

Space Power

Space Traffic Management Is Critical for National Security

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A Space Traffic Management (STM) framework is critical for national and global security. With the rapid growth of commercial satellites and satellite operators, the sheer volume of space traffic to monitor and track is overwhelming, let alone the ability to identify risks and risky behaviours. This ultimately creates an unnecessary resource drain on national defence and other sectors of civilian government that monitor on-orbit activities. This paper will highlight how current events and behaviours have blurred the line between civil and non-civil operations on-orbit. Furthermore, it will showcase how our increasing dependence on space and the absence of a framework that establishes the baseline behaviour norms places additional resource strain and complexity on the military to monitor and determine belligerent activity from behaviours that are not widely accepted.

1. Introduction

A Space Traffic Management (STM) framework is critical for national and global security. An agreed and preferably enforceable framework can establish the technical, legal (regulatory) and operational behaviours required for safe and sustainable satellite operations. With the rapid growth of commercial satellites and satellite operators, the sheer volume of space traffic to monitor and track is overwhelming, let alone the ability to identify risks and risky behaviours. This ultimately creates an unnecessary resource drain on national defence and other sectors of civilian government that require the ability to monitor on-orbit activities. It also creates opportunities for belligerent actors to hide behind a veil of uncertainty created by the lack of an STM framework.

There are many nuances within the international treaties¹ and the application of various domestic legislation, bilateral agreements and international law which will not be examined here. Nonetheless, this paper will highlight, through case study examples, how current events and behaviours have blurred the line between civil and non-civil operations on-orbit. Furthermore, it will showcase how our increasing dependence on space and the absence of a framework that establishes the baseline behaviour norms place additional resource strain and complexity on the military to monitor and determine belligerent activity from behaviours that are not widely accepted.

To provide clarity and establish a baseline understanding, various groups often use terms such as Space Situ-

ational Awareness (SSA) and Space Domain Awareness (SDA). This may lead some to believe that there are already frameworks and practices in place. Where this often leads to confusion is the fact that the United States (US) or the European Union (EU) support many space operations which ultimately has led to some semblance of commonality as a result of a tendency to adopt what is already in place. However, these practices can often diverge slightly due to the differences in the regulatory frameworks of each nation operating in space.

The Aerospace Corporation (with reference to their sources) provides an easy set of definitions (Skinner et al., 2022). SSA refers to the understanding, knowledge and characterisation of artificial space objects, including spacecraft, rocket bodies, mission-related objects and fragments, natural objects such as asteroids including near earth objects (NEOs), comets and meteoroids, as well as effects from space weather, including solar activity and radiation. SSA also refers to maintained awareness of the space environment and potential risks to persons and property in space, on the ground and in air space due to accidental or intentional re-entries, on-orbit explosions and release events, on-orbit collisions, radio frequency interference, and occurrences that could disrupt missions and services. On the other hand, SDA refers to the identification, characterisation and understanding of any factor, passive or active, associated with the space domain (the area surrounding the Earth at altitudes equal to, or greater than, 100 km) that could affect space operations and thereby affect the security, safety, economy or environment of a nation.

¹ The original five United Nations space treaties are: the Outer Space Treaty; the Rescue Agreement; the Liability Convention; the Registration Convention; and the Moon Agreement (UNOOSA, 2024). The space treaties also extend to newer documents including the UN Long Term Sustainability Guidelines which also call out updates and amendments to the five original treaties, such as Resolution 62/101 which is an enhancement to the Registration Convention (UN General Assembly, 2007).

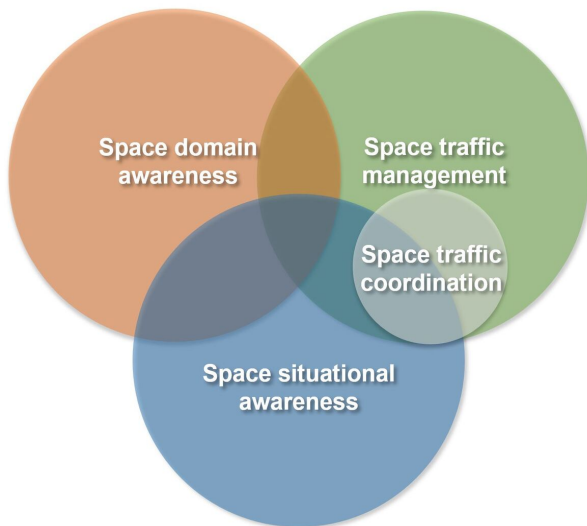


Figure 1. Relationship diagram between space domain awareness, space traffic management, space situational awareness and space traffic coordination.

In addition to SSA and SDA, STM refers to the assurance value chain that contributes to a safe and sustainable space operational environment based on regulation and licensing and dependent on a foundation of continuous SSA. It also depends on space traffic coordination (STC), which refers to the cooperative planning, coordination, sharing of data and information, and on-orbit synchronisation of space activities. It is important to note that the Office of Space Commerce, a US organisation empowered by the Space Policy Directive-3, is establishing an STC capability which is highlighted by their Traffic Coordination System for Space (TraCSS) (Office of Space Commerce, 2024; Trump, 2018). STC is only a subsection of STM. However, both STM and SDA are underpinned by SSA as a foundational capability. There is overlap between SDA and STM (see [Figure 1](#)) as both activities require a lot of the same, or similar, understanding of operations and the space environment.

This is where the root issue is: without clarity around the boundary of STM, there is a level of complexity in monitoring activity on orbit. In addition, without an established STM framework, there is ambiguity about who is responsible or accountable for the STM activities.

2. The role of the military

The role of the military is critical for safeguarding Australia's national security interests which increasingly depend on space-based capabilities. The Air Power Manual (Royal Australian Air Force [RAAF], 2013) defines this role as protecting against 'any threat to the fundamental identity of a nation' and emphasises the scope has expanded

over time to include 'safeguarding national institutions and values; and enhancing the economic and social wellbeing of its people'. The manual also highlights that these interests are increasingly tied to those of our allies.

According to the Air Power Manual, a nation protects these security interests through elements of national power: Strategic geography, Political structure, Economic development, Security and culture, and Military capabilities (RAAF, 2013).. Many of these elements of national power are now underpinned by space-based systems, making space an integral part of these elements of national power (RAAF, 2013). The rapid expansion of space capabilities suggests that the impact to national power will only increase.

The private sector's rapid technological advancement and deployment in space means that many of these elements of national power are controlled by private industry, often in the form of dual use systems. This has blurred the lines between civil and military applications of these technologies, many of which are indispensable to the economic and social wellbeing of a nation, yet this line inevitably introduces vulnerabilities to our national security.

3. Challenges in Space Traffic Management

A vulnerability in space operations exists, at least partially, due to the absence of an STM framework. STM is associated with civil operations and linked closely with the concept of safety of flight. The lack of an agreed international framework means that there is no common system establishing enforceable norms of behaviour or operational procedures, or shaping national regulatory frameworks. In a common analogy to airspace, there is no body equivalent to the International Civil Aviation Organization. While this does not mean there is a vacuum of good behaviours, it does mean there is not always consistency or compatibility between operators let alone between nations globally.

The absence of an STM framework also places additional resource costs onto military operations. The ability to determine what the intentions of satellite operators are, how best to mitigate hazards, and even provide a timely and proportionate response to the actions of another actor can be difficult when many satellites are dual-use and the interpretation of behaviour is not always clearly defined between a potential civil or military role. This ultimately means that the Defence role becomes more complicated and resource intensive.

The lack of any formal STM framework also means that poor behaviour, especially behaviour accepted in previous decades that may be outdated in today's space environment, cannot easily be challenged. As a result, an ability to determine intent is particularly difficult. None of the five key international treaties² highlights how to do this and, from a civil perspective, on-orbit activity has an 'at-fault'

² The treaties commonly referred to as the five UN treaties on outer space are: the Outer Space Treaty, the Rescue Agreement, the Liability Convention, the Registration Convention and the Moon Agreement. While the UN Long Term Sustainability Guidelines and the enhancement to the Registration Convention (62/101) attempt to address shortfalls they are non-binding.

liability element. From a military perspective, determining intent will have the same problem as status quo behaviour in the absence of an STM framework in that it cannot easily determine the difference between malicious intent as compared to poor behaviour, bad design or just bad luck.

3.1. Geostationary parking

The geostationary orbit (GEO) is a cornerstone of modern infrastructure, hosting satellites vital for global communication, weather forecasting and national security. However, its strategic importance has made it a contested space, exemplified by the activities of Russia's Luch Olymp satellite. The Luch Olymp, a known 'inspector satellite,' has a documented history of lingering near allied satellites for extended periods conducting rendezvous proximity operations (RPOs) as close as 20 km to allied satellites (Erwin, 2024), far closer than the average separation between satellites in GEO of approximately 207 km (Roberts, 2022). This raises concerns about the military potential, including eavesdropping, jamming and data interception (Bingen et al., 2023).

The International Telecommunications Union (ITU) allocates orbital slots in GEO and manages spectrum to mitigate interference (Barnes, 2023). However, the mandate of the ITU is insufficient to address many of the challenges concerning the governance of behaviour in GEO. The ITU is limited in the ability to carry out enforcement and does not provide technical oversight of newer technologies. The ITU is also overwhelmed by the emergence of new commercial space actors (Khabazian, 2007) and as a result satellites such as Luch are able to exploit these gaps carrying out operations across GEO with relative impunity.

The absence of a clearer framework to operate within, the growth of the commercial space sector plus the speed at which states are developing their military space capabilities create an environment for satellites, such as Luch, to operate. While the satellites' activities may be clearly non-civilian in nature, the lack of enforceable guidelines means the safety and security of key satellites systems remains vulnerable and simultaneously increase the resources required in monitoring activity and provide proportionate responses to on-orbit activity.

3.2. Debris removal

Active Debris Removal (ADR) is essential for ensuring the sustainability of Earth's orbital environment. However, the dual-use nature of ADR technologies, as demonstrated by Astroscale and China's Shijian 21 (SJ-21) missions, highlights the critical need for a supportive STM framework to mitigate risks to key assets and national security. An effective STM framework would establish clear norms for ADR activities, reduce the ambiguity around on-orbit operations, improve the ability to determine intent, and enable timely responses to potentially belligerent actions.

In December 2024, Astroscale Japan Inc. conducted an RPO coming within 15 metres of a rocket upper stage before aborting the manoeuvre (Astroscale, 2024). This is the closest approach achieved by a commercial company, highlight-

ing the growing opportunity and role of the private sector in ADR. Organisations such as the European Space Agency (ESA) and the United Nations Office for Outer Space Affairs (UNOOSA) have also emphasised the importance of ADR, with missions like ESA's ClearSpace-1 demonstrating international commitment to orbital sustainability (European Space Agency, 2024) and UNOOSA, only in September 2024, reiterating that ADR missions are 'critical for mitigating the growing problem of space debris' (Lafleur, 2024).

In contrast, the Chinese used their SJ-21 satellite to rendezvous with their defunct Compass G2 satellite in December 2021; several weeks later, in January 2022, the SJ-21 grabbed the defunct G2 satellite and towed it into a 'graveyard' orbit (Pardo, 2022). The operation demonstrated China's technical capability but the dual-use nature of ADR raised concerns over the potential militarisation of such capabilities, as noted by ExoAnalytic Solutions which first publicly reported on the operation (Gough, 2022).

Without an appropriate STM framework, ADR technology is not only at a higher risk of being misused but also posing a greater risk to national security (Love, n.d.). Additionally, being able to monitor effectively and provide a timely and proportionate response to activity if it is later deemed belligerent becomes increasingly difficult; without a framework on which to guide and monitor activities, those falling outside what should be acceptable can be hidden by the uncertainty created by the absence of guidelines created by STM.

Addressing the technical, procedural and legal (regulatory) hurdles associated with STM is essential to ensuring ADR technologies support orbital sustainability without compromising global security (May, 2021).

3.3. Conjunctions and orbital safety

There have been instances of a lack of data sharing potentially increasing the risk of on-orbit events. One such example was between the Australian company Skykraft and a Chinese military satellite Yaogan 37 (YG-37) which was predicted to have a miss distance of 'just 100 metres' (Greene, 2023). These two satellites were in low earth orbit (LEO) and met the critical threshold for a conjunction data message (CDM) by the US 18th and 19th Space Defense Squadrons that define a critical threshold as a miss distance less than 1 km and a probability of collision of 1 in 10,000 within 3 days to the time of closest approach (US Space Command, 2023).

This may, on the surface, be a cause for concern because the miss distance was dangerously close: that is until a closer examination of the CDM and the assumptions used by the 19th SDS are made to provide additional context. First, the calculations utilise an assumed satellite size, a necessity given the practical challenges of processing CDMs for a large portion of global operators and the limited availability of accurate size data for all space objects – often obscured under the guise of commercial sensitivities. This often results in conservative conjunction estimates, which may exaggerate the conjunction risk.

The methodology varies from other organisations such as the EU's Space Surveillance and Tracking (EUSST) net-

work or even the UK's National Space Operations Centre (NSPOC). Both organisations use different data inputs and probability calculations that can vary the assessments of miss distances, probabilities and risk assessments. This is coupled with the fact that if either Skykraft or the Chinese had provided their own positional data to the US Space Command, an updated CDM may have been significantly different.

It is important to note that Skykraft acted appropriately and did not engage in behaviours that would be considered risky. However, the absence of a point of contact within the Space-Track system that would allow operators to contact each other to de-conflict the risks associated with any potential collision is a critical limitation with the current systems. The absence of any data sharing agreements between all the parties involved exacerbated the situation and left Skykraft navigating a potentially sensitive event.

Despite all these concerns, an examination of the history of the YG-37 revealed nothing particularly noteworthy about the identified close approach. The YG-37 was not operating in a manner that would be belligerent, contrary to the ABC article published, yet this still was raised to the highest levels in the Australian Defence Force's Space Command, meaning that resources were allocated to assess and report on the risk posed by this incident (Greene, 2023). Based on the increasing number of satellites in LEO, and the forecast growth over the next five years, the number of CDMs are increasing, with an expected corresponding increase in critical conjunctions.

4. Implications

There are many practices, guidelines and ideals that operators and nations are proposing. However, this patchwork provides no enforceable or agreed international framework that everyone can operate. Even the adoption of either US or EU guidelines still leaves room for divergent interpretations under an individual nation's domestic regulatory frameworks.

While there is an absence of an STM framework, there will always be a risk to national security and elements of our national power. Without a clear framework, it becomes difficult to monitor, interpret and effectively respond to on-orbit activities leaving room for misunderstanding and potentially hostile actions.

STM, while clearly in the civil domain, has a clear and direct impact on the military's role. Effective collaboration and support from civil counterparts such as the Australian Space Agency is necessary for national security. A whole-of-government approach to space, and support of both the SDA and STM operations, is essential to ensure policy and capability align and that the Australian military can safeguard national security interests.

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References

- Astroscale. (2024). *Astroscale's ADRAS-J Achieves Historic 15-Meter Approach to Space Debris*. Astroscale. <https://astroscale.com/astroscales-adras-j-achieves-historic-15-meter-approach-to-space-debris/>
- Barnes, J. (2023). *Orbital Slot Rights: Ensuring Order in the Satellite Sphere*. SkySift. <https://skysift.com/orbital-slot-rights-ensuring-order-in-the-satellite-sphere/>
- Bingen, K., Johnson, K., Young, M., & Raymond, J. (2023). *Space Threat Assessment 2023*. Center for Strategic and International Studies.
- Erwin, S. (2024). *Russian spy satellite reportedly continues suspicious maneuvers*. Space News. <https://spacenews.com/russian-spy-satellite-reportedly-continues-suspicious-maneuvers/>
- European Space Agency. (2024). *ESA advances ClearSpace-1 development*. European Space Agency. https://www.esa.int/Space_Safety/ClearSpace-1/ESA_advances_ClearSpace-1_development
- Gough, E. (2022). *A Chinese Space Tug Just Grappled a Dead Satellite*. Universe Today. <https://www.universetoday.com/articles/a-chinese-space-tug-just-grappled-a-dead-satellite>
- Greene, A. (2023). *Details emerge of near collision between Australian and Chinese satellites*. ABC News. <https://www.abc.net.au/news/2023-10-18/space-incident-australia-china-satellite-conjunction/102988030>
- Khabazian, S.-L. (2007). *International Regulation of Access to the Geostationary Orbit: Mission Impossible? AUSTLII*. <https://www.austlii.edu.au/au/journals/CommsLawB/2007/23.pdf>
- Lafleur, A. (2024). *Advancing Space Sustainability: Insights from UNOOSA at the ITU Forum*. Space Insider. <https://spaceinsider.tech/2024/09/10/advancing-space-sustainability-insights-from-unoosa-at-the-itu-forum/>
- Love, T. (n.d.). *Dual-Use Digest: Active Debris Removal*. Trinity Space Technologies. <https://www.trinity-st.com/blog/dual-use-digest-active-debris-removal>
- May, C. (2021). *Triggers and Effects of an Active Debris Removal Market*. Center for Space Policy and Strategy. <https://csp.aerospace.org/sites/default/files/2021-08/adr%20paper.pdf>
- Office of Space Commerce. (2024). *TraCSS Listening Session: Updated TraCSS Data Sharing Policy*. Office of Space Commerce. <https://www.space.commerce.gov/tracss-listening-session-updated-tracss-data-sharing-policy/>
- Pardo, E. (2022). *Chinese "space cleaner" throws old satellite away*. DW. <https://www.dw.com/en/chinese-space-cleaner-spotted-grabbing-and-throwing-away-old-satellite/a-60658574>
- Roberts, T. (2022). *Unusual Behavior in GEO: Luch (Olymp-K)*. Aerospace Security: A Project of the Center for Strategic and International Studies. <https://aerospace.csis.org/data/unusual-behavior-in-geo-olymp-k/>
- Royal Australian Air Force [RAAF]. (2013). *The Air Power Manual*. Air and Space Power Centre. Commonwealth of Australia.
- Skinner, M., Oltrogge, D., Strah, M., Rovetto, R., Lacroix, A., Anil Kumar, A., Grattan, K., Francillout, L., & Alonso, I. (2022). *Space Traffic Management Terminology*. Aerospace Corporation. <https://doi.org/10.1016/j.jsse.2022.09.001>
- Trump, D. (2018). *Space Policy Directive-3, National Space Traffic Management Policy*. <https://trumpwhitehouse.archives.gov/presidential-actions/space-policy-directive-3-national-space-traffic-management-policy/>
- United Nations General Assembly. (2007). *Resolution adopted by the General Assembly: 62/101 Recommendations on enhancing the practice of States and international intergovernmental organizations in registering space objects*. United Nations General Assembly. https://www.unoosa.org/pdf/gares/ARES_62_101E.pdf
- United States Space Command. (2023). *Spaceflight Safety Handbook for Satellite Operators*. https://www.space-track.org/documents/SFS_Handbook_For_Operators_V1.7.pdf
- UNOOSA. (2024). *Space Law Treaties and Principles*. United Nations Office for Outer Space Affairs. <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html>