Australian Government

Department of Defence

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SPACE POWER EMANUAL

LIGHT-SPEED EDITION

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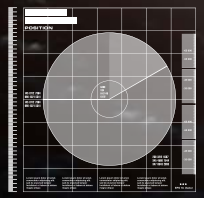


DEFENCE SPACE COMMAND

CONTENTS

Space Power eManual: 1st Edition, 2022

INTENDED PURPOSE

The *Space Power Manual* is the foundational Defence reference on the employment of space power, complementing and supporting all levels of Defence education and doctrine.

The *Space Power eManual*'s core purpose is to support the training and education of those who will employ and enable space power. The eManual presents the theory of space power and introduces the space power contributions model. The eManual also describes the practical aspects of its employment and integration through space power roles and mission areas, consistent with the space power considerations of Defence's major Combined Space Operations partners. The eManual introduces the terminology, definitions and concepts that underpin space power and situate its employment within the Australian strategic context; it clearly explains that space power is not an end in or of itself — its purpose is to achieve national objectives.

IMPORTANCE OF SPACE

The immutable nature of the space domain provides advantages to humanity that are unattainable from other physical domains. These advantages have permeated into almost all aspects of human society, from the celestial navigation techniques developed and employed by the very first seafarers, to the modern reliance on space-based positioning, navigation and timing (PNT) systems.

Like all modern nation-states, Australia has become reliant on space; from the simple networked way of life Australians lead, to the national and global infrastructure of the world's economy. Access to space systems and space-derived information and data has become crucial to Australia's social, economic and national security interests, and place in the world.

Expansive exploitation of this domain has given rise to an expectation of continuous connection. Space services are ubiquitous, persistent and omnipresent; ideally suited to meeting the connection and information needs of Australian society.

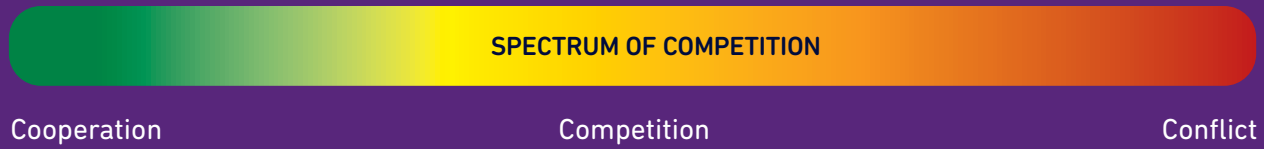
For the military, access to space systems and services is critical to enabling military capabilities and activities. The space domain provides, amongst other key services: positioning, navigation and timing; force protection; intelligence gathering and targeting ability; over-the-horizon and long-range communications and command and control. Defence recognises the importance of this environment as both an essential enabler of military terrestrial operations and an operating domain in its own right.

The space domain and its component capabilities, services and technologies are critical enablers of the ADF, underpinning Australia's ability to project military force across the spectrum of conflict (figure 1). Defence recognises the degradation or restriction of space capabilities by an adversary, or a natural phenomena that restricts the use of space, would threaten the ADF's operational capability. This would impede Defence from supporting Government decision-making.

Figure 1 – Spectrum of conflict

SPECTRUM OF COMPETITON

The framework used to describe the complex range of geostrategic interactions of national power that range dynamically between cooperation, competition and conflict.



THE SPACE DOMAIN

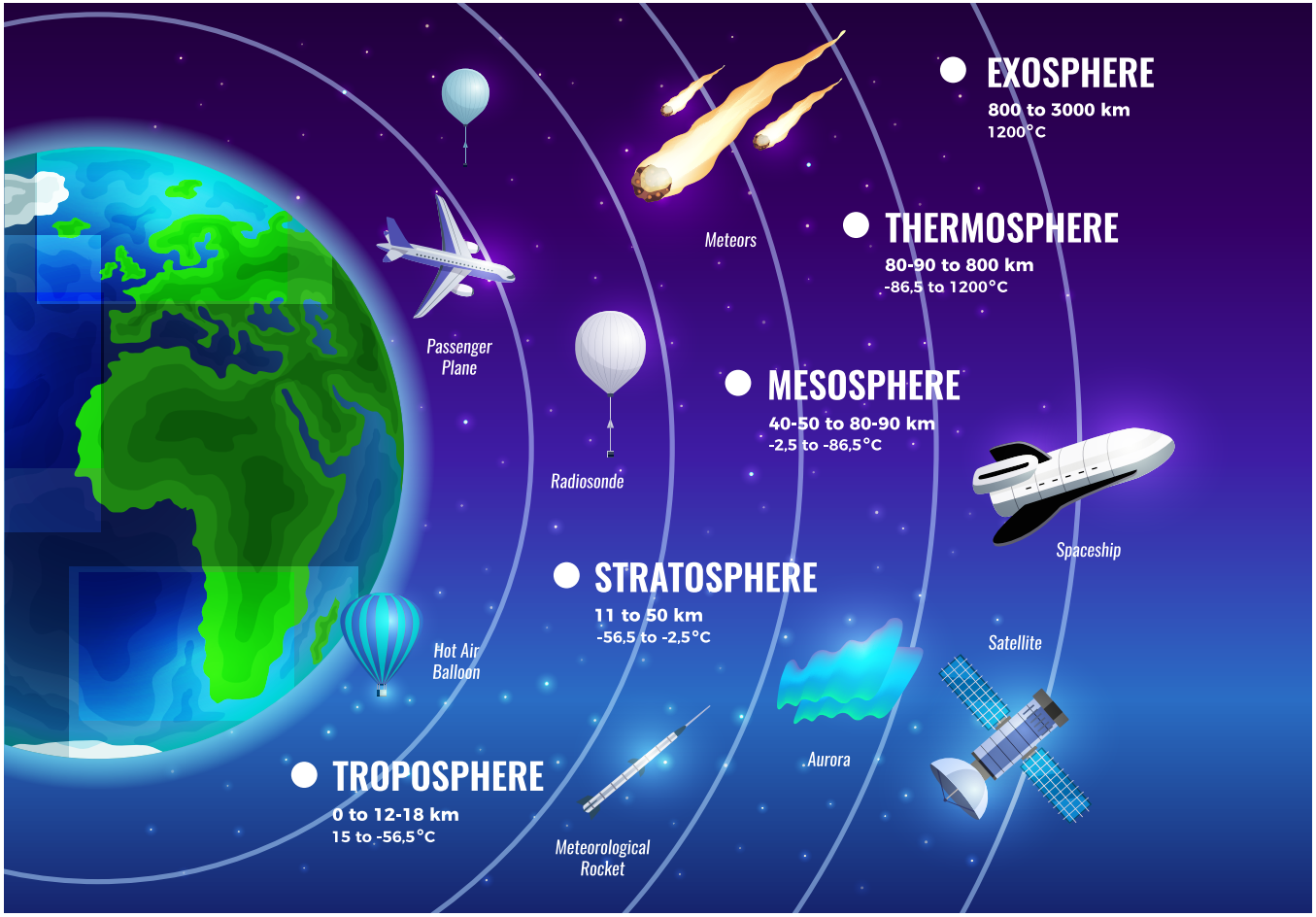
Understanding the nature of the space domain is necessary in order to understand the complex utilisation of space in a space power context and how threats to the domain may manifest.

PHYSICAL DESCRIPTION

As a physical dimension, *space* is the expanse of volume beginning at 100km altitude above the surface of Earth and which does not end[1]. Space is generally accepted as a global commons.

This physical expanse of space is dominated by phenomena not ordinarily experienced on the surface of the Earth or any other physical domain. The influence of gravity, the presence of radiation and charged particles and the lack of atmosphere in the state of vacuum are all unique aspects of the space domain.

SPACE IS GENERALLY ACCEPTED AS A GLOBAL COMMONS



1. Australia accepts that space commences at 100km above sea level but this is not universally accepted.

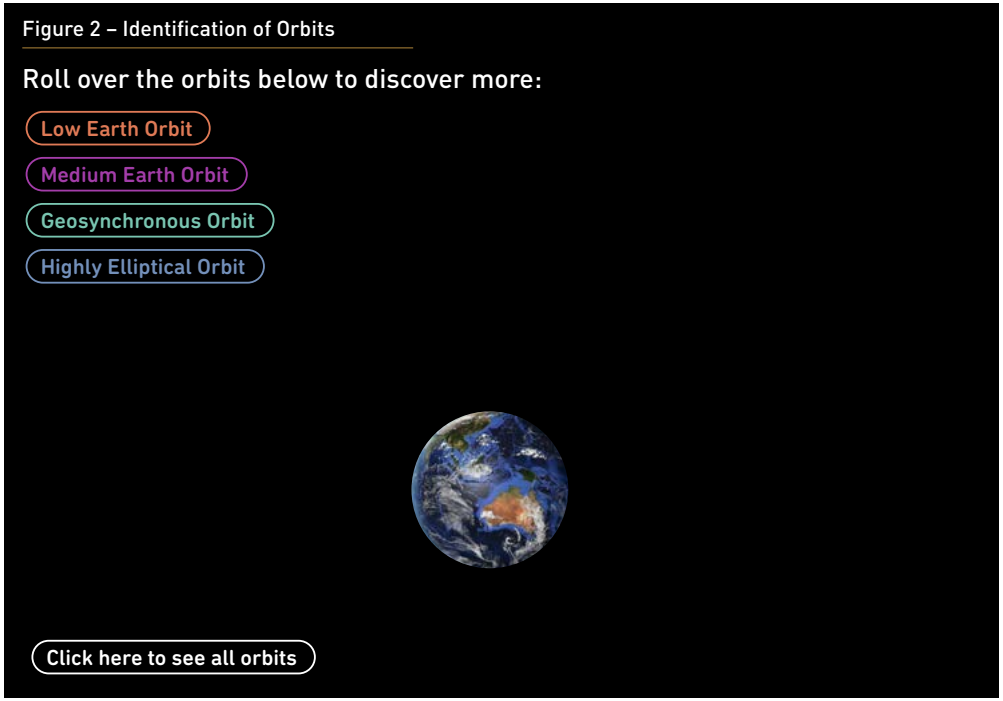
ORBITS

Within the context of modern space power, we can define the space domain using an orbital regime taxonomy. The nature of the gravity well the Earth produces and the way humankind interacts with it allows for objects in orbit around Earth to be simply and collectively grouped. The most common orbits are described (figure 2) by the average altitudes and shapes of each orbital regime.

ORBIT TYPE	ALTITUDE	COMMON USE
Low Earth Orbit (LEO)	100km – 2000km	ISR, Environmental Monitoring, Communications, Human spaceflight
Medium Earth Orbit (MEO)	2000km – 35785km	PNT, Communications
Geosynchronous Orbit (GEO)	Average of 35785km	Communications, Missile Warning, ISR, Environmental Monitoring
Highly Elliptical Orbit (HEO)	Approximately 1000km to 40000km	High Latitude Communications, Missile Warning and ISR

There are numerous special cases of orbital regimes, spacecraft missions and activities that do not fit this taxonomy. Details of these special cases are addressed in space fundamental training courses.

Figure 2 – Identification of Orbits



SPACE SYSTEM SEGMENTS

Descriptions of the space domain should not be limited to its purely physical nature nor simply as a description of orbital regimes and the satellites that inhabit it. Instead, the activity occurring in and through space, predominately caused by human endeavour on Earth, can be described through the systems that enable the activity. Defence uses the concept of space system segments to do this. These segments are identified on the next page and visually represented in Figure 3.

Space segment
This is the spacecraft in the system – either individual or a constellation. The satellite bus provides the structure and supporting subsystems – including power, communications, thermal control and attitude/orbit control – to support the payload (the equipment that actually performs the spacecraft's mission). A single satellite may carry multiple payloads and payloads may serve many customers.

User segment
User segment capabilities can be hand-held, or mounted in vehicles, on maritime vessels and in aircraft.

Link segment
The link segment is the communications network that connects the other segments and includes both the electromagnetic spectrum and cyber considerations.

Ground segment
Differentiated from the user segment, the ground segment is the ground-based infrastructure and associated services or support mechanisms and personnel critical to the functioning of the space system, such as satellite monitoring and control, uplink and downlink ground stations and mission operations centres.

These four segments can be found interspersed throughout all five operating domains and, when used in real world operations, the definitions of each segment can be porous and malleable. It is the human element that applies understanding to the complexities of operations.

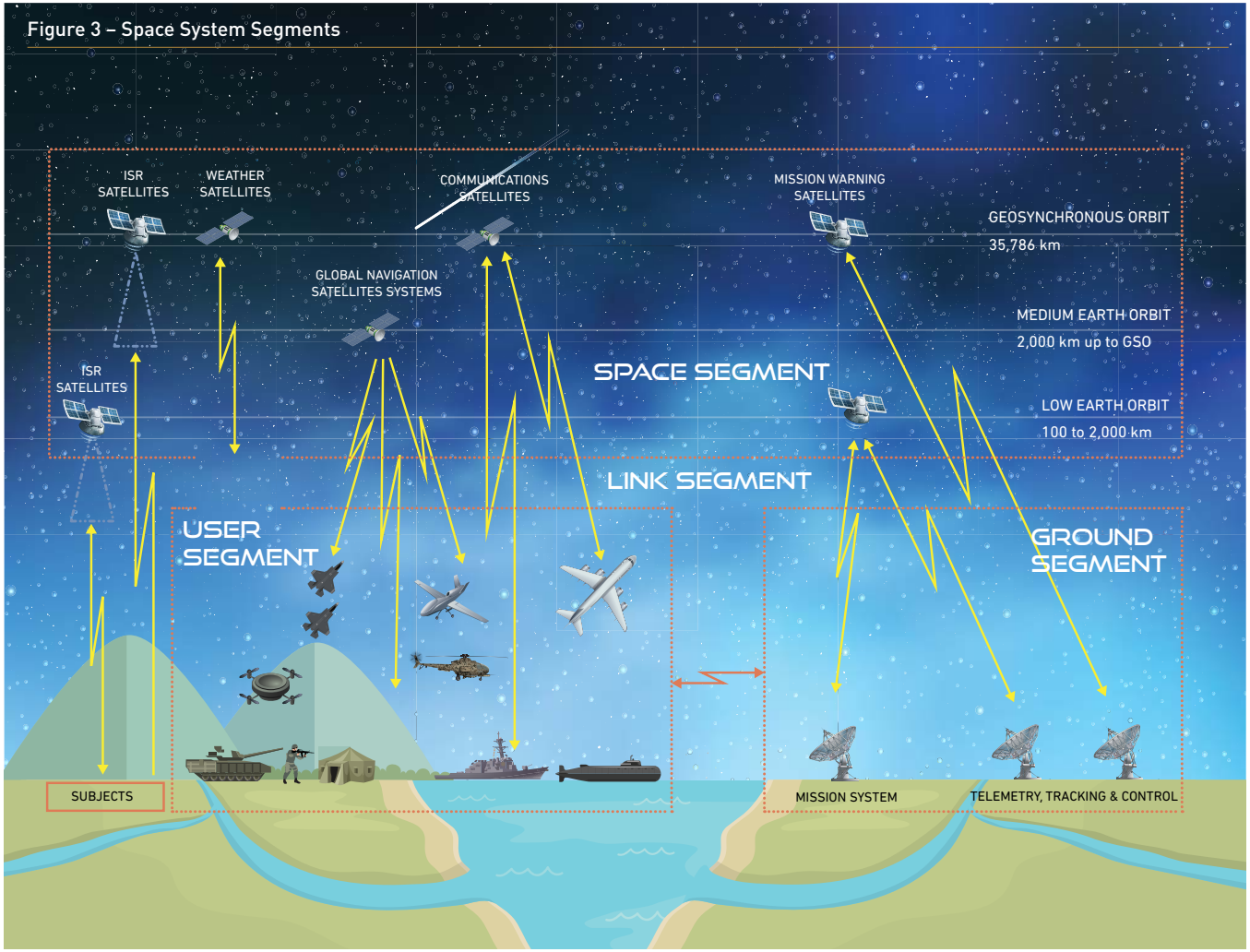


Figure 3 – Space System Segments

HUMAN DIMENSION

An appreciation of the human-centric attributes of the space domain are vital in understanding the space domain. These include the:

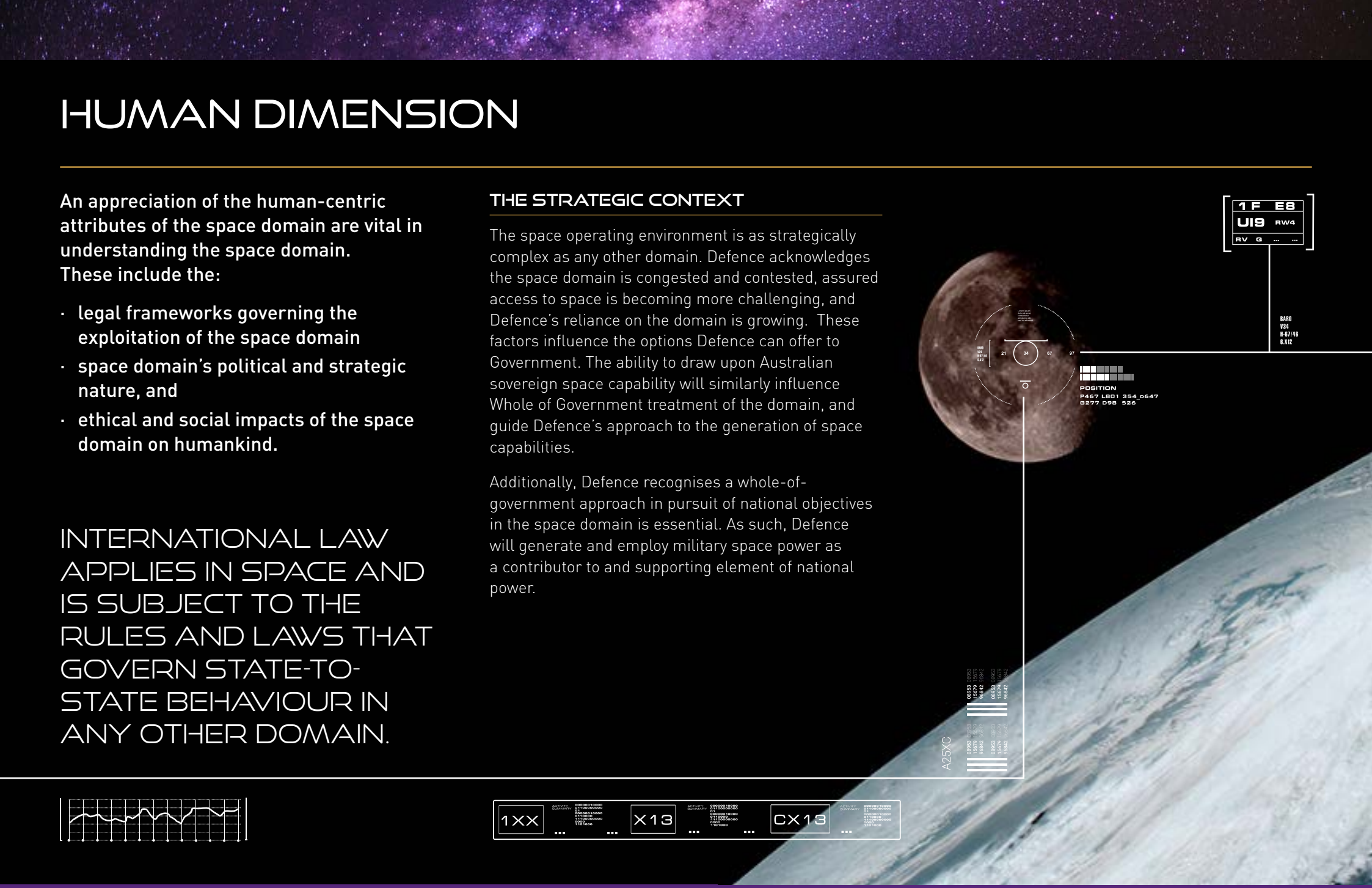
- **legal frameworks governing the exploitation of the space domain**
- **space domain's political and strategic nature, and**
- **ethical and social impacts of the space domain on humankind.**

INTERNATIONAL LAW APPLIES IN SPACE AND IS SUBJECT TO THE RULES AND LAWS THAT GOVERN STATE-TO-STATE BEHAVIOUR IN ANY OTHER DOMAIN.

THE STRATEGIC CONTEXT

The space operating environment is as strategically complex as any other domain. Defence acknowledges the space domain is congested and contested, assured access to space is becoming more challenging, and Defence's reliance on the domain is growing. These factors influence the options Defence can offer to Government. The ability to draw upon Australian sovereign space capability will similarly influence Whole of Government treatment of the domain, and guide Defence's approach to the generation of space capabilities.

Additionally, Defence recognises a whole-of-government approach in pursuit of national objectives in the space domain is essential. As such, Defence will generate and employ military space power as a contributor to and supporting element of national power.



LEGAL ASPECTS

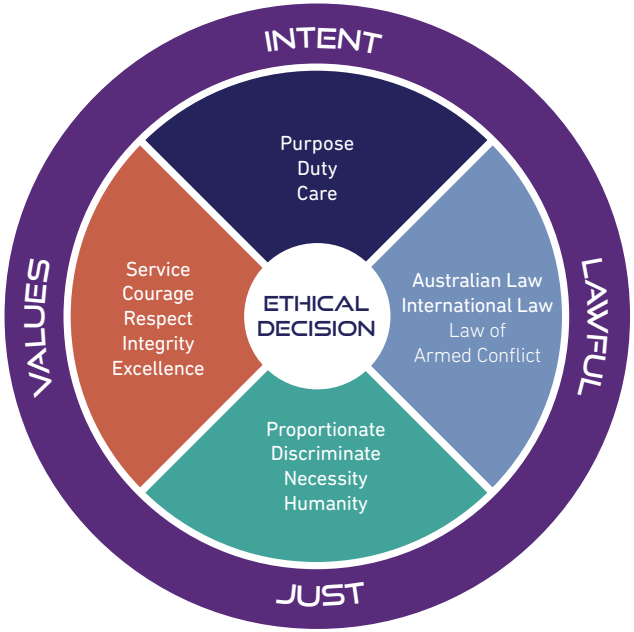
Space is not a lawless domain. International law applies in space and is subject to the rules and laws that govern state-to-state behaviour in any other domain. Space is a global commons and therefore not subject to national appropriation by claim of sovereignty. Importantly, this translates to the concept of legal overflight unhindered by political boundaries. This concept is captured and enshrined within the Outer Space Treaty, the foundation of international space law*.

ETHICAL AND SOCIAL CONTEXT

Within any legal frameworks as they may exist, members of the ADF are part of the profession of arms, regardless of the domain in which they may operate and produce effects. The ADF will regulate its conduct in the space domain within the legislative and policy frameworks created by Government. This defines what is legally right and wrong, and is the instrument of trust that allows the ADF to perform actions otherwise restricted in society.

Moral and social obligations exist to temper, limit and guide actions in the space domain; some of which are entwined in the Outer Space Treaty and others within the longstanding treaties and agreements governing the behaviours of militaries and nation states. These obligations may further limit what is legally allowed. The ADF acknowledges this and will rely upon the ADF's Ethical Framework and decision-making model to add social and moral value to decision-making in the space domain (figure 4).

Figure 4 – ADF's Ethical Framework



*There are many other legal frameworks that are applicable to space, including: Convention on International Liability for Damage Caused by Space Objects, Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Convention on Registration of Objects Launched into Outer Space, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies and Agreement on Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes (INTERCOSMOS).

THREATS TO SPACE

Space is not a benign environment; either physically, politically, or as a finite and economically exploitable resource. A wide range of threats to the space domain exist from the artificial, to the natural, within the electro-magnetic spectrum and cyber domains, terrestrially and within the economic endeavours that utilise space.

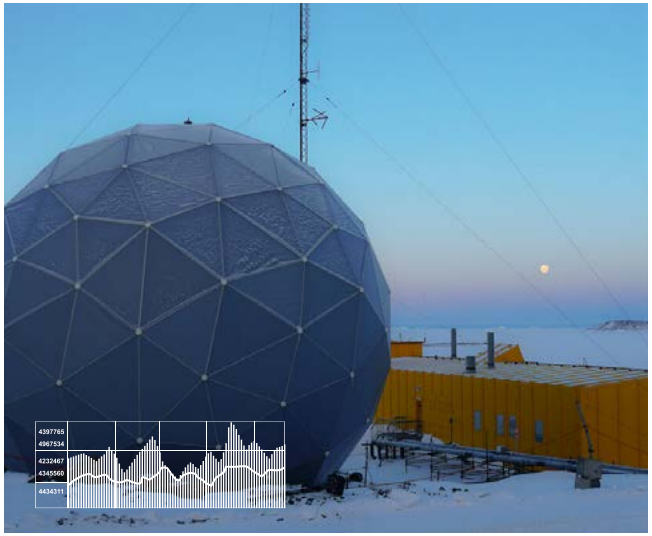
THE NATURAL ENVIRONMENT AND SPACE DEBRIS

The space domain is a naturally hostile environment. Spacecraft need to be specifically designed to operate in a vacuum and protect sensitive components from charged particles and radiation, and effects from space weather. The increasing problem of space debris further complicates the military use of space. Both human-made orbital debris and natural micro-meteoroids may collide with spacecraft and damage or destroy components. For spacecraft travelling at extreme velocities, collisions with even small pieces of orbital debris can cause considerable damage.

COMPETITORS AND COUNTER-SPACE CAPABILITIES

Defence acknowledges space is an operational domain where adversarial conduct does occur. Capabilities and actions, both active and passive, can be employed by competitors to interfere with and influence satellites. These actions can range from the physical through hit-to-kill weapons, non-kinetic effects through electronic attack capabilities against the electro-magnetic spectrum, and can manifest in any domain.

A WIDE RANGE OF THREATS TO THE SPACE DOMAIN EXIST FROM THE ARTIFICIAL, TO THE NATURAL...

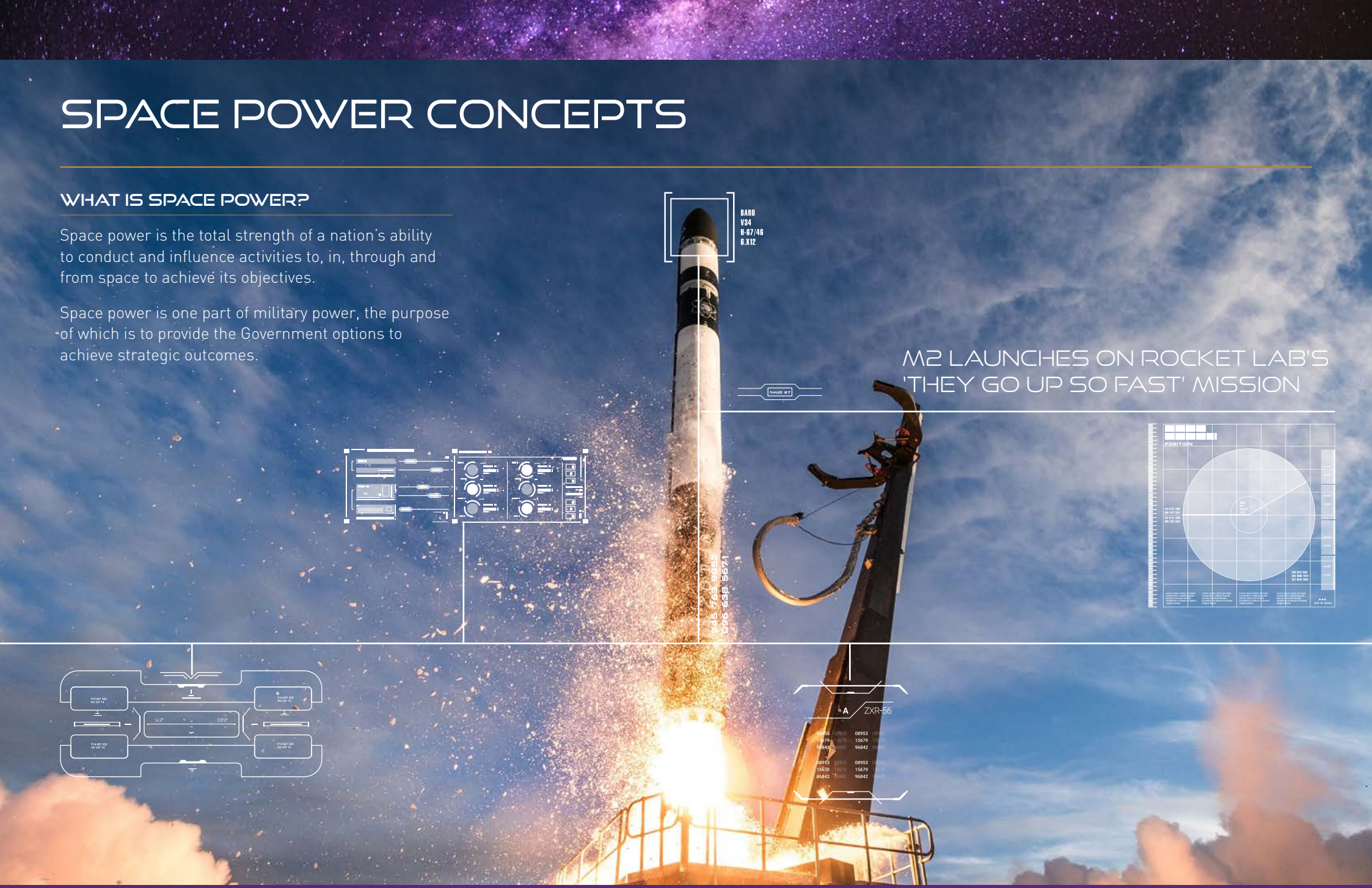


SPACE POWER CONCEPTS

WHAT IS SPACE POWER?

Space power is the total strength of a nation's ability to conduct and influence activities to, in, through and from space to achieve its objectives.

Space power is one part of military power, the purpose of which is to provide the Government options to achieve strategic outcomes.



SPACE POWER CHARACTERISTICS

Parallels can be drawn between the air and space domains; endeavours in each look to exploit the advantages offered by the vertical dimension. The following are characteristics that identify the uniqueness and value of space. **Roll over the icons below to discover more:**

GLOBAL PERSPECTIVE, as a space power characteristic – the greater field of view and extended horizon of the operational environment obtained by virtue of a platform's orbital altitude.

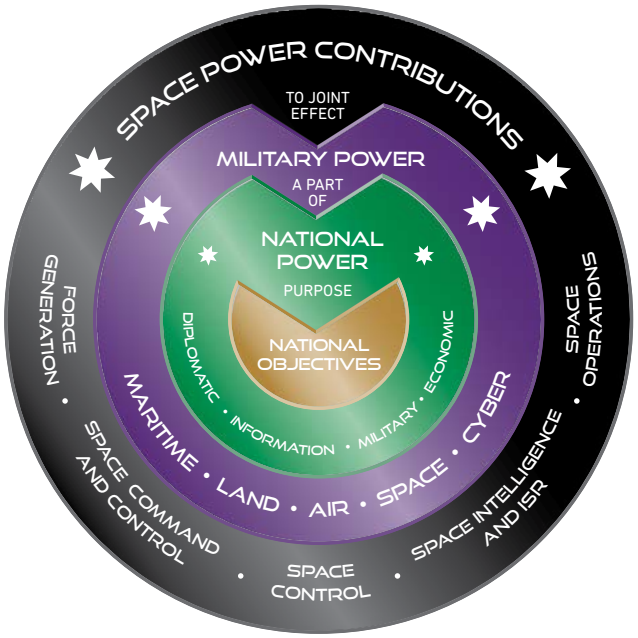
REACH, as a space power characteristic – the distance over which a military capability or system can contribute to desired effects.

ADAPTABILITY, as a space power characteristic – the ability of space systems to alter functionality in anticipation of, or response to, changes to missions, threats and natural environments, either by flexible design, internal adjustment or planned functional modification.

SPACE POWER CONTRIBUTIONS FRAMEWORK

The space power contributions framework is designed to open up thinking on the possible application and utility of space power. It aims to ensure that Defence space power, as a part of military power, is continually enhanced to best support national objectives.

Defence space power contributes to joint effects in support of whole-Government-efforts through force generation, space command and control, space control, space intelligence and ISR and space operations.



FORCE GENERATION

The joint force conducts Defence operations by bringing together the best array of available capability options, across all of the operational domains.
The Service Chiefs, through the authority granted to them by CDF, are accountable for the force generation of capabilities and for preparing them to contribute to the joint force.

Force generation contributions from the space domain include, but are not limited to; community engagement, international engagement, space systems engineering, and force preparation, education and training. Generating and preparing forces will always be the cornerstone of military power, with the central element being people. Space power is but one element that contributes to this whole-of-Defence enterprise endeavour.

SPACE COMMAND AND CONTROL

Command and control is means for the exercise of authority over, and lawful direction of, assigned forces. It unites the people, systems and processes used to make policy, develop capability, enact operational decisions and prepare forces for operations to achieve national objectives.

Command and Control contributions from the space domain include, but are not limited to; theatre space command and control, space battle management, satellite communication (SATCOM), and positioning, navigation and timing (PNT) capabilities.

Space command and control utilises a complex system that involves personnel, platforms, information management technology, communications networks and decision support and operational environment awareness tools.

SPACE CONTROL

Space control involves offensive and defensive operations to ensure freedom of action in space by defeating efforts to interfere with or attack Australian or allied space systems and, when directed, deny space services to a competitor. Space control activities may occur in any operating domain and are comprised of offensive space control, defensive space control, space electronic warfare and the aspects of navigation warfare that deal with space based PNT.

Space control contributions need to be considered across all operational domains. It is essential for joint planners to harmonise effects across all domains to achieve the desired outcome via the most effective means for each specific operational context. It is critical to note that space control may be conducted with or against any of the space system segments — not only space, but also ground, link or user segments.

SPACE INTELLIGENCE AND ISR

Intelligence is an enduring function carried out through constant activity across all domains as part of a Whole of Government enterprise. The Defence Intelligence Enterprise (DIE) comprises all activities conducted by collection elements and by intelligence organisations that process and exploit data to produce fused intelligence products.

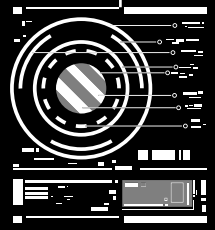
Effective space intelligence enables decision superiority over an adversary with respect to the operational use of the space domain, providing the analysis of available information required to enable commanders and operators to make better informed decisions at a tempo faster than the adversary does.

There is a link between intelligence, and Intelligence, Surveillance and Reconnaissance (ISR) activities. ISR is not part of the intelligence cycle but supports the collection phase of that cycle. ISR synchronises and integrates the direction, planning and operation of collection capabilities and processing, exploitation and dissemination systems. ISR links to the collection phase of the intelligence cycle.

Space intelligence contributions synchronise and integrate the planning and operation of sensors, assets and systems in direct support of current and future operations. Space intelligence specialists are a critical part of any joint force.

SPACE OPERATIONS

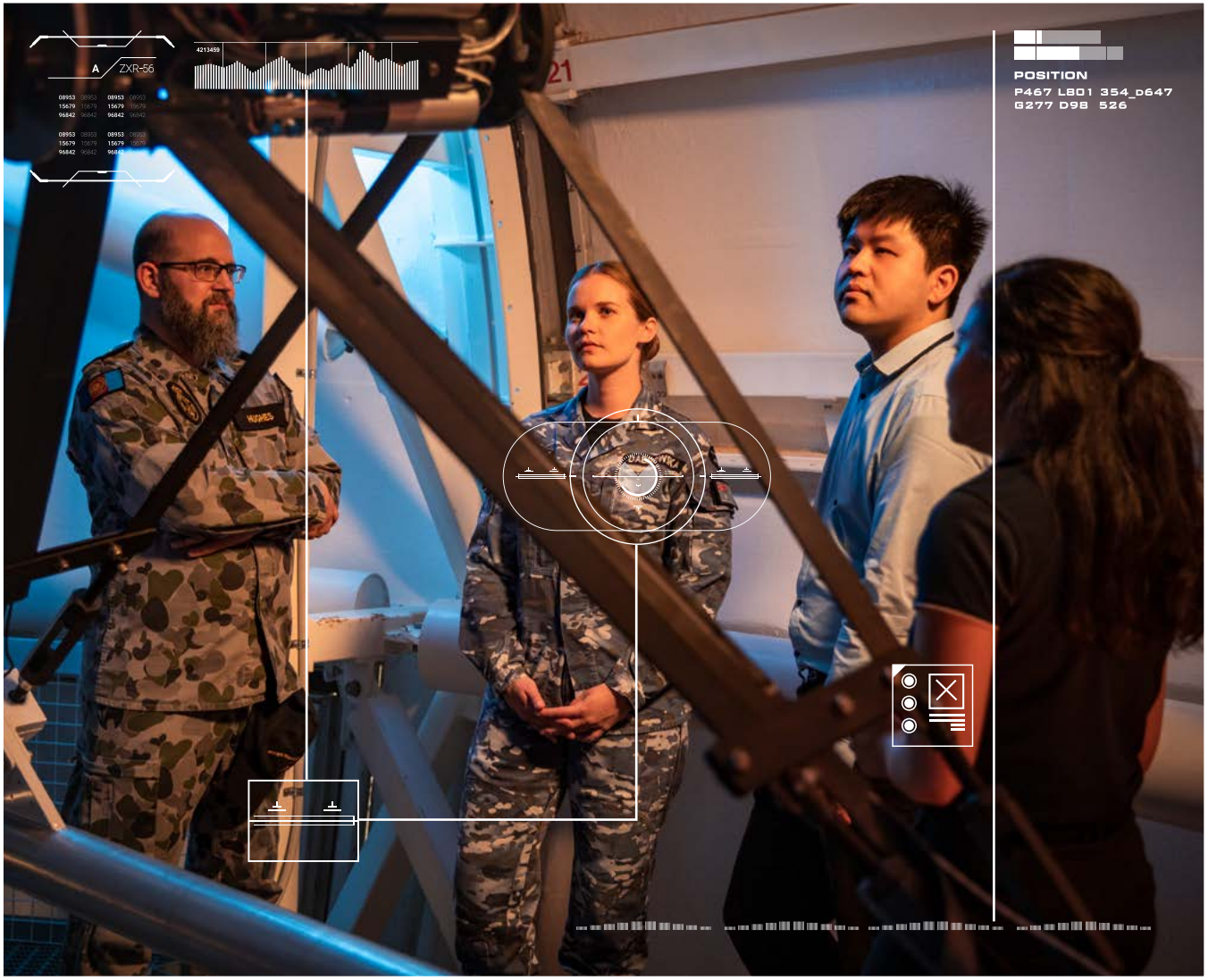
As is the case for other domains, the provision of space capabilities requires relevant systems to be deployed and sustained. Space operations include space mobility and logistics to launch, sustain and recover space systems—spacecraft operations to manoeuvre, configure and operate spacecraft on orbit.



RELATIONSHIPS BETWEEN THE SPACE POWER CONTRIBUTIONS

While we have presented the space power contributions as different entities, they should never be viewed as standing alone. The space power contributions framework is not intended to create arbitrary divisions that result in capability stovepipes nor an implied hierarchy. To be most effective, each space power contribution must be integrated with the others, and with their counterparts in other domains.

The space power contributions framework is designed to open up thinking on the possible employment of space power in support of national objectives. The reader is encouraged to reflect on how each contribution presented could be applied to shape, deter and respond as part of the joint force and in support of Whole of Government efforts. To support combined space operations alignment with allies and international partners, the implementation of space power contributions is addressed through the lens of space power roles and space mission areas that are addressed in the following section.



SPACE POWER ROLES AND SPACE MISSION AREAS

Defence considers the space power roles as efforts that encapsulate the core motivations for military engagement in the space domain. This can be contrasted with the space mission areas that encapsulate the core tasks of the space power efforts that result in the roles being fulfilled.

SPACE POWER ROLES

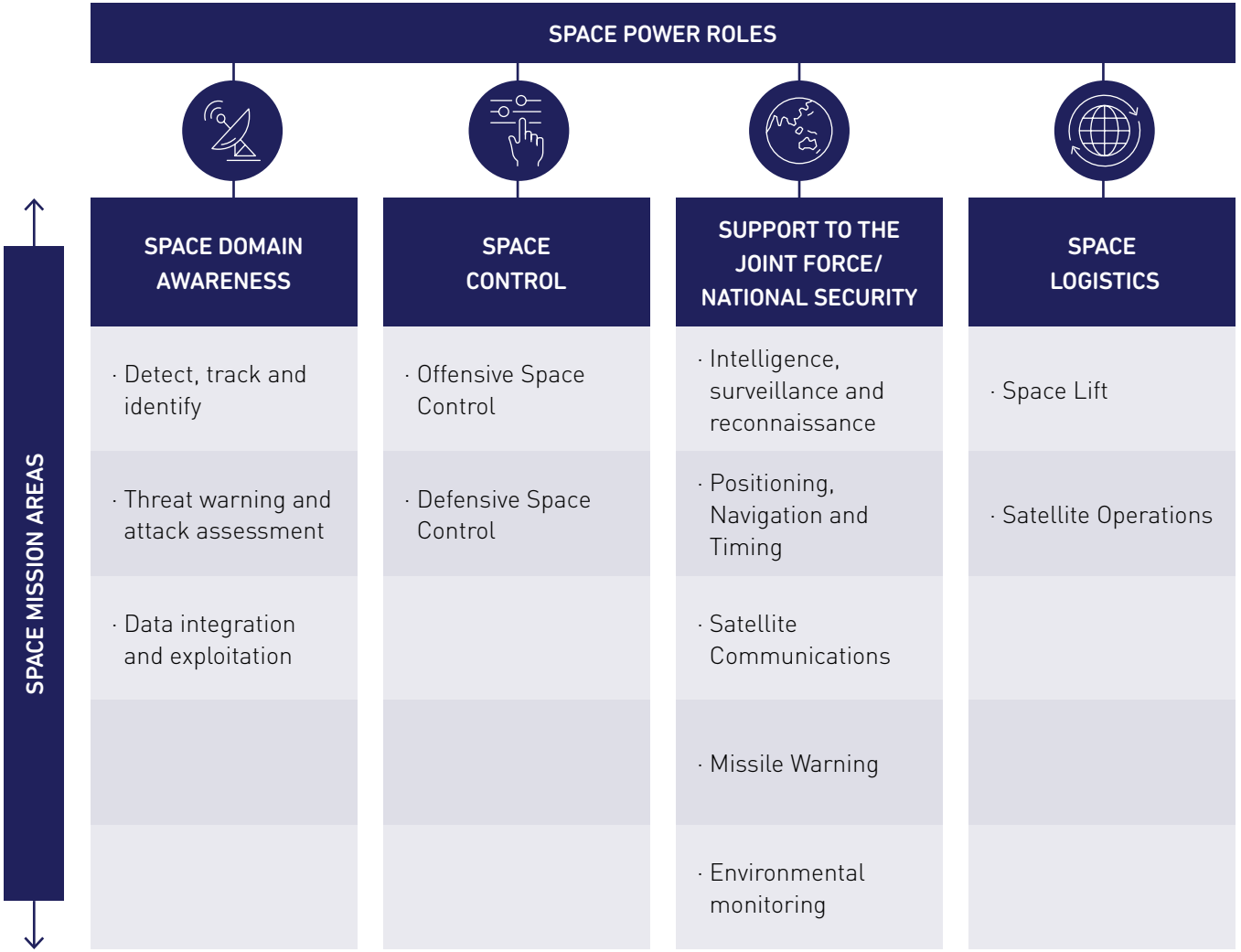
Defence recognises four distinct space power roles, within which the ADF will conduct space operations:

- Space domain awareness
- Space control
- Support to the Joint Force and national security
- Space logistics

Freedom of action and the ability to directly influence adversaries is enabled by space control capabilities and underpinned by and enabled through space domain awareness. Operational effectiveness across all domains is enhanced by space support to the joint force and national security, and access to space and satellite operations is enabled by space logistics.

Given the complexities, interdependencies and coordination required to effectively employ space power concepts, a common understanding of space power roles with partners is advantageous.

Figure 5 – Relationship of Space Power Roles and Space Mission Areas



SPACE MISSION AREAS

In support of the space power roles, the ADF conducts space operations within the following space mission areas (Figure 5). **Roll over the icons below to discover more:**

Positioning, navigation and timing

Space-based ISR

Satellite communications

Space domain awareness

Missile warning

Space weather

Satellite operations

Space control

Space lift

HOW WE INTEND TO OPERATE

Throughout this document the space domain has been discussed in a singular fashion; definable by physical space, utility and its unique nature. The ADF concept of operational domains is used solely as a way to organise, understand, and coalesce thought and practice of military endeavour. In practice, as with the other operational domains, the space domain is interdependent on the other domains. The space domain is, by its functional nature, a joint domain. The ADF's doctrinal approach to multi-domain warfare will drive practical implementation.

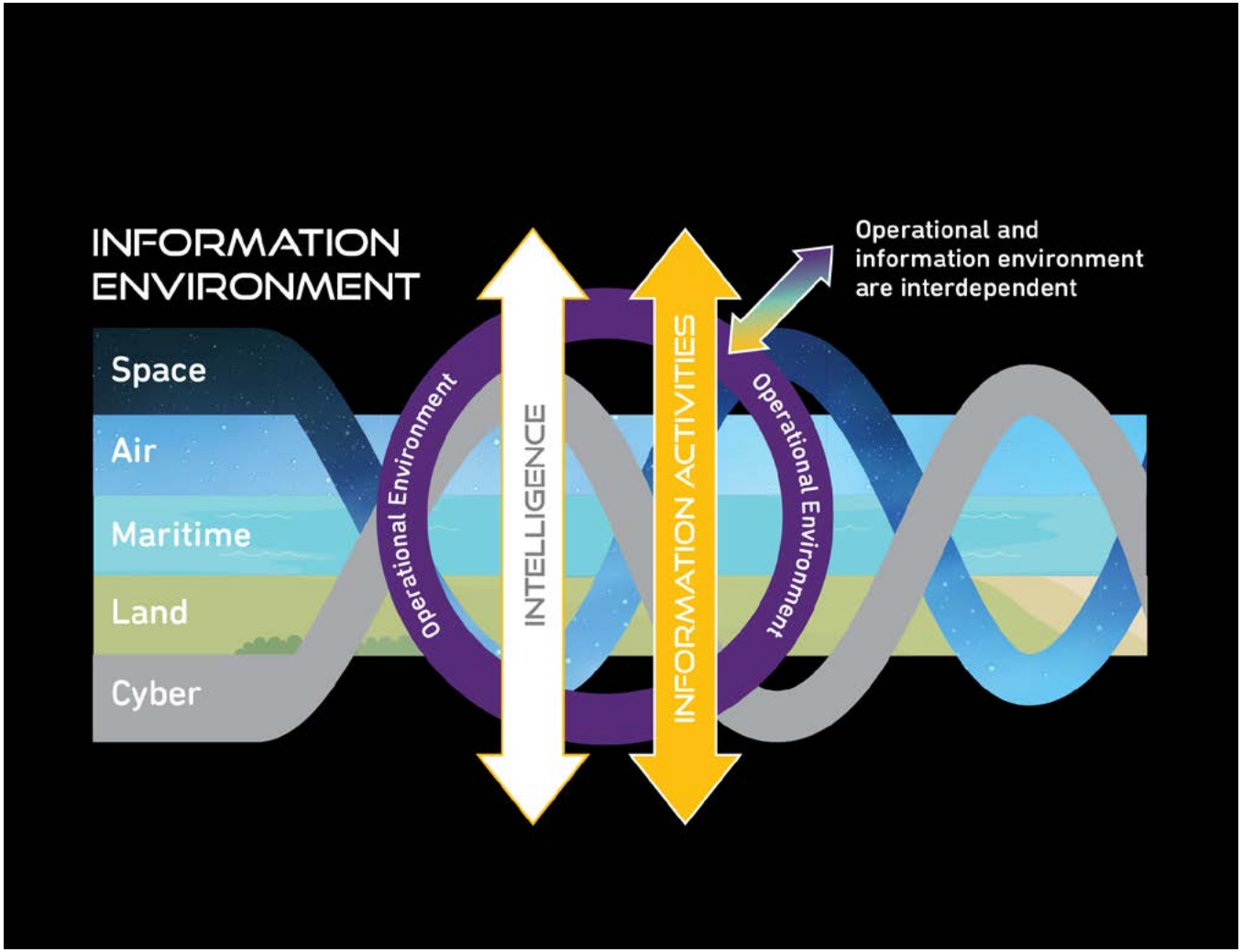
THE SPACE DOMAIN IS, BY ITS FUNCTIONAL NATURE, A JOINT DOMAIN.

SPACE POWER COORDINATION

The military is but one instrument of national power. The military use of space requires integration across the operational environment and across all phases of the spectrum of warfare to achieve the diplomatic, information, military and economic outcomes required by Government.

Space enables operations in other domains to be expeditionary, connected, informed, efficient and lethal. Space systems operating in the space domain may have segments in all of the domains – space segment (in the space domain), link segment (in the cyber domain), ground segment, (typically in the land and cyber domains) and user segments (in all of the domains).

Ultimately, the aim for the ADF is a joint force that can achieve the highest level of interoperability across all operational domains.



NATIONAL SPACE POWER

The following sections identify significant contributors to Australian space power.

Space Domain Lead - Chief of Air Force

Chief of Air Force is designated the Space Domain Lead for Defence with responsibilities identified in a charter from the Chief of the Defence Force. Beyond capability lifecycle responsibilities, Chief of Air Force has a broader mandate of foundational responsibility including domain leadership, supporting the development of space doctrine and strategy, space workforce management and growth and engagement with industry.

Defence Space Command

The Space Domain Lead executes their responsibilities through Defence Space Command (DSpC) that has been established to effectively and efficiently manage Defence space equities. DSpC provides focused leadership and operational coordination to deliver capabilities in support of the joint force and national security. Commander Defence Space Command is assigned Technical Authority for all operational Defence space capabilities.

DSpC will coordinate space support across multiple theatres and across all phases of conflict from peace to war and provide space forces and expertise to Joint Operations Command. These operational efforts will be coordinated by the Australian Space Operations Centre (AUSSpOC), which is permanently force assigned to Commander Joint Operations (CJOPS).

> WATCH VIDEOS

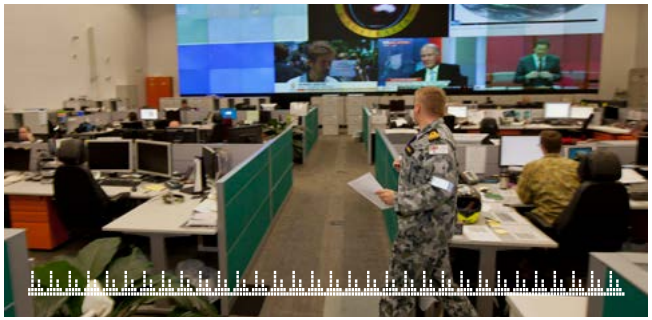
The Australian Space Agency

The Australian Space Agency is the Government body charged with managing civil space policy and activity. Strategic decision-making regarding the use of space, industry potential and development, international cooperation and carriage of the *Australian Civil Space Strategy* are the purview of the ASA.

The ASA is key to generating an integrated Whole of Government approach to a national space enterprise and a national security approach to space. This approach will account for the various Government organisations that contribute to space power elements including Geoscience Australia, Department of Foreign Affairs and Trade, Bureau of Meteorology, and Commonwealth Scientific and Industrial Research Organisation.

The Australian Space Operations Centre

The AUSSpOC is the focal point for the generation of space domain awareness, planning and execution of space control measures and integration and coordination of other space operations in support of the joint force. The AUSSpOC is permanently force assigned to CJOPS, through Director General Air and Space, the environmental commander.



Joint Operations Command

Theatre command of assigned space forces resides with Commander Joint Operations Command (CJOPS). CJOPS delegates command and control responsibilities of space forces to Director General Air and Space; the subordinate theatre commander.

WE MUST BE ABLE TO GENERATE SPACE POWER TO SUPPORT THE JOINT FORCE, WHOLE-OF-GOVERNMENT, ALLIES AND INTERNATIONAL PARTNERS.

M.E.G. HUPFELD AO DSC, AIR MARSHAL CHIEF OF AIR FORCE SPACE DOMAIN LEAD

International coordination

Coordination with allies and international partners is critical to the success of Australia's space domain operations. Australia has limited sovereign space capabilities and leverages agreements with the United States, other international partners and commercial entities for many of its required space capabilities. These agreements include Australia's role in the Wideband Global Satellite (WGS) constellation and the hosting of space domain awareness capabilities at the Harold E. Holt Naval Communications Station. Planned and future space-related projects will deliver capabilities that will enhance Australia's sovereign space capabilities in line with Government direction and intent.

The Combined Space Operations (CSpO) initiative Memorandum of Understanding provides the framework for Five Eyes plus France and Germany international cooperation, coordination and integration in a space context. Partnering with the US-led coalition operation, Operation OLYMPIC DEFENDER (OOD) is the key pathway for practical space operations coordination. Operation DYURRA is Australia's contribution to OOD and addresses space operations support to Joint Operations Command for peacetime activities. This arrangement formalises coalition linkages in the space domain for the conduct of space operations, and allows for day-to-day coordination efforts between the coalition space operations centres such as the AUSSpOC, United Kingdom Space Operations Centre, Canada Space Operations Centre and the United States based Combined Space Operations Center.

CSpO
COMBINED SPACE OPERATIONS

HOW WE WILL GROW SPACE POWER

Space power as a concept is not stationary. As the strategic space environment, space technology and application skills evolve, so too will understanding of the space domain and space power.

Defence will account for this through various lines of effort aimed at achieving assured access to space, and integrating military effects across the operating domain with allies, international partners and with the support of Australian space industry.

AS THE STRATEGIC SPACE ENVIRONMENT, SPACE TECHNOLOGY AND APPLICATION SKILLS EVOLVE, SO TOO WILL UNDERSTANDING OF THE SPACE DOMAIN AND SPACE POWER.

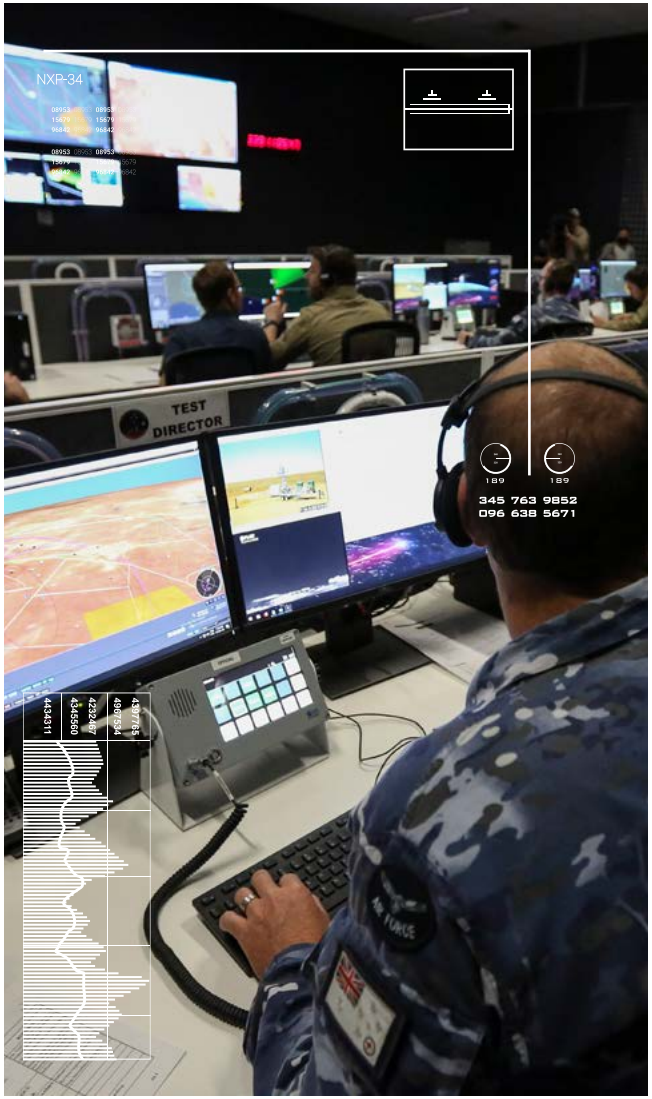
ENHANCING CAPABILITY AND GROWING THE FORCE

Defence will continue to enhance Australia's ability to generate military effects utilising the space domain, accounting for the contested nature of the space domain.

This will be achieved through efforts that include developing capabilities resilient in denied environments, assuring access to space and reconstitution. The development of operational doctrine, concepts and strategies that align with allies and international partners, will articulate the value of sovereign and independent actions in space, illustrate the value of Australia's contribution to those partnerships and alliances, and will influence efforts to enhance capability.

As the human dimension of the space domain is a point of critical failure; training and education, workforce management and exercising the force are fundamental requirements of capability development and growth. Defence will continue to develop a workforce plan to include genuine and motivational career paths.

Through individual and collective training and exercise events, Defence will continue to develop space power concepts and doctrine and build upon operational experience and culture. Defence will utilise space power and multi-domain education opportunities throughout Defence's ab initio training and education organisations regardless of service.



HIGHLIGHTING THE CRITICALITY OF SPACE

Defence has a role in understanding the criticality of space for the conduct of military operations. Defence also has a role in understanding the criticality of space from a national security, national critical infrastructure and resiliency perspective.

Defence recognises a responsibility to raise the national awareness and understanding of the criticality of space to Australia. Through the publication of doctrine, the *Defence Space Strategy* and other targeted engagements, Defence will continue to be an advocate for recognising the criticality of space and will≈ support the national effort in establishing norms of behaviour in space and protecting Australia's strategic interests.

GROWING NATIONAL SPACE ENTERPRISE

Led by the Australian Space Agency, Defence will support the growth and sustainment of the Australian space enterprise. The development and publishing of a set of Defence priorities for the space industry, along with a science and technology innovation strategy and establishment of specific engagement points with industry will support this endeavour.

EVOLVING THE DEFENCE SPACE ENTERPRISE

Space power will be enhanced through Defence's plan to evolve the Defence Space Enterprise. The development and refinement of the concept of operation of Defence's space command and control system will enhance Defence's multi-domain approach to operations. This will lead to organisational transformation in decision-making at all levels of command, not just for the space domain.

Leveraging the space experience and capabilities of allies and international partners will be crucial in raising Defence's baseline capability. Evolving, expanding and engaging with international partners, in particular the US, to take advantage of cultural and training opportunities will enhance operational expertise and culture. Continuing to develop and refine strategy and doctrine as these opportunities are taken will mature Defence's understanding of the space domain and space power application.


DEFENCE
SPACE COMMAND
https://www.airforce.gov.au/our-mission/space