NATO OTAN

Science & Technology Organization (STO)

Resilience

NATO Chief Scientist Research Report

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The Chief Scientist Research Reports (CSRRs) provide NATO's senior political and military leadership with clear, evidence-based insight into science & technology (S&T) developments. These reports translate complex research results into actionable analysis to help the Alliance anticipate potential technological disruption, identify likely capability gaps, and adapt strategically in order to shape the future security environment and battlespace.

As the senior scientific advisor to NATO leadership, the Chief Scientist provides the evidence base that supports planning, policy, and decision-making, leveraging cutting-edge research from the NATO Science & Technology Organization (STO). The CSRRs contribute to scientific awareness, supporting long-term reflection, and ensure that S&T considerations are factored into broader defence planning and policy development. CSRRs are decision-support tools that help connect the Alliance's knowledge base with real-world priorities. They guide senior leaders in translating knowledge into action and reinforcing NATO's ability to respond with agility and coherence to emerging security challenges.

At the core of NATO's scientific community is the STO, the Alliance's principal body for cooperative defence S&T. Governed by the NATO Science & Technology Board (STB), the STO conducts a multinational Programme of Work and acts as the hub for scientific collaboration among Allied and Partner Nations. It brings together national experts who pursue applied research, experimentation, prototype testing, and analysis. By fostering interoperability and information exchange, the STO enables NATO to derive decisive advantages across all Instruments of Power from the Nations' combined investment in NATO's shared knowledge base.

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Foreword

In the 2022 NATO Strategic Concept, Allies agreed to enhance their individual and collective resilience and technological edge. All NATO Summits since 2016 have emphasised the need to continue strengthening NATO's resilience through the Alliance's collective awareness, preparedness and capacity across all hazards and domains, critical infrastructure, and supply chains to counteract the wide range of malicious activities and hybrid challenges. At the same time, continued investment in Science & Technology (S&T) strengthens NATO's and Allies' ability to outperform the adversaries and competitors of today and tomorrow, ensuring the Alliance remains robust, resilient, and ready to respond to any threat in order to fulfil NATO's three core tasks of deterrence and defence, crises prevention and management and cooperative security in accordance with the Nations' commitments under Article 3 of the 1949 Washington Treaty.

The Chairs of the NATO Science & Technology Board (STB) and the NATO Resilience Committee (RC), respectively, have proactively strengthened collaboration between the two communities. This Chief Scientist Research Report aims to provide insights into the completed and ongoing work of the NATO Science & Technology Organization (STO) that enables Allies' resilience and improves the visibility of relevant outcomes. The report also aims to create better alignment between the research resilience communities, to shape upcoming work in both areas by raising awareness of existing work and to identify key gaps in research that can be considered in the STO's Collaborative Programme of Work (CPoW) Challenge on Resilience. This report highlights that resilience is a key research theme for ongoing and future work in the STO.

The STO is a unique forum for experts in defence research, government, industry and academia to work together on topics of international priority across Allies and collaborate with a wide range of stakeholders in the civil and military sectors. This has important parallels with NATO's resilience work, which relies on a robust civil-military partnership. As innovation and technology is increasingly driven by the civil commercial sector, leveraging technological enablers of resilience and confronting related challenges will rely on a solid foundation of public-private cooperation in the science and technology sectors.

This report also aims to provide guidance on some strategic trends to be taken into account in medium- and long-term resilience planning by the RC and its Planning Groups. The STO not only leads the Alliance in fundamental research by scientists and engineers, but also identifies S&T trends with key defence implications for the NATO Enterprise and Allied national defence stakeholders. Increasingly, these trends incorporate an expanded view of resilience, and an increasing demand for NATO to remain at the forefront of supporting Allies in securing the resilience of their populations against a wide range of threats from diverse actors.

As the work of the RC continues and the portfolio of the STO expands through its strategic research challenge on Resilience (CPoW Challenge), this report serves as a guideline for shaping future programmes and activities as well as expanding the partnerships between the two communities.

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NATO Chief Scientist

Introduction

NATO is facing an unpredictable strategic environment where competitors and adversaries seek to exploit the openness and interconnectedness of the Nations within the Alliance, as well as targeting the security of Allies' citizens through hybrid tactics, either directly or through proxies. Strategic competition, instability and recurrent shocks define NATO's broader security environment and, in particular, the lines between conventional and unconventional conflicts can be blurred. The use of new technologies provides benefits as well as vulnerabilities to our societies due to interdependencies within the economic, financial, information and cyber areas.

Each NATO Ally must be resilient to withstand major shocks such as a natural disaster, failure of critical infrastructure, or a hybrid or armed attack. *Resilience is the individual and collective capacity to prepare for, resist, respond to and quickly recover from shocks and disruptions, and to ensure the continuity of the Alliance's activities. Resilience is both a national responsibility and a collective commitment.* It is rooted in Article 3 of the 1949 Washington Treaty, setting out that Allies will maintain and develop their individual and collective capacity to resist attack (Fact Box 1). Thus, one Nation's resilience contributes to the resilience of the whole Alliance, positioning national and collective resilience as essential enablers for credible deterrence and defence, and supporting the fulfilment of the Alliance's three core tasks.

Strengthening preparedness for deterrence and defence, therefore, requires a whole-of-government approach with whole-of-society considerations including active cooperation across government, public-private cooperation, societal resilience considerations, and a wide range of military and civilian capabilities. Resilience also strengthens deterrence by keeping more options open longer, thereby diminishing the likelihood of conflict and crises escalations.

Fact Box 1: Article 3 is rooted in the Washington Treaty, 1949: "In order to more effectively achieve the objectives of this Treaty, the Parties, separately and jointly, by means of continuous and effective self-help and mutual aid, will maintain and develop their individual and collective capacity to resist armed attack."

Hybrid operations, or operations below the threshold of Article 5, against Allies could reach the level of an armed attack and lead the North Atlantic Council to initiate a response under Article 5 of the Washington Treaty. The Russian Federation has intensified its hybrid actions against Allies through various means, such as sabotage, acts of violence, provocations, cyber-attacks, electronic interference, and malign political influence[1], constituting a threat to the Alliance's security. The ambitions and policies stated by The People's Republic of China's (PRC) pose systemic challenges to NATO's interests, security and values. The PRC and Russia have deliberately used crises to weaken governance, such as through financial crisis, immigration crisis, COVID-19 and turning the digital domain into a weapon of misinformation.[2]

[1] NATO Summit 2024, Washington
[2] NATO (2024), 'Countering hybrid threats', NATO, 7 May, available at https://www.nato.int/cps/en/natohq/topics_156338.htm. And NATO (2025), 'NATO's approach to counter information threats', *NATO*, 3 February, available at https://www.nato.int/cps/en/natohq/topics_219728.htm.

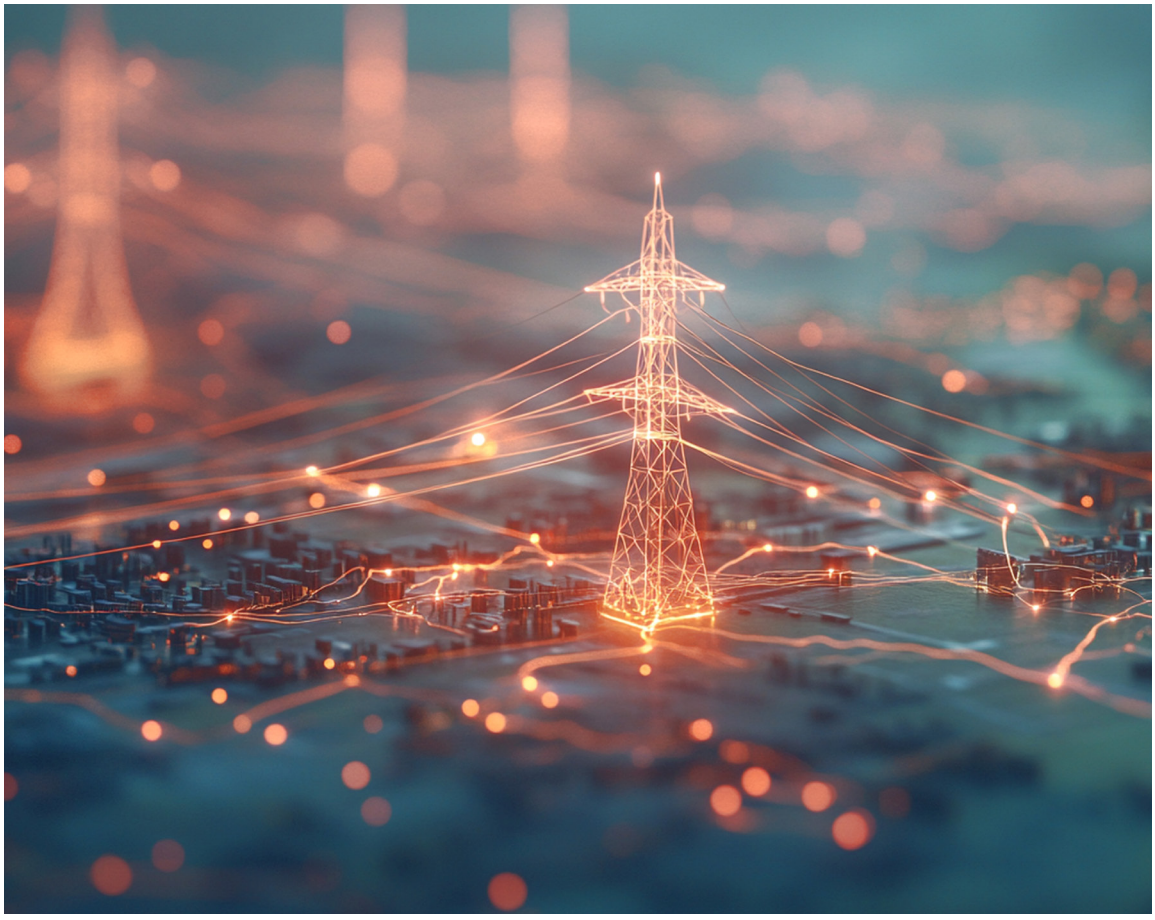
Aggressive and intentional actions against critical infrastructure such as energy supplies and communication systems impact national and NATO's security and defence and are continuously exploited by adversaries to achieve both short- and long-term goals. Systemic hybrid war by an adversary can include degrading any systems vital to the critical functioning of the state or continuity of government and governance, thereby exploring and impacting national resilience and robustness. Actions taken against the energy sector in Ukraine are an example of how civilian infrastructure could be targeted to impact resilience.

Technology is a primary driver of new opportunities, challenges and threats to Allies' security and defence. Emerging and advanced technology and technological systems can be used to build resilience while reducing vulnerabilities. As NATO is accelerating its transformation, integrating new technologies and innovation, and improving technological adoption to derive decisive advantage from technology across all Instruments of Power[3], these approaches are also relevant for building resilience.

For example, NATO Allies agree that energy is a critical capability enabler for military forces. As energy technologies and systems evolve, tracking innovative energy technologies and identifying their military applications with resilience, effectiveness and interoperability across the Alliance in mind, can contribute to their timely adoption and provide strategic advantages to the Alliance.

The Alliance has experienced challenges impacting health systems, exemplified by COVID-19, which exposed vulnerabilities within global supply chains, leading many Nations to reevaluate their global dependencies on critical goods and services. Thus, preparedness planning for severe crises and war is crucial for building national resilience, deterrence and defence. This demonstrates the importance of building resilience to strengthen NATO's defence and deterrence and crises prevention and management. Effective resilience calls for active consequence management, including in relation to cyber defences, civilian structures important for maintaining military effort and military mobility, and prevention of information threats on social media. Building resilience through partnerships among Allies and partners and with organisations such as the European Union is also crucial for NATO's cooperative security.

Lessons learned from Ukraine emphasise the importance of a whole-of-society approach to strengthen resilience, including also appropriate legislation, as there is a need to strengthen joint planning between civil and military stakeholders.



[3] NATO's Strategic Concept 2022;
NATO Science & Technology Strategy 2025.

NATO's Approach to Resilience

During the Cold War, civil preparedness (previously known as civil emergency planning) was well organised and resourced by Allies, and was reflected in NATO's organisation and command structure. During the 1990s, the focus on out-of-area operations and crisis management (rather than defence) caused the weakening of civil emergency capabilities and planning. In response to the changes in the strategic environment following Russia's illegal annexation of Crimea in 2014, NATO made a "Commitment to Enhance Resilience" at the 2016 Warsaw Summit. During this Summit, Heads of State and Government agreed on "The Seven Baseline Requirements for National Resilience" with guidelines and evaluation criteria that Allied Nations could use to conduct their national resilience assessments, in alignment with the NATO Defence Planning Process (NDPP). These Baseline Requirements cut across three core national functions (civil preparedness):

- Continuity of government
- Essential services to the population
- Civil support to the military

These are all crucial for strengthening national resilience and must be maintained under (the most) demanding circumstances.

The Seven Baseline Requirements provide a comprehensive framework to support the effective enablement of the Armed Forces, the host nation support planning and NATO's three core tasks[4] (Fact Box 2). The interdependencies among the Seven Baseline Requirements were clearly demonstrated during the COVID-19 pandemic and Russia's war of aggression against Ukraine.

[4] NATO (2024), 'Resilience, civil preparedness and Article 3',NATO, 13 November, available at https://www.nato.int/cps/en/natohq/topics_132722.htm.

Fact Box 2: NATOs Seven Baseline Requirements (2016)

1. Assured **continuity of government and critical government services**, for instance, the ability to make decisions and communicate with citizens in a crisis
2. **Resilient energy supplies**, ensuring a continued supply of energy and having back-up plans to manage disruptions
3. **Ability to deal with uncontrolled movement of people** and to de-conflict these movements with NATO's military deployments
4. **Resilient food and water** resources ensuring resilient supplies that are safe from disruption or sabotage
5. **Ability to deal with mass casualties**; ensuring that civilian health systems can cope and that sufficient medical supplies are stocked and secure
6. **Resilient civil communications systems**; ensuring that telecommunications and cyber networks can function even under crisis conditions, with sufficient back-up capacity. This also includes the need for reliable communications systems including 5G, robust options to restore these systems, priority access to national authorities in times of crisis, and thorough assessments of risks to communications systems
7. **Resilient civil transportation systems**; ensuring that NATO forces can move across Alliance rapidly and that civilian services can rely on transportation networks, even in a crisis

At the Brussels Summit in **2021**, Allies agreed to further strengthen the Resilience Commitment from Warsaw in 2016 and emphasised that resilience is a national responsibility and a collective commitment against conventional, non-conventional and hybrid threats and activities of adversaries. Thus, the Alliance's resilience stems from a combination of civil preparedness and military capacity.[5]

The **2022** NATO Strategic Concept stated *"We will pursue a more robust, integrated and coherent approach to building national and Alliance-wide resilience against military and non-military threats and challenges to our security the importance of national and collective resilience as a national responsibility and a collective commitment rooted in Article 3 of the North Atlantic Treaty".* Areas such as strategic vulnerabilities and dependencies, energy security and supplies, critical infrastructure, supply chains and health systems were highlighted for further investigations and mitigations. The Strategic Concept also underscored that the Alliance needed to boost its capacity to prepare for, resist, respond to, and quickly recover from strategic shocks and disruptions stating *"ensuring our national and collective resilience is critical to all our core tasks and underpins our efforts to safeguard our nations, societies and shared values".*[6,7]

New collective Resilience Objectives[8] were agreed by Allies at the Vilnius Summit in **2023** to strengthen the Alliance's Resilience Commitment through a more integrated and better-coordinated approach to reduce vulnerabilities and boost national and collective abilities to maintain continuity of government, essential public services, and enable civil support to military operations, in peace, crisis and conflict. The Resilience Objectives address

[5] NATO (2021), 'Strengthened Resilience Commitment', NATO, 14 June, available at https://www.nato.int/cps/en/natohq/official_texts_185340.htm.
[6] NATO's Strategic Concept 2022.
[7] NATO (2024), "Resilience, civil preparedness and Article 3' NATO, 13 November, available at https://www.nato.int/cps/en/natohq/topics_132722.htm.
[8] NATO (2023), 'Vilnius Summit Communiqué', NATO, 11 July, para 61, available at https://www.nato.int/cps/en/natohq/official_texts_217320.htm.

collective vulnerabilities across the Seven Baseline Requirements and from these collective objectives, Allies can develop their own national goals and implementation plans.[9] The 2023 Summit also launched the Centre for the Security of Critical Undersea Infrastructure based at NATO's Maritime Command at Northwood, UK.

The Washington Summit in **2024** further emphasised the Alliance's effort to strengthen national resilience[10] (Fact Box 3). This brought civil and military preparedness even closer through joint planning and harmonised understanding of necessary needs and measures across government and public-private cooperation. This requires a whole-of-government approach, public-private cooperation and societal resilience considerations. The 2024 Summit also resulted in an agreement among Allies to integrate civilian planning into national and collective defence planning (such as the Deterrence and Defence in the Euro-Atlantic Area (DDA) family of plans, to further boost collective resilience, and to cooperate more with like-minded partners.

Fact Box 3: "We will continue to boost our resilience by increasing the Alliance's collective awareness, preparedness and capacity across all hazards and in all domains, to address growing strategic threats, including against our democratic systems, critical infrastructure, and supply chains. We will employ the necessary capabilities to detect, defend against, and respond to the full spectrum of malicious activities. We will also take concrete steps to deepen our cooperation with our partners engaged in similar efforts, in particular the European Union". NATO Washington Summit Communiqué (paragraph 12).

Since 2016, NATO has increased its focus on building collective and national resilience against military and non-military threats and security challenges as a national responsibility and a collective commitment. There is no doubt that this effort will and must continue, and requires all Allied Nations to implement their commitment, including by allocating the necessary resources. However, Nations will address and strengthen resilience differently, reflecting their national resilience structures, arrangements and responsibilities.

NATO Warfighting Capstone Concept

The NATO Warfighting Capstone Concept (NWCC, 2021) identified Layered Resilience as a Warfare Development Imperative (WDI) for the Alliance.[11] The WDI Layered Resilience Concept provides a Military Instrument of Power (MIoP) that supports the Alliance's ability to anticipate and resist strategic shocks or surprises, manage consequences, fight through and ultimately out-last and prevail against adversaries. This requires a layered approach, comprising mutually reinforcing 'layers' of military resilience and civilian resilience. The approach supports NATO's comprehensive resilience agenda, and recognises the importance of the continuity of command, military structures and processes, reserve forces, redundancy and the balance between capability and capacity. The Layered Resilience Concept increases the Alliance's ability to absorb shocks and fight-on across all layers, military, civil-military and military-civilian. Allied Command Transformation (ACT) has developed a Layered Resilience Concept to support the planning processes among military and civilian stakeholders and to contribute to NATO's resilience agenda.

[9] NATO (2021), 'Strengthened Resilience Commitment', NATO, 14 June, available at https://www.nato.int/cps/en/natohq/official_texts_185340.htm (Vilnius Summit declaration, para 61)
[10] NATO (2024), 'Washington Summit Declaration', NATO, 10 July, para 12, available at https://www.nato.int/cps/en/natohq/official_texts_227678.htm.
[11] NATO (2024), 'Resilience, civil preparedness and Article 3',NATO, 13 November, available at https://www.nato.int/cps/en/natohq/topics_132722.htm.

NATO Resilience Committee

NATO's policy on resilience and civil preparedness is guided by the Resilience Committee (RC). It reports directly to the North Atlantic Council, NATO's principal political decision-making body.

The RC[12] serves as the senior NATO advisory body delivering strategic and policy direction, planning guidance, and overseeing the coordination of NATO's resilience activities. The RC is supported by six specialised *Planning Groups* comprised of Allied national representatives covering NATO's seven resilience baseline areas (Fact Box 4). This Committee provides a crucial link to partner nations, international organisations, industry and other stakeholders.

The RC sets the priorities for resilience activities within the Alliance, translating NATO's level of ambition for national and collective resilience into concrete actions and guidance. The Committee ensures a whole-of-government and whole-of-society perspective across the full range of resilience-related activities undertaken by the Alliance. The RC also oversees the activities of the Euro-Atlantic Disaster Response Coordination Centre (EADRCC) at NATO Headquarters, which is the focal point for coordinating disaster relief efforts among Allies and Partner Nations, and in Nations where NATO is engaged in military operations and missions.

In addition to policy and planning, education and awareness constitute another important pillar in strengthening resilience. The Resilience Reference Curriculum offers an important guiding framework for developing courses, study programmes, and training on the topic of resilience for defence education purposes. It supports efforts by NATO Allies and partners to strengthen their resilience against military and non-military threats and challenges to the Alliance's security and to their own national security.[13]

Fact Box 4: The Resilience Committee Six Planning Groups

Civil Communications Planning Group (CCPG) provides advice on building resilience in the communications sector

Civil Protection Group (CPG) addresses ways to ensure continuity of government as well as the ability to deal effectively with uncontrolled movements of people

Energy Planning Group (EPG) is responsible for the oversight of resilient energy supplies

Food and Agriculture Planning Group (FAPG) addresses resilience matters in the food and water sector

Joint Health Group (JHG) covers Allies' ability to deal with mass casualties and disruptive health crises

Transport Group (TG), subdivided across inland surface, maritime and aviation, supports resilient civil transport systems

[12] NATO (2022), 'Resilience Committee', NATO, 7 October, available at https://www.nato.int/cps/en/natohq/topics_50093.htm
[13] See also NATO (2025), 'NATO launches the Resilience Reference Curriculum', NATO, 21 February, available at https://www.nato.int/cps/en/natohq/news_233458.htm

STO supports NATO's work on Resilience

The NATO STO continues to support enhancing national and collective resilience for credible deterrence and defence as highlighted at NATO Summits since 2016.

The Science & Technology Board (STB) Chair and the Chair of the RC have led efforts to strengthen collaboration and coordination between the S&T and resilience communities. Together, they have agreed to provide insights and guidance on how S&T can support Allies' national and collective resilience. A Food-for-Thought (FFT) paper was published in December 2023 that highlights four key recommendations to *"enhance individual and collective resilience and technological edge"* by;

- Building stronger bridges and **strengthening strategic collaboration** between the Resilience and Science & Technology communities
- Strengthening the **committees' collaboration and coordination on the Seven Baseline Requirements,** also including initial observations and lessons from Ukraine's national resilience activities
- Promoting understanding about resilience and **together guiding a common evidence-based future research agenda**
- **Enhancing communication** between RC's Planning Groups, pool of NATO Civil Experts and STO communities through **networking events**

The FFT paper also identifies several areas where scientific knowledge could strengthen resilience advice. Following the publication of this paper, the Office of the NATO Chief Scientist (OCS) mapped that last 25 years of STO activities against the Seven Baseline Requirements. This study builds a collective understanding of the concept of resilience and assists in shaping a shared research agenda by identifying active and completed S&T activities that could support the provision of resilience advice to policymakers.

The OCS study found that 52 out of nearly 4,000 STO research activities were aligned to the Seven Baseline Requirements. This represents less than two percent of the total number of activities (task groups, specialist meeting, workshops and symposia), highlighting the need to emphasise and increase S&T knowledge on resilience. The 52 activities were identified using a set of predetermined keywords through the STO CPoW database for the time-range 1999-2025. The study results also showed that the CPoW activities align more closely with the Baseline Requirements R2, R5 and R6 representing energy, mass casualties and communications, respectively (Figure 1).

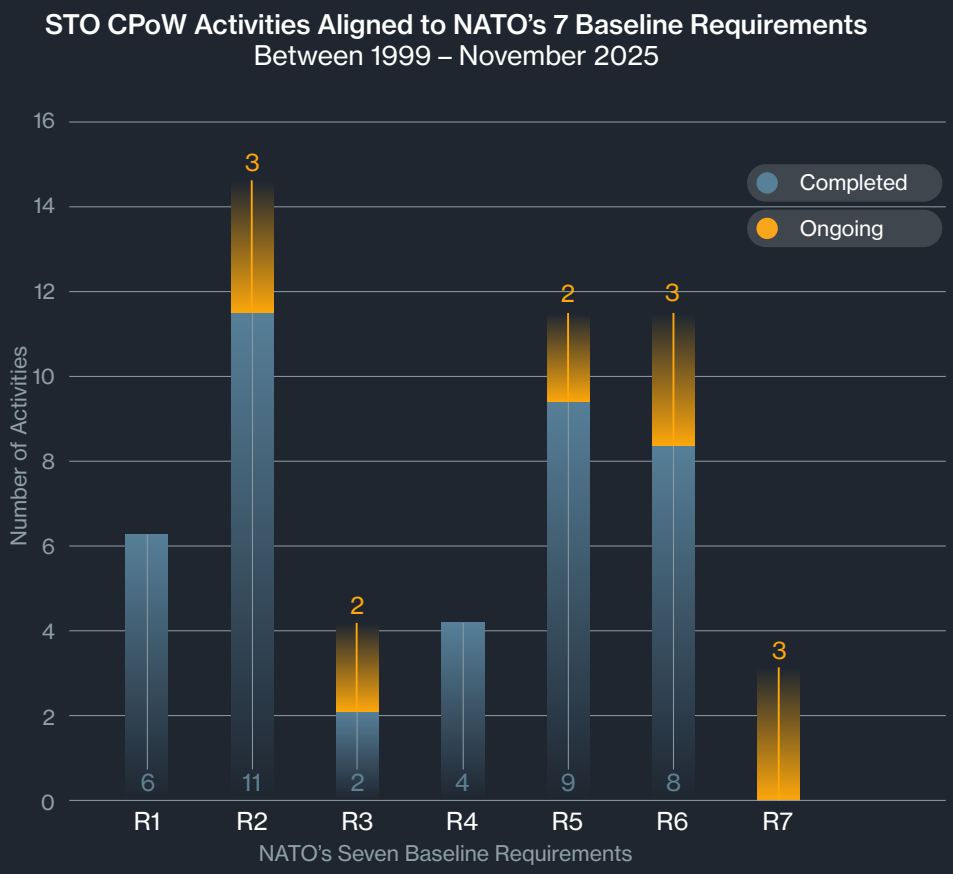


Figure 1. Number of STO activities aligned to NATO's Seven Baseline Requirements during 1999-2025.[15] The Baseline Requirements are described in Fact Box 2.

Ongoing STO CPoW activities aligned with R7 are primarily focused on the use of swarm systems for logistics and ensuring supplies. STO's focus is centred around military logistics and supply issues, meaning that studies on civil infrastructure had not been prioritised or that the military-civilian vulnerabilities and interdependencies have not been addressed in detail during the studied period.

An overview of the 52 research activities is provided in Annex 1. Of the 52 activities across the seven Baseline Requirements, STO has a range of activities covering each requirement. The technical reports from 40 out of the 52 activities are distributed among seven STO Scientific and Technical Committees (STCs). Thus, seven out of eight STCs are engaged in supporting the Resilience Commitment. Since 2022, the CPoW has significantly increased the activities that are aligned to NATO's Seven Baseline Requirements without top-down prioritisation by the STB. This highlights the increased demand for S&T research in topics related to resilience. Three examples of STO activities on resilience are shown in Fact Box 5.

[15] The sum is 53 because the activity SAS-HFM-ET-GD is aligned both with R2 and R7.

Fact Box 5: Three examples of STO's activities on Resilience related to Baseline Requirements 2 and 6

EXAMPLE 1. Energy Security (SAS-198, 2025). NORDIC PINE 2025: Hybrid Threats To Renewable Energy Systems. (NATO Baseline Requirement 2).

The unimpeded flow of affordable energy is critical to maintaining a technologically advanced civil society, and ensuring state viability. Energy security has become a topic of considerable concern within the Alliance, and as we transition from fossil fuels to renewable sources, it will be vital to understand the potential vulnerabilities in the process. Newer energy systems may not be based in mature and well analysed systems of governmental control, security analysis and experience that traditional systems are, and may therefore be less well protected against adversaries. This project's goal is to transfer practical knowledge and recent field developments to military decision makers, in order to increase preparedness for hybrid incidents aimed at renewable energy systems, specifically within the areas of cyber, supply chains and malign influence.

EXAMPLE 2. Energy Security (SAS-191, 2024). Energy Security in the Era of Hybrid Warfare. NORDIC PINE 2024. (NATO Baseline Requirement 2).

Energy security is vulnerable to hybrid warfare causing destabilization of a society. Recognizing that NATO has a role at the forefront of the combination of energy security, cyber security and hybrid warfare, STO addresses how NATO energy security and hybrid threats are used as deliberate actions by state or non-state actors aimed to undermine or harm NATO's assured access to affordable and acceptable supplies of energy and the ability to protect and deliver sufficient energy to meet mission essential requirements by influencing its decision-making at the local, regional, state, or institutional level. The project's goal is to provide analytic support to NATO's civilian and military leadership.

EXAMPLE 3. Cooperative Navigation in Global Navigation Satellite Systems (GNSS) Degraded/ Denied Environments (SET-229, 2016 – 2020). (NATO Baseline Requirement 6).

GNSS are used throughout the NATO forces but the availability of GNSS signals in contested environments due to signal jamming, obstruction, or spoofing is a subject of great concern. The objective of the research activity is to explore technologies to enhance NATO military effectiveness in challenging indoor and urban, and Anti-Access/Area Denial environments through i) implementing advanced, collaborative navigation sensor technologies and integration techniques and demonstration of concepts related to GNSS denied or degraded operations. The research activity addressed Position, Navigation and Time technologies from various Nations and several 'best of breed' technologies were considered for use by Allies. The research project also led to a follow-on lecture series and symposium within STO.

Resilience as a strategic research challenge

The NATO STB adopted resilience as one of the strategic research challenges to STO's CPoW Challenge in 2022, with the aim of identifying needs and promoting further S&T work in this important area. CPoW Challenges are mechanisms used annually by the STB to provide top-down demand signals of areas of strategic importance for Allies. They are led by one or more Nations and revolve around an overarching problem statement with the goal of generating collaboration and new STO research activities in the short- and medium-term. They typically last one year and involve expert workshops to translate specific demand into actionable scientific collaboration.

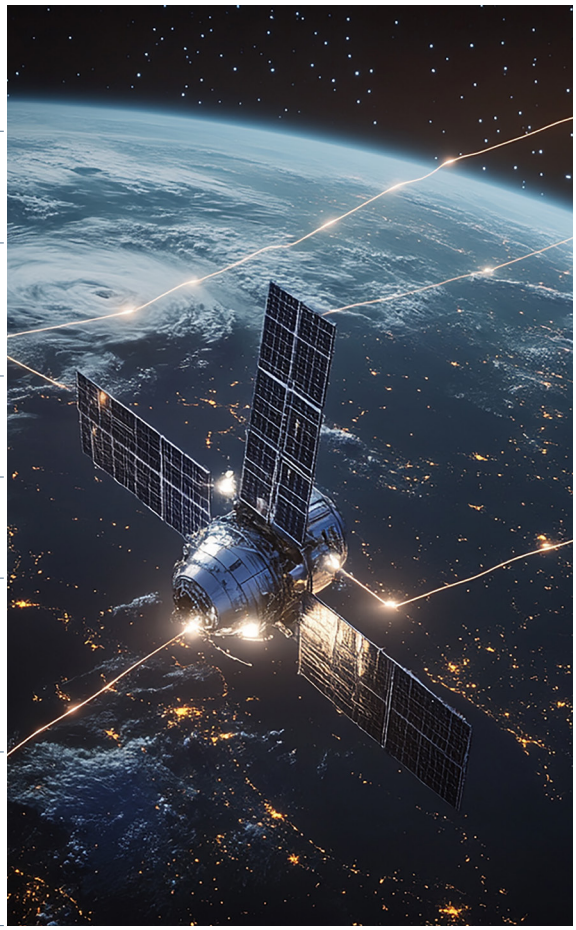
Finland led the CPoW Challenge on Resilience, which was the 5th Challenge in sequence. The first workshop addressing resilience was held in December 2024 in Helsinki, with a follow-up workshop in March 2025 in Oslo, Norway. The previously identified CPoW Challenges and their scientific outcomes "Cognitive Warfare" (Norway) and "Climate Change" (Canada) are of particular relevance to the Resilience Challenge.

Collaboration with other Organizations/ Entities

The Wilton Park Future Defence, Deterrence and Resilience Conference 2024, the third in a trilogy of policy-focused future war/defence conferences, specifically addressed resilience. The participants were from both governmental and private entities covering defence and security. The STO has supported all Wilton Park conferences and provided significant contributions to the 2024 Conference, including with its preparation as well as through STO staff delivering presentations and serving as Panel Moderator and Rapporteur at the event, and contributing to the Conference's Final Report.[16]

The Deterrence and Resilience Conference 2024 highlighted the importance of people and power protection, as failure to protect will highly impact NATO's deterrence. Also, public education and communication is crucial to promote citizen's trust in their governments to respond and recover from potential strategic shocks. Key findings from the Conference highlighted the need to:

- Share resilience best practices between Allies and partners and create synergies
- Obtain greater transparency between government, industry and citizens about the scope and scale of threats
- Build stronger partnerships between state and citizens
- Build redundancy into critical national infrastructures
- Involve defence, technological and industrial bases and a wider supply chain in thinking, planning and action about resilience at an early stage
- Strengthen EU-NATO partnership and whole-of-government approaches to ensure effective consequence management



[16] Wilton Park (2024), 'The Future Defence, Deterrence and Resilience Conference', Wilton Park, WP3395, October, available at https://www.wiltonpark.org.uk/event/the-future-defence-deterrence-and-resilience-conference/. See also the related video playlist, available at https://www.wiltonpark.org.uk/idea/the-future-defence-deterrence-and-resilience-conference-video-playlist/

Conclusions and Way Forward

Resilience has always been at the core of the Washington Treaty, and at last year's Summit, Allies committed to strengthen NATO's resilience through collective awareness, preparedness and capacity across hazards and domains, and against malicious activities and hybrid challenges. These efforts will support NATO in executing its three core tasks: deterrence and defence, crises prevention and management and cooperative security.

In response, the Chairs of NATO Science & Technology Board (STB) and the NATO Resilience Committee (RC) have been increasingly proactive in strengthening their collaboration to support NATO's goals and mission.

The STO and RC together will further strengthen their partnership, enhance communication through networking events and strengthen strategic collaboration between their communities, including observations and lessons from Ukraine's national resilience activities. Their strategic partnership will guide the NATO resilience and Science & Technology (S&T) communities toward a common future research agenda.

Further collaborative work may encourage "thinking innovation" between NATO Science & Technology Organization (STO) and their S&T communities, the RC and its Planning Groups along with industry and critical private entities to further strengthen national and collective resilience. The collaboration between the STO and RC also stimulates further collaboration across the wider NATO Enterprise. In addition, the STO-RC partnership represents how defence science expertise can contribute to address civil preparedness challenges, and how civilian communities can engage with defence communities through research and jointly provide guidance to decision- and policymakers.

For example, resilient critical national infrastructure and supply chains are crucial to NATO's ability to maintain operational readiness in the face of adversarial disruptions or global crises. STO addresses a wide range of challenges by advancing technologies such as in additive manufacturing and exploring solutions to ensure energy security resilience. Through developing a robust supply chain framework, NATO enhances its ability to rapidly adapt to any logistical disruptions and ensures that its forces are prepared for sustained operations across a wide range of environments. The interoperability of supply chains, from munition and health management to energy security capabilities, is essential for NATO to sustain Allied forces in the field.

STO also addresses other areas that align with the Seven Baseline Requirements. Examples are mass movements and casualties, Chemical, Biological, Radiological and Nuclear (CBRN) countermeasures, electronic warfare, navigation systems, communication systems, and system approaches countering hybrid challenges. The results from STO can support the work by the Planning Groups of the RC and provides the basis for evidence-based advice to NATO's political and military leadership for policy development as well as policy implementation.

The STO will continue to strengthen its S&T within the topic of resilience to support Allies' commitment to resilience as a national responsibility and collective commitment, and by addressing new research activities to be identified, also from the Collaborative Programme of Work (CPoW) Challenge on Resilience in 2025.

STO's work on resilience aims to engage and build even broader communities across military and civilian stakeholders to support NATO's mission of enhancing deterrence and defence and safeguard NATO's values against threats and security challenges.

List of Acronyms

ACT – Allied Command Transformation

CBRN – Chemical, Biological, Radiological and Nuclear

CCPG – Civil Communications Planning Group.

COVID-19 – Coronavirus.

CPG – Civil Protection Group.

CPoW – Collaborative Programme of Work.

CSRR – Chief Scientist Research Report. Plural, CSRRs.

DDA – Deterrence and Defence in the Euro-Atlantic Area

EADRCC – Euro-Atlantic Disaster Response Coordination Centre

EPG – Energy Planning Group.

FAPG – Food and Agriculture Planning Group.

FFT – Food-for-Thought

GNSS - Global Navigation Satellite System.

JHC – Joint Health Group.

MIoP – Military Instrument of Power

NDPP – NATO Defense Planning Process

NWCC – NATO Warfighting Capstone Concept

OCS – Office of the NATO Chief Scientist

PRC – People's Republic of China

S&T – Science & Technology

STB – Science & Technology Board

STCs – Scientific and Technical Committees.

STO – NATO Science & Technological Organization

RC – Resilience Committee

WDI – Warfare Development Imperative

Annex 1

List of STO CPoW activities of relevance to NATO Seven Baseline Requirements (1999-2025).

STO CPoW finalised activities1999-2025

Reference	Title	R1	R2	R3	R4	R5	R6	R7
HFM-201	Social Media: Risks and Opportunities in Military Applications	●						
HFM-ET-201	Human Security	●						
IST-086	C3I in Crisis, Emergency and Consequence Management	●						
MSG-147	M&S Support for Crisis and Disaster Management Processes and Climate Change Implications	●						
SAS-121	Hybrid Warfare A Case Study	●						
SAS-127	Hybrid Warfare A Case Study: NATO Implications	●						
AVT-165	Benefits and Barriers for Emerging Small-Scale Electrical Power Sources		●					
AVT-209	Energy Efficient Technologies and Concepts of Operation		●					
AVT-227	Balancing energy storage with safety in large format battery packs		●					
AVT-231	Scarcity of Rare Earth Materials for Electrical Power Systems		●					
AVT-ET-248	Hydrogen as Fuel, Power Source & Infrastructure Challenges to NATO		●					
SAS-119	Energy and Defence: Reducing Dependencies & Vulnerabilities – Enhancing Efficiency		●					
SAS-165	Assessing the Implications of Emerging Technologies for Military Logistics		●					
SAS-191	Nordic Pine 2024: hybrid threats to renewable energy systems		●					
SET-150	Energy Technologies for Portable Power Supplies and Energy Management for Military Applications		●					
SET-173	Fuel Cells and Other Emerging Man Portable Power Technologies for the NATO War fighter		●					
SET-206	Energy Generation for Man wearable/Man portable Applications and Remote Sensors		●					
IST-112	Persistent Surveillance: Networks, Sensors, Architecture			●				
MSG-213	M&S in support of Building Resilience and Refugee Flow Management			●				

Reference	Title	R1	R2	R3	R4	R5	R6	R7
HFM-154	Nutrition Science and Food Standards for Military Operations				●			
HFM-305	Synthetic Biology in Defence: Opportunities and Threats				●			
HFM-382	Human Security And Military Operations				●			
SAS-022	Approaches to The Implementation of Environment Pollution Prevention Technologies at Military Bases				●			
HFM-041	Prophylaxis & Therapy Against Chemical Agents					●		
HFM-060	Operational Medical Issues in Chemical and Biological defence					●		
HFM-100	NATO Force Health Protection Requirements from Pre- to Post-Deployment: Population Health for the Military					●		
HFM-108	NATO Medical Surveillance and Response, Research and Technology Options					●		
HFM-137	Force Health Protection					●		
HFM-157	Medical Challenges in the Evacuation Chain					●		
HFM-186	State-of-the-art in Research on Medical Countermeasures against Biological Agents					●		
HFM-253	Medical Chemical Defence against Chemical Warfare Agent Threats					●		
HFM-273	Chemical, Biological and Radiological Defence					●		
IST-010	Protecting NATO Information Systems in the 21st Century						●	
IST-062	Dynamic Communications Management						●	
IST-174	Secure Underwater Communications for Heterogeneous Network-enabled Operations						●	
IST-187	5G Technologies Application to NATO Operations						●	
SCI-030	Communication, Electronic Warfare Control and Coordination						●	
SCI-268	NATO Space: S&T Developments to Enhance Resiliency and Effectiveness of NATO Operations						●	
SET-167	Navigation Sensors and Systems in GNSS Denied Environments						●	
SET-229	Cooperative Navigation in GNSS Degraded and Denied Environments						●	

STO CPoW proposed and active activities1999-2025

Reference	Title	R1	R2	R3	R4	R5	R6	R7
SAS-183	Energy Security Resilience, Capability and Interoperability		●					
SAS-190	Enhancing Energy Security Resilience, Capabilities and Interoperability		●					
SAS-198	Nordic Pine 2025: hybrid threats to renewable energy systems		●					
MSG-221	M&S in support of Building Resilience and Management of People Mass Movement			●				
HFM-306	Translating Medical Chemical Defence Research Into Operational Medical Capabilities Against Chemical Warfare Agent Threats					●		
HFM-MSG-354	Study, Design, Building and Deployment of a CBRN XR Training Platform					●		
IST-181	Terahertz-band Communications and Networking						●	
IST-189	Hybrid Military and Commercial SATCOM Networks						●	
IST-199	Free-Space Optical Communications						●	
SAS-HFM-ET-GD	UAV-logistics Using A Grid Of Autonomous Charging Stations		●					●
SAS-HFM-ET-GC	Autonomous transport swarms							●
SAS-218	Autonomous Transport Swarms							●

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Website

NATO OTAN

Science & Technology Organization (STO)

The Chief Scientist Research Reports (CSRRs) provide NATO's senior political and military leadership with clear, evidence-based insight into science & technology developments.

The Alliance's resilience stems from a combination of civil preparedness and military capacity. The STO activities that are aligned with the Seven Baseline Requirements for resilience build our collective understanding of the concept of resilience. This CSRR serves as a guide for shaping both future research programmes and activities, as well as building partnerships between the research and resilience expert communities.

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