where it can monitor a classified US intelligence satellite, USA 245, part of the latest generation of electro-optical imagery satellite. The satellites were in close proximity of 20 kms several times in January 2020. Russia has also conducted a series of RPO experiments in GEO too.

While everyone understands the important consequences of these actions, these are still being pursued by some states with the goal of presumably maintaining an edge and because they don't want to be left behind in one of the critical national security technologies. It is very likely that the rapidly altering geopolitics and the changing balance of power dynamics will continue to determine the trajectory in outer space affairs. Outer space had managed to stay free of the terrestrial politics for a while, but major rivalry has intensified to an extent where the geopolitics on earth is extended to outer space as well. Outer space has become one more domain where the competitive politics and rivalry are playing out. Also, the early trends shifting from space militarization to space weaponisation is dangerous because that is a slippery slope that can provide imperative for a large number of players to weaponize outer space without considering in entirety the implications of their own actions. With the competition already on among the top few players including China, Russia and the US, it is a

matter of time before this goes from a peaceful space to militarized space to a domain of active warfare.

But the implications are not going to be limited to the security sector. The effects are going to be felt across many domains including the civilian activities as well. Given the growing relevance of space for important functions in the social and economic domains, including health, disaster response, weather forecasting, directional data, and financial transactions, any loss or degradation of space assets would have multi-domain effects. Also, the globalisation of space would mean that the impact is not going to be limited a specific country, but it is going to have wider ramifications across geographies. Any destruction or disruption caused to satellite functioning will also hamper critical military functions including the ability to gather ISR (Intelligence, Surveillance, Reconnaissance) data, PNT (Position, Navigation, Timing) data, situational awareness capabilities (especially for the militaries), and communication. In addition, these will also affect pure civilian and scientific missions which will have a larger impact on science and technology, and innovation.