SPACE ARTICLE

SPACE IN 2040

THE FIRST NATO SPACE CENTRE OF EXCELLENCE CONFERENCE

It is with great pride and a deep sense of purpose that I present the foreword to the proceedings of the first NATO Space Centre of Excellence (COE) Conference, held in Toulouse between 28 and 30 April 2025. This landmark event gathered around 300 participants from 29 nations – including NATO Allies and key partners – representing a rich tapestry of expertise from across military institutions, government authorities, academia, industry, and the commercial space sector.

Developed under the theme "**Space in 2040: Deterrence, Security, Interoperability, and Technological Innovation**," the Conference provided a significant opportunity for attendees to exchange ideas on NATO's strategic thinking and operational Space posture with the highest authorities and most skilled experts from across the Alliance. Our collective aim was not only to reflect upon the challenges we face today but also to chart a bold and collaborative course for the decades ahead.

Conference discussions were both informative and thought-provoking. From the keynote addresses to the panel debates, the message was consistent: Space is no longer a distant enabler – it is a core operational domain, delivering its own operational effects and playing a critical role in modern deterrence, defence, and resilience; we must move beyond legacy mindsets and develop capabilities, doctrines, and partnerships that reflect the contested and interconnected nature of this domain.

Notably, the Conference underscored three key imperatives for NATO's Space posture: accelerating operational readiness, embedding interoperability by design, and deepening collaboration with industry and commercial partners. The speed of modern technological innovation demands agile and forward-thinking approaches; the Alliance must not only keep pace – it must lead.

The NATO Space COE is committed to supporting this transformation through its divisions, structured around the four key COE pillars: Concept Development & Experimentation; Doctrine and Standardization; Education and Training; and Analysis and Lessons Learned. As a hub of expertise and a platform for innovation, we will continue to foster dialogue, build competencies, and champion initiatives that enhance NATO's strategic depth in Space.

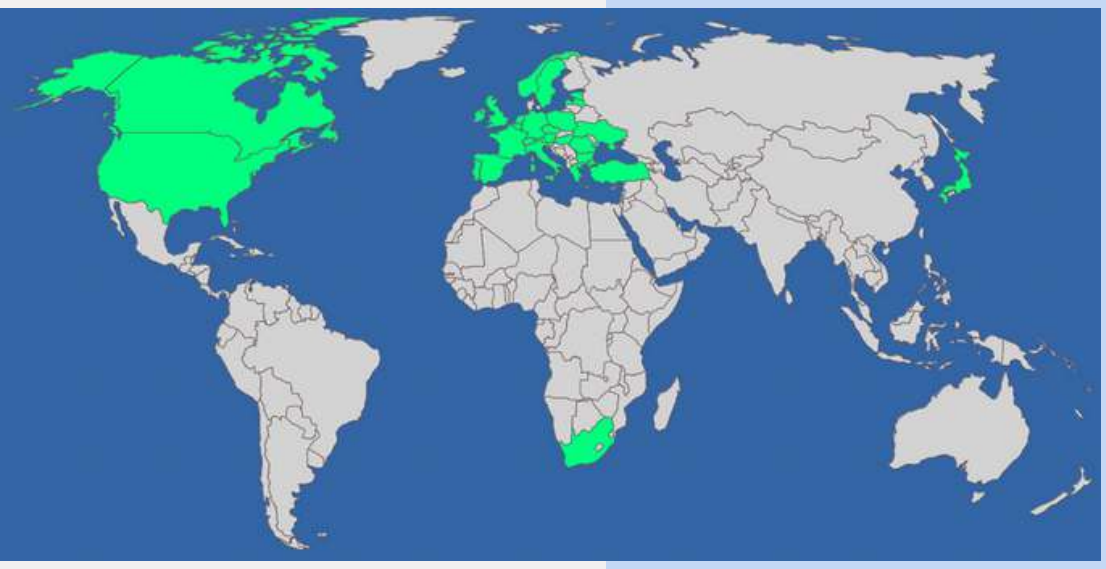
On behalf of the NATO Space COE, I would like to extend my sincere gratitude to all participants, speakers, sponsors, and partners who contributed to the success of this inaugural event. We believe that your insights, vision, and collaboration have been – and will continue to be – instrumental in shaping the future of Space within NATO.

Together, we have taken an essential step toward ensuring that the Space Domain – in 2040 and beyond – remains a source of security, resilience, and strategic advantage for the Alliance.

Col. Sylvain Debarre
Director, NATO Space Centre of Excellence

CONFERENCE IN NUMBERS

The first NATO Space COE Conference brought together approximately 300 participants, comprising a diverse array of institutional representatives, senior authorities, space experts, and industry stakeholders, including 22 sponsoring organisations. All attendees were united by common objectives: to convene, share perspectives, and engage in dialogue on the Conference theme, "**Space in 2040: Deterrence, Security, Interoperability, and Technological Innovation.**"



Delegates hailed from 29 countries, primarily NATO member states, as well as Austria, Japan, and Ukraine. This broad international representation significantly enriched the event, fostering a dynamic exchange of insights and perspectives drawn from diverse national and professional backgrounds.

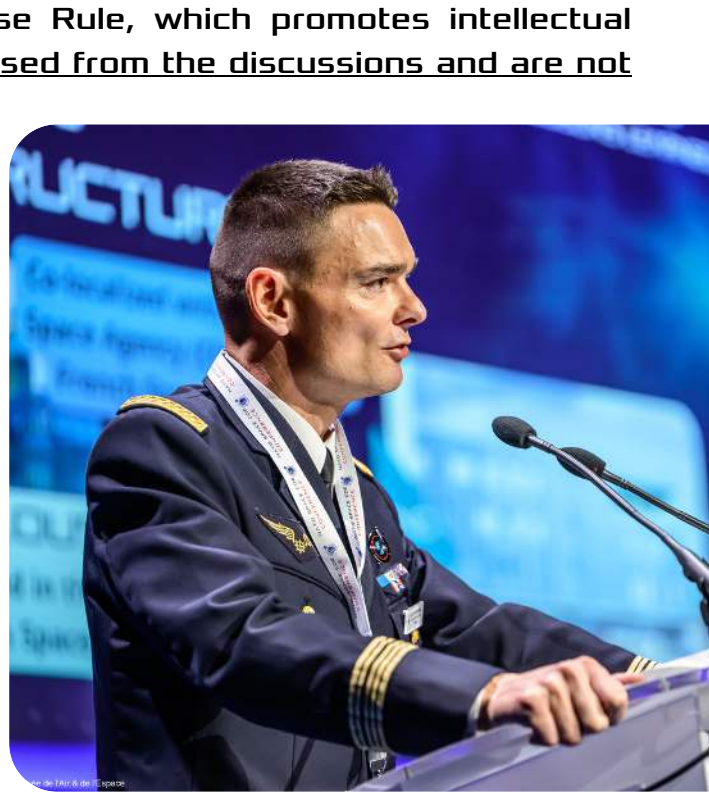
A total of 22 sponsors supported the event, contributing resources and funding that helped to ensure its success. This support was provided in full respect of the independence of the ideas and perspectives shared throughout the Conference and in this report.

CONFERENCE PROCEEDINGS

The NATO Space COE Conference, held in Toulouse, France, from 28 to 30 April 2025, focused on the future of the Space Domain. Under the theme "**Space in 2040: Deterrence, Security, Interoperability, and Technological Innovation**," the Conference aimed to explore developments within NATO and Allied Space capabilities, challenges to be met, and necessary changes for achieving allied objectives in Space.
The following proceedings aim to capture the key messages conveyed during the event, rather than providing a complete, chronological record of the topics discussed. In accordance with the Chatham House Rule, which promotes intellectual freedom of thought and speech, the ideas presented in these proceedings are synthesised from the discussions and are not attributed to any specific individuals.

INTRODUCTION

The Conference started with an opening speech by the Director of the NATO Space COE, highlighting the organisation's role in supporting the development of the Space Domain. During his speech, he outlined its core responsibilities across the four COE pillars, which apply to every NATO COE: **Concept Development and Experimentation, Doctrine and Standardization, Education and Training, and Analysis and Lessons Learned**. He then outlined the sub-themes and associated panel discussions, highlighting that they reflected the Space COE's evaluation of the Alliance's most pressing challenges.



KEYNOTE SPEECHES – MAIN MESSAGES

In **2019**, NATO declared Space as an operational domain; however, even before that, it served as a critical enabler and force multiplier – essential for the conduct of any military operation and for the Alliance's deterrence and defence posture. **Space is a vital component of critical security infrastructure, fundamental for both military and civilian life.** It is also a field in which military and civilian solutions intersect and often overlap. Access to Space-based technologies is seen as essential for maintaining NATO's strategic advantage and ensuring the security of the Allies. For these reasons, NATO is increasing its attention on Space as an operational domain, developing dedicated structures, capabilities, and expertise to support its role. Potential adversaries are rapidly expanding their Space and counterspace capabilities, which could undermine NATO's advantages and exploit potential vulnerabilities in the Allies' capabilities. This high-paced progress poses growing threats to both civilian and military systems and infrastructure. To keep pace and effectively respond to challenges, many speakers recognised the need for NATO to accelerate its operationalisation of Space as a domain. In this context, three key challenges were identified: the intellectual challenge of developing a comprehensive doctrine for the Space Domain; the need to attract and retain qualified personnel; and the importance of maintaining strong, cohesive cooperation among Allies. Some speakers recognised the **fundamental role of the NATO Space COE in this context, as its "Programme of Work" can play a crucial role in helping the Alliance address these challenges.**

Most speakers are convinced that NATO and Allied Nations must prepare to **operate in a denied and degraded Space environment**, including through the development of the necessary Space capabilities to deter and, if required, defend the Space Domain. The development of these capabilities is required for Space to become a fully operational domain and to provide decision-makers with an extensive range of options to be used in critical situations. At the same time, distributed and resilient satellite and ground architectures need to be implemented by Allies to secure access to Space Data, Products, and Services (DPS) during crises and conflicts, in order to withstand a first strike and sustain activities.

Although the current **democratisation of Space** allows for increased private investment and commercial use of space DPS, some speakers highlighted that governmental funding remains the primary source of revenue for the space industry. With new commercial solutions increasingly capable of meeting military requirements and ever more accessible, NATO has the opportunity to assess their potential and to integrate them into operational planning processes and activities. Collaboration with partners and industry is essential to meeting the growing demand for space DPS, building resilient and reactive architecture "at the speed of relevance". This approach requires a high level of interoperability between all actors. Several speakers highlighted that Space, as a relatively new domain where capabilities are still being developed, presents a unique opportunity to embed interoperability 'by design', promoting standardisation from the early phases of capability development.

Keynote speakers also emphasised the need for NATO to take action to **improve its understanding of the space environment**, to integrate emerging and disruptive technologies, and to strengthen its space-related command and control (C2) structures. Furthermore, they highlighted the opportunity for common funded capabilities and the importance of refining capability requirements to be met by Allies under the NATO Defence Planning Process. In conclusion, enhancing resilience through strengthened civil-military cooperation and collaboration with international organisations is considered essential. In their view, collaborative efforts like Joint Commercial Operations, the Combined Space Operations initiative, and the Multinational Force Operation Olympic Defender – along with best practices shared by Allies with advanced Space capabilities and structures – can effectively support NATO's development of C2 structures, standardisation, and intelligence-sharing procedures for the Space Domain.

NATO SPACE POLICY: STRATEGIC DEVELOPMENTS AND DIRECTIONS

The Conference offered a **strategic overview of NATO's evolving approach to Space**, stressing the importance of aligning NATO's Space Policy with the Alliance's broader defence and deterrence posture, particularly as preparations intensify for the 2025 Hague Summit. Speakers noted growing defence investments among NATO Allies, with some Nations approaching 5% of GDP, reflecting a collective commitment to strengthening deterrence across all domains. Space is increasingly recognised, not merely as a support function, but as a critical and contested operational environment.

Speakers highlighted that NATO is not starting "from scratch" in Space, pointing to historical experience, existing policy frameworks, and infrastructure developments such as the NATO Space Operations Centre. A forthcoming Space package will focus on several strategic priorities, which will include integrating Space into NATO's core decision-making processes, ensuring that Space is regarded as a central element of operational planning, and addressing escalation dynamics involving Space through scenario-based planning and political-military dialogue.

Further priorities involve **strengthening NATO's internal Space capacity by developing a robust C2 structure**, refining Space capability targets through the NATO Defence Planning Process (NDPP), and accelerating capability delivery through industrial partnerships – particularly with the commercial space sector. Ensuring the resilience of Space services, including guidance on civil preparedness, will also be a key part of NATO's resilience agenda.

A key outcome of the discussions was an urgent call to shift from **planning to execution**, emphasising that warfighting readiness in Space is now a strategic imperative; Space must be integrated into NATO's defence framework to ensure that the Alliance is prepared to respond to evolving threats.

INTEGRATION OF SPACE INTO NATO OPERATIONS

The **mentioned NATO's recognition of Space as an operational domain in 2019 was a significant milestone**. However, the initial assumptions that Space capabilities were too expensive, too classified, and too specialised are no longer valid. Rapid advancements in commercial space technologies, increased Space accessibility for Allies, and the acknowledged use of Space in active conflicts have fundamentally changed the strategic and operational landscape of the Domain.

The 2022 NATO Strategic Concept identified Russia as the primary threat to Allied security, and the invasion of Ukraine highlighted the critical role of Space across all phases of conflict. The first action in the Russia-Ukraine conflict was, in fact, a cyberattack on satellite communications. Ukraine's use of commercial SATCOM, electro-optical, and hyperspectral imagery, as well as AI-powered analysis, demonstrated the effectiveness of Space technologies in enabling precision effects and ensuring operational resilience. **These developments offer valuable lessons for NATO as it shapes its future posture**.

Since 2019, NATO has undergone substantial transformation, including updated defence planning, a revised force model, modernised alert systems, and integration across all five operational domains (Air, Land, Maritime, Cyber and Space). The shift from bespoke national Space programmes to scalable, commercially driven capabilities now allows all 32 Allies to contribute effectively, such as by using nanosatellites for maritime surveillance and leveraging commercial electronic warfare tools to support military operations.

Most speakers highlighted that increasing the "space IQ" across NATO is essential. **Space is now recognised as a contested domain that plays a vital role in Multi-Domain Operations (MDO)**, strengthening cyber resilience, contributing to electromagnetic spectrum operations, and providing essential data, products and services.
NATO's deterrence posture will also benefit from Space. Proliferated commercial constellations, diverse SATCOM sources, and mesh network architectures reduce vulnerability and raise the threshold for hostile acts in Space, complicating adversary planning and execution. Enhanced Space Situational Awareness tools increase attribution, undermining adversaries' plausible deniability and reinforcing strategic messaging.

Looking ahead, some speakers advocated for NATO to move beyond legacy structures. **Use of commercial off-the-shelf Space solutions offers an efficient means by which to absorb increased defence spending**. As some Allies increase defence spending, Space provides scalable investment opportunities that are quicker to deploy than traditional defence systems. NATO's partnerships with capable Space actors strengthen collective resilience and provide strategic depth.

In conclusion, **all keynote speakers emphasised the need to transform NATO's approach to Space from a supportive function into a fully operationalised, integrated domain** in order to enhance deterrence, support mission success, and strengthen the Alliance's collective defence. Some speakers underlined the need to ensure that NATO's Space Policy is "fit for purpose" and accurately reflects the current strategic and technological environment.

INDUSTRY INTEGRATION INTO SPACE OPERATIONS

Space is now a core component of modern warfare and defence strategies; it is no longer a niche domain. Speakers emphasised that, despite significant progress over the past 15 years, Space remains underfunded and its integration into NATO's defence planning still needs improvement. While NATO exercises demonstrate the importance of interoperability, more needs to be done to address capability gaps in the Space Domain, particularly as the Alliance works to expand its Space posture.

Historically, military Space capabilities have focused on Intelligence, Surveillance and Reconnaissance (ISR), Satellite Communications (SATCOM), Position, Navigation and Timing (PNT), and Shared Early Warning (SEW). These capabilities are becoming increasingly critical, meaning that Space is no longer optional, but essential for defence.

Speakers also noted that Europe's dependence on the United States for strategic Space capabilities is unsustainable, especially during crises such as the conflict in Ukraine and tensions in the Indo-Pacific. Europe must develop autonomous Space capabilities and adopt a self-reliant Space defence posture. Discussions identified three primary focus areas for Space capability development: strengthening connections with the private space sector, enhancing radar and imaging technologies, and ensuring secure communication systems.

Speakers also highlighted the need for NATO to prioritise Space capabilities across Allied Nations and mentioned the **NATO Space COE's crucial role in supporting increased interoperability and alignment of national Space capability development objectives**. Since a fragmented Space architecture could undermine collective defence, it is critical for NATO to move toward a unified, interoperable Space system of systems that connects sensors, decision-makers, and effectors. A key initiative supporting these ambitions is the creation of national operational Space commands to ensure low-latency data flow for real-time operational decision-making. In short, NATO can become stronger, faster, and more resilient only by fully integrating space into its defence planning and fostering collaborative efforts among Allies.

PANEL 1: SPACE AS THE KEYSTONE OF MULTI-DOMAIN OPERATIONS (MDO)

Space is increasingly recognised as a critical operational domain, yet it remains fundamentally different from traditional warfighting environments. NATO itself does not own Space assets, but instead relies on its Allied Nations and commercial partners for access to capabilities. This dependency calls for a more coherent and collaborative structure, especially as **Space superiority becomes foundational to achieving MDO**. Panellists agreed that the integration of Space cannot be an afterthought; it must be embedded from the outset of operational planning.

Crucially, Space cannot be considered in isolation. **While it has long been viewed as a supporting domain for Land, Air, Maritime, and Cyber operations, it now demands reciprocal support from these domains.** Ground forces must defend terrestrial infrastructure, cyber capabilities must secure space-based links, and strategic planning must acknowledge Space as central to deterrence and decision-making superiority. The cost of losing access to Space would be severe, placing NATO's deterrence credibility and operational dominance at risk. Importantly, the speed of relevance can also be dictated by our adversary, not only by our Alliance.

Achieving interoperability and resilience requires more than just technology; it demands procedural harmonisation, a C2 architecture adapted for continuous Space operations, and a robust training pipeline. There is a call to rethink how NATO organises its command structures, moving beyond models designed for episodic operations planned through Air Tasking Orders (ATO) and, instead, developing persistent command models suited for the uninterrupted nature of Space operations. Building Space IQ across political and military leadership is essential. Leveraging a range of tools, from joint exercises to dedicated Space Coordinators at NATO commands, increased awareness and expertise is a strategic necessity.
Commercial partnerships and national contributions remain vital pillars of NATO's approach, which rests on three interdependent lines of effort: leveraging national capabilities, acquiring commercial solutions swiftly and effectively, and coordinating acquisition plans to avoid redundancy and capability gaps. Each Nation, regardless of size, has the potential to contribute meaningful capabilities or innovation to this shared mission.

Panellists stressed that, while Space is technologically complex and expensive in the short term, failing to act now would be far costlier in the long run. Strategic flexibility and deterrence in **Space require proactive investment, both in people and in infrastructure**. Policymakers must understand the strategic value of Space assets and the industrial implications of counterspace operations. Policy decisions must be informed, timely, and supported by a shared understanding across military, industrial, and political instruments.

Ultimately, there is no preset formula for success in integrating Space into MDO. It will require creative thinking, strong partnerships, and the deliberate cultivation of expertise across NATO. As one panellist noted, **Space is no longer a frontier to be explored; it is, today, the centre of gravity for modern operations, and must be treated as such.**

PANEL 2:
INTEROPERABILITY AS A DETERRENT IN THE SPACE DOMAIN

This panel emphasised that, for the Space Domain, shared understanding is crucial. An overly simplistic or outdated mindset, still shaped by 20th-century concepts, would risk undermining the development of effective Space doctrine and operational procedures. Space is not merely a supporting element, but a distinct warfighting domain that is inherently integrated into MDO. Offensive and defensive actions in Space span all domains, making the integration of Space operations into the broader military context non-negotiable.

Interoperability has emerged as the cornerstone of credible deterrence and operational effectiveness, and must be incorporated by design – not only through technical means, but also through cultural, doctrinal, and institutional alignment. Cultural interoperability is especially challenging yet essential: it requires consideration of the perspectives, objectives, and capabilities of all Allies. As today's personnel will shape the Space forces of 2040, early education and exposure to joint, combined, and commercial practices are key. Exercises must reflect realistic, contested scenarios and include partners (military and commercial) to build trust and ensure readiness.

The synchronisation of national- and NATO-level policy, plans, and capabilities is necessary for credibility. Interoperability serves as a message to adversaries and a multiplier for collective strength. Yet, it demands careful alignment of legal, political, and technical frameworks; this is particularly critical in Space, where data moves at unmatched speeds and technologies evolve rapidly. Nations must ensure that their national postures are aligned with NATO's strategic goals in order to build a cohesive, collective deterrence posture.

Several participants highlighted that NATO's current Space capabilities depend heavily on national contributions, with the Alliance having no Space assets of its own. This, they said, raises questions about the timely distribution of a comprehensive Recognised Space Picture and, as such, operational responsiveness. An ideal vision for interoperability would enable NATO to conduct Space campaigns that leverage national capabilities without requiring any formal transfer of authority, ensuring timely delivery and seamless integration.

Exercises are seen as a vital tool for testing and reinforcing interoperability. However, according to the panellists, Space effects remain insufficiently integrated into broader joint exercises. Participants said there is resistance in some communities to accepting the operational impact of the domain. However, in order to prepare for real conflict, exercises must include degraded environments and contested scenarios. As one panellist noted, "train as you fight" should be the standard.

In conclusion, **the path to credible deterrence in Space lies in preparing for both defensive and offensive operations, building trust, aligning policies, and ensuring realistic joint training.** Interoperability is not just a technical requirement; it is a strategic necessity, a deterrent, and the foundation for future success in the evolving Space Domain.

PANEL 3:
ENGAGING INDUSTRY TO ACHIEVE MILITARY GOALS

In an era marked by accelerating innovation and intensifying geopolitical challenges, it has become both **a strategic necessity and operational imperative to involve the commercial sector in the pursuit of NATO's military objectives**, especially in the Space Domain. Panel discussions highlighted the rapidly evolving relationship between defence priorities and the private sector, particularly as Space transforms into a contested and operationally-critical domain.

The commercial space sector has emerged as a central force in shaping the strategic landscape. **Agile, innovative actors now provide essential capabilities for redundancy, resilience, and technological advancement.** These contributions offer NATO more adaptive, efficient, and scalable solutions. However, to harness this potential, collaborations must evolve from ad hoc arrangements into structured, trust-based, and strategically anchored partnerships.

Participants emphasised the importance of a hybrid operational architecture that integrates three key elements: **military assets, multinational cooperation frameworks, and commercially sourced capabilities**. Such a model – underpinned by trust and regulatory alignment – is key to ensuring continuous access to Space-based services, especially during times of crisis.

Both the defence technological and industrial base, as well as academia, were recognised as foundational to long-term deterrence and defence. **Early engagement with industry enables faster innovation cycles and closer alignment between emerging technologies and military requirements.** However, such collaboration requires clearly defined roles, streamlined procurement models, and cautious classification management to avoid hindering innovation through unnecessary restrictions. The panellists highlighted the role of the NATO Industrial Advisory Group (NIAG) as a key mechanism for bridging the gap between the industrial and defence communities. The body enhances interoperability and provides technical insight into capability development, while its involvement in formal procurement remains intentionally limited to preserve neutrality.

The upcoming release of NATO's first-ever Commercial Space Strategy was noted as a policy milestone. The strategy will advocate for flexible contracting mechanisms, centralised communication hubs for industry engagement, and the formation of a Space Capability Committee to identify and close capability gaps. A strong focus was placed on moving beyond strategic formulation and toward practical implementation, with measurable outcomes and enduring industry relationships.

Nonetheless, speakers agreed that institutional inertia and bureaucratic procurement processes continue to present significant obstacles to proactive collaboration. The panel called for procurement reform, including faster, more adaptive acquisition and financing models that can keep pace with the commercial sector.

In conclusion, this panel expressed that enduring, agile, and trust-based collaboration between NATO and the commercial space sector is critical to maintaining the Alliance's strategic edge. As NATO expands its Space posture, **a balance must be struck between leveraging commercial innovation and preserving operational control**, ensuring that Space remains a domain of opportunity, stability, and collective security.

CONCLUSION

The NATO Space COE Conference brought together approximately **300 participants** from around the world to discuss the future of NATO's Space posture under the theme **"Space in 2040: Deterrence, Security, Interoperability, and Technological Innovation."** The event focused on ways to enhance NATO's Space capabilities, its response to emerging threats, and its integration of Space into Multi-Domain Operations.

Key messages highlighted the urgency of fully integrating Space into the Alliance's deterrence and defence posture, developing both defensive and offensive Space capabilities, adapting NATO's doctrine, and strengthening interoperability among Allies. The rapid advancement of adversary Space technologies, as well as lessons learned from recent conflicts, underline the need for NATO to build resilience through distributed architectures and closer cooperation with commercial industry.

Panel discussions emphasised that Space is a core element of modern warfare and deterrence, not a supporting domain. Interoperability must be established not only on a technical level, but also on a doctrinal and cultural level. Commercial partnerships and national contributions are essential, and NATO must move from strategic intent to implementation, with practical, scalable, and integrated solutions.

The Conference concluded with broad agreement that NATO must act decisively to operationalise Space as a fully-fledged domain. This requires accelerating capability development, increasing collaboration with industry, and embedding Space into all levels of defence planning to ensure long-term security and strategic advantage.

PHOTOS CAPTION

1/ By NATO Space COE: The NATO Space COE First Conference
2/ By NATO Space COE: The NATO Space COE Director
3/ By NATO Space COE: Illustration of the First NATO Space COE Conference
4/ By NATO Space COE: Graphic showing the countries represented at the First NATO Space COE Conference
5/ By NATO Space COE: A total of 22 sponsors supported the event
6/ By NATO Space COE: Welcome address by the NATO Space COE Director
7/ By NATO Space COE: Space is a vital component of critical security infrastructure
8/ By NATO Space COE: Building Resilient Capabilities for NATO Operations in a Denied and Degraded Space Environment
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12/ By NATO Space COE: Panel 1 – Space as the Keystone of Multi-Domain Operations (MDO)
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