NATO Parliamentary Assembly

SCIENCE AND TECHNOLOGY COMMITTEE

DEFENCE INNOVATION:
CAPITALISING ON NATO’S SCIENCE AND TECHNOLOGY BASE

DRAFT SPECIAL REPORT

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Special Rapporteur

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* Until this document has been adopted by the Science and Technology Committee, it only represents the views of the Special Rapporteur.
# TABLE OF CONTENTS

ACRONYM

I. INTRODUCTION ............................................................................................................ 3

II. NATO'S ROLE IN MAINTAINING THE S&T EDGE .................................................. 4
    A. KEY OBJECTIVES ................................................................................................. 4
    B. NATO'S ADDED VALUE ...................................................................................... 5
    C. NATO'S S&T TOOLS .......................................................................................... 7

III. THE NATO S&T COMMUNITY .............................................................................. 9
    A. THE SCIENCE AND TECHNOLOGY ORGANISATION ........................................ 9
       1. OFFICE OF THE CHIEF SCIENTIST ............................................................. 9
       2. COLLABORATION SUPPORT OFFICE ......................................................... 9
       3. CENTRE FOR MARITIME RESEARCH AND EXPERIMENTATION ........ 10
    B. ALLIED COMMAND TRANSFORMATION ......................................................... 11
    C. CONFERENCE OF NATIONAL ARMAMENTS DIRECTORS ........................... 12
    D. NATO INDUSTRIAL ADVISORY GROUP ......................................................... 12
    E. EMERGING SECURITY CHALLENGES DIVISION .......................................... 13
    F. COMMITTEE OF THE CHIEFS OF MILITARY MEDICAL SERVICES ........ 13
    G. CONSULTATION, COMMAND AND CONTROL BOARD ............................... 14
    H. NATO COMMUNICATIONS AND INFORMATION AGENCY .......................... 14

IV. INITIAL THOUGHTS ON THE WAY FORWARD .................................................... 14

SOURCES AND BIBLIOGRAPHY ............................................................................... 17
<table>
<thead>
<tr>
<th>ACRONYMS</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT</td>
<td>Allied Command Transformation</td>
</tr>
<tr>
<td>AFSC</td>
<td>Alliance Future Surveillance and Control</td>
</tr>
<tr>
<td>C3</td>
<td>Consultation, Command and Control</td>
</tr>
<tr>
<td>CBRN</td>
<td>Chemical, Biological, Radiological and Nuclear</td>
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<td>CFI</td>
<td>Connected Forces Initiative</td>
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<td>CNAD</td>
<td>Conference of National Armaments Directors</td>
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<tr>
<td>CMRE</td>
<td>Centre for Maritime Research and Experimentation</td>
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<td>COMEDS</td>
<td>Committee of the Chiefs of Military Medical Services</td>
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<tr>
<td>CPoW</td>
<td>Collaborative Programme of Work</td>
</tr>
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<td>DAT PoW</td>
<td>Defence Against Terrorism Programme of Work</td>
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<td>IED</td>
<td>Improvised Explosive Devices</td>
</tr>
<tr>
<td>NATO HQ</td>
<td>NATO Headquarters</td>
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<tr>
<td>NATO PA</td>
<td>NATO Parliamentary Assembly</td>
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<td>NCIA</td>
<td>NATO Communications and Information Agency</td>
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<tr>
<td>NDPP</td>
<td>NATO Defence Planning Process</td>
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<td>NIAG</td>
<td>NATO Industrial Advisory Group</td>
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<td>OCS</td>
<td>Office of the Chief Scientist</td>
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<td>R&amp;D</td>
<td>Research and Development</td>
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<td>S&amp;T</td>
<td>Science and Technology</td>
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<td>SFA</td>
<td>Strategic Foresight Analysis</td>
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<td>SPS</td>
<td>Science for Peace and Security</td>
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<td>STB</td>
<td>Science and Technology Board</td>
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<tr>
<td>STC</td>
<td>Science and Technology Committee</td>
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<td>STCTTS</td>
<td>Sub-Committee on Technological Trends and Security</td>
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<tr>
<td>STO</td>
<td>Science and Technology Organisation</td>
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I. INTRODUCTION

1. On 4 October 1957, the Soviet Union launched Sputnik, the world’s first satellite. Given the military advantages the technology promised, the launch sent shockwaves through the transatlantic Alliance, and Allies had to race to make up for lost time. NATO cannot be caught off-guard again. Unfortunately, there is a real possibility the Alliance could fall behind in the coming years. A look at missile technology, artificial intelligence and quantum computing illustrates the risks. In March 2018, President Vladimir Putin boasted about new nuclear weapons under development, including a heavy intercontinental missile, an ‘invincible’ cruise missile and an unmanned nuclear-armed underwater vehicle. Shortly after, Russia also successfully tested its Kinzhal hypersonic missile. In the East, China is investing USD 150 billion in artificial intelligence to become the world’s leading innovator in the sector by 2030. The country is also making huge strides in quantum computing. The government is spending USD 10 billion on a new national laboratory. In 2016, Chinese and Austrian researchers successfully held the first intercontinental video call secured through quantum encryption by way of a Chinese satellite.

2. The Alliance has been devoted to the settlement of international disputes by peaceful means since its creation. At the same time, Allies stand united in their commitment to deter any potential aggression and, if deterrence fails, to collectively defend themselves. Therefore, NATO must possess the full range of capabilities to fulfil its duty to deter and defend the citizens of the Alliance. NATO’s unrivalled defence science and technology (S&T) edge has been the hallmark of the Alliance. Sheer quantity alone will never be enough to face the most demanding threat, i.e. the challenge of a military near-competitor. Numbers do not matter much if opposing fighter aircraft outmatch NATO jets in missile range or if NATO submarines cannot detect the other sides’ submarines. Therefore, one of NATO’s highest priorities must be to remain at the cutting edge of technology.

3. Since US Senator Henry Jackson’s visionary leadership over 60 years ago, the Science and Technology Committee has remained vigilant in guarding NATO’s S&T edge. Former STC and STCTTS Chairperson Jan Arild Ellingsen (Norway) described the STC’s core mission in May 2016: “As parliamentarians of the Alliance, we must make sure that our defence and security capabilities correspond with the need to ensure our common defence and security and the well-being of our citizens and societies.” Alas, in 2017, the Committee – supported by the NATO Parliamentary Assembly as a whole – noted its worry “that NATO’s technological edge is eroding” (NATO PA, 2017a). As a consequence, the STC is redoubling its efforts to identify the challenges in meeting Alliance goals and to lend political support to rectify any shortcomings. Your Rapporteur is eager to carry forward this vital work, to communicate our findings to Allied governments, parliaments and – vitally important – citizens and thus effect a change in mindsets. Most Allies are beginning to understand the importance of maintaining the S&T edge. However, your special Rapporteur would argue that a much greater sense of urgency must prevail. If the Alliance does not redouble its efforts, the window of opportunity to adapt to the changing circumstances will rapidly close.

4. The challenges become even more urgent when one considers the volatile and unsettling international situation. NATO today finds itself at an exceptionally critical juncture in its almost 70-year history. The hope that Russia would become a true strategic partner has been quashed by President Putin and his cyber and hybrid warfare tactics. Russia illegally occupies Crimea and parts of Georgia, continues its armed support to separatist militants in Eastern Ukraine and has interfered in democratic elections in Allied and partner countries. What began as an Arab Spring full of hope has turned into a region riven with strife and a springboard for terrorist groups. The expectation that economic growth would, over time, lead to a more democratic and less militaristic China has not come to pass. The list of strategic challenges goes on. As NATO leaders correctly put it, the Alliance is “faced with an increasingly diverse, unpredictable, and demanding security environment” (NATO, 2016).
5. A changing global S&T landscape also presents new challenges in maintaining a S&T edge. Emerging technologies have the potential to disrupt the strategic balance. Technological innovation is increasingly driven by the commercial, non-defence sector. Small- and medium-sized enterprises, start-up companies and even individuals are making substantial gains in technological innovation compared to traditional large corporations. Perhaps most importantly, more and more cutting-edge technologies are being developed in countries outside the Alliance, and some of these countries could soon begin to outpace traditional S&T leaders.

6. This draft special report is a direct follow-up to the 2017 General Report Maintaining NATO’s Technological Edge: Strategic Adaptation and Defence Research and Development by US Congressman Tom Marino (NATO PA, 2017b). Your Rapporteur’s ambition is to further refine this draft and present concrete and realistic policy proposals at the 2018 Annual Session in Halifax, Canada. Therefore, this draft report is, first and foremost, a mapping exercise of NATO S&T. Your Rapporteur is looking forward to discussing the draft at the Spring Session in Warsaw, Poland and to gathering further input from Committee members. With the help of the Committee Director, she will then conduct interviews with relevant national and NATO officials. Indeed, she has already held a special meeting with the NATO Chief Scientist in February 2018. Furthermore, the topics covered in this draft will be discussed during Committee visits to Norway and California, United States.

7. Congressman Marino’s 2017 STC General Report primarily scrutinises whether Allies spend enough on defence research and development (R&D) and how Allies are changing their defence R&D processes in the new S&T landscape. In this draft report, a complement to the previous report, your Rapporteur would like to answer the following questions:

- How are we defining and measuring NATO’s S&T edge?
- What is NATO’s role in maintaining the S&T edge?
- What tools does NATO have to fulfil this role?
- How are we evaluating NATO on its delivery of its S&T mission?
- Does the Alliance need new instruments or policies to maintain its S&T edge?

II. NATO’S ROLE IN MAINTAINING THE S&T EDGE

A. KEY OBJECTIVES

8. Your Rapporteur would argue that the Alliance must, at a minimum, continue to fulfil two key objectives to ensure that NATO maintains its S&T edge.

9. **Objective 1:** Defence innovators in the Alliance must maintain their leadership positions. The Alliance must have the most advanced defence capabilities at its disposal to deter and, if that fails, defend against a near-competitor. The leading Allied defence innovators – in particular the United States, the United Kingdom, France, and Germany – must remain committed to spending sufficient resources on defence S&T and R&D and to continually evaluate and adapt their defence S&T and R&D processes. If potential adversaries overtake the defence innovators in the Alliance, NATO’s ability to carry out its core tasks will suffer gravely.

10. **Objective 2:** The defence technology gap between Allies must remain small enough to be bridged by interoperability. The large diversity of Allies is ultimately a primary source of NATO’s strength, but it also means that large differences exist in defence capabilities. However, it is critically important that NATO keep the technology gap between Allies small enough that interoperability – the glue binding NATO’s militaries on the battlefield – remains possible. Even if the United States and other Allies possess the most advanced capabilities, these are of little use
if Allies cannot operate together on the most demanding battlefields. In other words, the most crucial defence technological innovations must diffuse within the Alliance in a timely manner.

**B. NATO’S ADDED VALUE**

11. In an Alliance of sovereign states, the primary responsibility to maintain a robust defence S&T base and to discover, develop and adopt cutting-edge defence technologies lies with NATO member states themselves. Part of the answer lies in sufficient defence S&T and R&D budgets; another part lies in continually evaluating and adapting defence S&T and R&D processes. In an Alliance united in purpose, a third ingredient is extensive and meaningful coordination, cooperation and collaboration. Hence, over the last six decades, NATO has put tools into place to facilitate the achievement of the above objectives. As a result, NATO provides substantial added value to national defence S&T and R&D by facilitating technological innovation and its diffusion.

12. NATO’s S&T tools (and do) provide added value in at least four crucial processes in technological innovation and diffusion (Rogers, 2003; see Figure 1 for an overview of the innovation-decision process).

13. **Identification of problems and needs:** Ideally, technological innovation and diffusion should be the result of a thorough defence planning process to equip the armed forces with the forces, assets, facilities and capabilities to carry out their tasks across the full spectrum of missions (see Figure 2 for a generic model of long-term defence planning and Figure 3 for the NATO Defence Planning Process (NDPP)). S&T plays a crucial role in identifying problems or needs. In particular, the S&T community provides important input about strategic foresight to identify the trends that could lead to gaps in the long term. However, S&T can also provide insights into near- or medium-term problems or needs. The NATO S&T community has several tools to connect with national defence planning processes and the NDPP.

14. **Basic and applied research:** It is rare that defence planners identify a problem that can be addressed by existing solutions on the market or even by capabilities under development. Technological innovation thus often starts at the level of basic and applied research. Only the largest defence spenders have the budgets, level of ambition and political will to engage in deep and broad basic or applied research efforts. Hence, NATO offers a range of tools to cooperate, coordinate and collaborate on basic and applied research. This is indeed the heart of NATO S&T efforts.

15. **Development of technological innovations:** Defence research works towards understanding whether S&T can be turned into a capability that can address the identified problems and needs. Fundamentally, capability development can thus be seen as “the process of putting a new idea in a form that is expected to meet the needs of an audience of potential adopters” (Rogers, 2003) – in this case, military decision makers, procurement officers or military operators. NATO has a wide range of capability development tools, and NATO S&T plays a vital supporting role in many of them.

16. **Diffusion and adoption processes of innovations:** The development of a technological innovation that addresses a problem or need does not guarantee that armed forces will adopt it. Fundamentally, the decision to adopt an innovation is “an information-seeking and information-processing activity in which an individual is motivated to reduce uncertainty about the advantages and disadvantages of the innovation” (Rogers, 2003; see also Figures 4 and 5). Your Rapporteur would argue that NATO can play a role in facilitating diffusion and adoption processes, including by reducing the time needed to get from idea to adoption.
17. Beyond NATO’s contribution in these four processes, NATO S&T also adds more specific value for its member states:

- **Burden sharing:** In the current global S&T landscape and at current budget levels, no NATO member state can shoulder the defence S&T burden alone. Working together within NATO S&T enables member states to share some of the burden.

- **Capacity building:** NATO S&T programmes bring together scientists, engineers and analysts in a learning environment. This helps them gain new skills and knowledge – to the benefit of member states.

- **Interoperability:** Interoperability is key to NATO operations. Thus, the earlier in the R&D process member states can work towards interoperability, the better for the Alliance.

- **Quality assurance:** S&T thrives on peer review. In NATO S&T, national experts can submit their ideas and work to a larger community in classified and non-classified settings – with the former adding substantial value.

- **Building trust:** The Alliance is built on trust. During operations and, at worst, wartime, Allies will need to send troops into harm’s way. Building trust at all levels, including at the S&T level, is therefore immensely valuable.

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**Figure 1:** Six Main Stages in the Innovation-Decision Process (based on Rogers, 2003)

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**Figure 2:** Process of Long-Term Defence Planning (Source: Stojkovic and Dahl, 2007)

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**Figure 3:**

**Four-Year NATO Defence Planning Process**

- Step 1 - Establish political guidance
- Step 2 - Determine requirements
- Step 3 - Apportion requirements and set targets
- Step 4 - Facilitate implementation
- Step 5 - Review results

*Current status: Step 5*

*Start of next NDPP cycle: July 2018*
C. NATO’S S&T TOOLS

18. NATO S&T can be understood as the totality of national and NATO-level S&T capacities charged maintaining NATO’s scientific and technological advantage. NATO S&T thus generates, shares and utilises advanced scientific knowledge, technological developments and innovation in support of NATO core tasks. Specifically, NATO S&T seeks to: a) accelerate capability development; b) deliver timely, targeted advice to the Alliance, and c) build capacity through cooperative S&T with partner countries and institutions.

19. Unified governance of NATO S&T is exercised through the NATO Science and Technology Board (STB), composed of national representatives and NATO S&T stakeholders. The NATO Chief Scientist chairs the STB with the support of two Co-Vice-Chairmen from NATO’s International Staff and International Military Staff. The STB promotes coherence of NATO S&T through objectives set out in the NATO S&T Strategy, focuses work through medium-term NATO S&T Priorities (see Figure 6) and serves as a focal point for all NATO S&T programmes of work.

20. The NATO S&T community is broad and deep (see Figure 8). In addition to national and NATO-level stakeholders, the Science and Technology Organisation (STO) is the main NATO body focused on S&T. The STO has three executive bodies:

- the Office of the Chief Scientist (OCS) at NATO Headquarters (HQ), which supports the STB and the Chief Scientist;
- the Collaboration Support Office (CSO) in Neuilly-sur-Seine, France, which provides a collaborative environment and support to NATO S&T activities; and
- the Centre for Maritime Research and Experimentation (CMRE) in La Spezia, Italy, which organises and carries out projects and experiments in the maritime domain.

21. The NATO S&T community carries out several hundred S&T-related activities. The lion’s share of NATO’s S&T work takes place in the STO’s Collaborative Programme of Work (CPoW) and the CMRE. At the NATO level, a number of other divisions, bodies and agencies in the areas of armaments, military, consultation, command and control as well as security are part of the larger NATO S&T community:

- Allied Command Transformation (ACT)
- the Conference of National Armaments Directors (CNAD)
- NATO Industrial Advisory Group (NIAG)
- the Emerging Security Challenges Division
- the Committee of the Chiefs of Military Medical Services (COMEDS)
- the Consultation, Command and Control (C3) Board
- the NATO Communications and Information Agency (NCIA)

1 Your Rapporteur recognises the strategic importance of partner countries and institutions. However, given the focus of this draft report, partnerships are not fully covered.
Figure 6: 2017 S&T Priority Areas

- Precision Engagement
- Advanced Human Performance & Health
- Cultural, Social & Organisational Behaviours
- Information Analysis & Decision Support
- Data Collection & Processing
- Communications & Networks
- Autonomy
- Power & Energy
- Platforms & Materials
- Advanced Systems Concepts

Figure 7: 2017 NATO S&T Activity across the whole NATO S&T Community

- 12% Precision Engagement
- 9% Advanced Human Performance & Health
- 8% Cultural, Social & Organisational Behaviours
- 11% Information Analysis & Decision Support
- 17% Data Collection & Processing
- 8% Communications & Networks
- 4% Autonomy
- 3% Power & Energy
- 8% Platforms & Material
- 20% Advanced Systems Concepts

Figure 8: NATO S&T Community
III. THE NATO S&T COMMUNITY

A. THE SCIENCE AND TECHNOLOGY ORGANISATION

1. OFFICE OF THE CHIEF SCIENTIST

22. At NATO HQ, there is the Office of the Chief Scientist (OCS) which consists of six staff members who support the Chief Scientist in his two main functions of chairing the STB and as the senior scientific advisor to NATO leadership. The OCS acts as the bridge between the CSO, CMRE and NATO structures at NATO HQ.

23. The OCS also leads or supports several sustained or ad hoc initiatives. Examples include:

- **Revisions of the NATO S&T Strategy:** The OCS managed the initial 2013 NATO S&T Strategy and the 2017/2018 revision process.
- **Tech Trends Report:** The OCS published its first Technology Trends Report in 2017, identifying emerging technologies with a potential disruptive impact in the short, medium or long term.
- **Von Karman Horizon Scanning:** The von Karman Horizon Scan is an instrument to quickly perform a technology scan on a particular S&T topic (time needed: two to six months). The Scan examines the state of the art in the field; the outlook for the next decade; its relevance for the armed forces; and potential avenues for investment. In 2016, a von Karman Horizon Scan was performed on laser weapons; a Scan on quantum capabilities has begun; and one on optronic 3D imaging systems is under consideration.
- **Maritime Security Initiative:** A Maritime Security Initiative is in its second phase, focusing on submarine warfare and naval mine warfare. The aim is to build an understanding of Allied approaches; develop innovative strategies to improve capabilities; identify potential game changing technologies; spur research collaborations and common approaches; and inform NATO S&T current and future work.

24. The OCS also links with other activities at NATO HQ that touch upon S&T. For example, the Alliance is currently in the early stages of assessing what capability might follow the Boeing E-3A Sentry Airborne Warning and Control System (AWACS) aircraft when they reach the end of their lifespan in 2035-2038. Conducted under the CNAD, the OCS led the working group on solutions for Alliance Future Surveillance and Control (AFSC). In 2017, the OCS worked with the NATO Support and Procurement Agency on two small-scale studies on specific AFSC issues.

2. COLLABORATION SUPPORT OFFICE

25. The Collaboration Support Office provides a collaborative environment and supports NATO S&T activities in six Panels and Groups (see Figure 9). The CSO has a staff of about 50. About 30% are voluntary national contributions by Allies.

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Figure 9: STO Panels and Groups

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<th>Applied Vehicle Technology</th>
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<td>Human Factors and Medicine</td>
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<td>Information Systems Technology</td>
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<tr>
<td>NATO Modelling and Simulation Group</td>
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<tr>
<td>Systems Analysis and Studies</td>
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<tr>
<td>Systems Concepts and Integration</td>
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<tr>
<td>Sensors and Electronics Technology</td>
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26. **STO Collaborative Programme of Work:** The CSO’s core activity is to support and enable the STO’s CPoW. In 2018, the CSO will support about 250 activities. The vast majority of funding for the CPoW comes from national budgets. While hard to estimate, investment in the CPoW lies somewhere between EUR 250 to 500 million. The CSO has a small budget to stimulate the initiation of activities, amounting to EUR 5.85 million in 2018. The STO Panels and Groups who carry out the CPoW are composed of national representatives and, if appropriate, joined by world-class experts. The CPoW taps into an active network of about 5,000 experts which, in turn, can reach out to an extended network of 200,000 colleagues. The NATO S&T network thus constitutes the world’s largest collaborative research forum in the field of defence and security. The CPoW enables Allies to identify areas of common interest and act upon them in a collaborative fashion. It is for the Allies by the Allies in line with their respective national needs as well as those of NATO as a whole. To start an activity, at least four Allies and/or NATO bodies must be interested in working together on an issue.

27. **STO Themes:** The CSO has in recent years introduced Themes focused squarely on operational needs. Several high-priority topics are not well-represented in the CPoW because they are multidisciplinary and thus do not fit neatly into the Panels and Groups. The aim is to foster communities of interest and boost CPoW activities focused on these Themes. The first three Themes are a) autonomy; b) military decision making using big data and artificial intelligence; and c) operations in contested urban environments. Early indications show that the approach has achieved success in boosting focus on these Themes. For example, activities focused on autonomy have tripled since 2016. Currently about 30% of the CPoW is aligned with these Themes.

28. **Demonstrations and field trials:** The CSO has identified that demonstrations and field trials can help bridge the so-called valley of death between research and development. Hence, the CPoW continues to increase the number of demonstrations and field trials. In 2018, the number is expected to rise to at least 20 (up from eight in 2017 and two in the previous years).

### 3. CENTRE FOR MARITIME RESEARCH AND EXPERIMENTATION

29. The CMRE is a customer-funded in-house STO lab of about 60 people. The CMRE organises and conducts basic and applied research as well as technology development. It delivers solutions to address Alliance defence and security needs that are both innovative and field-tested. The CMRE is a knowledge repository for NATO.

30. As an STC delegation learned first-hand during a visit in 2016, the CMRE has a particular focus on the underwater environment, as the Russian underwater threat is rising and NATO faces significant capability shortfalls in this area. The CMRE pays particular attention to new challenges in mine countermeasures and anti-submarine warfare and new opportunities in maritime autonomy technologies. Current research focus areas are collaborative autonomy; big data analytics and decision support tools; artificial intelligence; and Arctic oceanography.

31. The CMRE’s current ambitions are centred on broadening its customer base beyond NATO, where its main customer is ACT. Recently, it has had success in winning bids for the the US National Oceanic and Atmospheric Administration and the European Union, including for the Preparatory Action for Defence Research and the Horizon 2020 Framework Programme for Research and Innovation.

32. The CMRE has access to two research vessels, the NATO Research Vessel NRV Alliance and the Coastal Research Vessel Leonardo, which can engage in S&T related work from concept development to multinational exercises. The NRV Alliance is ice-capable and the most silent ship in the world. The CMRE thus combines S&T expertise with hands-on oceanic research. Further assets include unmanned vehicles (underwater and surface) as well as underwater and wave
gliders. In 2017, CMRE assets participated in five operational engagements from the Greenland-Iceland-UK Gap to the Mediterranean Sea.

**B. ALLIED COMMAND TRANSFORMATION**

33. Allied Command Transformation in Norfolk, Virginia remains the only permanent NATO headquarters outside of Europe and the only one in North America (at least until a proposed Atlantic NATO command is established).

34. ACT leads NATO’s initiatives for military transformation, with six focus areas: command and control; capabilities; future sustainment; human capital; collective training and exercises; and partnerships. ACT’s work is broad and deep, and concentrates on five lines of efforts: future work; the NDPP; requirements; capability development; and force development. Several specific activities routinely involve input from the NATO S&T community. ACT also contributes to programmes of work with NATO S&T stakeholders. First and foremost, ACT works with the STO and its executive bodies on a number of activities and initiatives, including the STO’s CPoW and the 2017 Tech Trends Report. However, it also collaborates on NATO S&T with other stakeholders. For example, in 2017, it worked with the COMEDS on modular medicine and conducted S&T work during several exercises.

35. ACT seeks input from the NATO S&T community in a variety of its programmes and on a variety of topics.

36. **ACT Priority Topics:** ACT works with the NATO S&T community on particular priority topics when appropriate. Currently, a number of priority topics have a distinct S&T dimension: autonomy; command and control; urbanisation; logistics and sustainment; and modelling and simulation for operational planning and future capability development analysis.

37. **Strategic Foresight Analysis (SFA):** A fundamental building block for ACT’s work on long-term military transformation is the Strategic Foresight Analysis (SFA). The SFA aims to identify common threats, security trends and their potential security implications on a longer timeframe. Considerable attention is paid to S&T trends and ACT thus works closely with the STO on these issues.

38. **Framework for Future Alliance Operations:** The Framework for Future Alliance Operations outlines NATO’s strategic context and examines solutions for NATO to shape the future security environment. Here again, coordination takes place with the NATO S&T community for S&T related aspects.

39. **Concept development and experimentation:** ACT seeks to create synergies in the field of concept development and experimentation. Each year, it holds an International Concept Development and Experimentation Conference where stakeholders discuss the current state of the art. The NATO S&T community is well represented in these discussions.

40. **Innovation Hub:** ACT’s Innovation Hub is an activity which gathers experts from across NATO members and partners to discuss and design innovative solutions to today’s security challenges. This knowledge-based hub convenes a wide range of stakeholders from across NATO structures and Allies.

41. **Connected Forces Initiative (CFI):** The Connected Forces Initiative is a central NATO framework to improve the interconnectedness and interoperability of its armed forces. Its main focus is education, training, exercise and evaluation, but it also has a significant technology component. Thus, CFI activities include the insertion of cutting-edge technology.
42. Chiefs of Transformation Conference: Another key annual event hosted by ACT is the Chiefs of Transformation Conference. Allied and partner Chiefs of Transformation come together to work towards a higher level of understanding of future security challenges, opportunities for innovation and models for transformation and cooperation. S&T is a key aspect of transformation.

C. CONFERENCE OF NATIONAL ARMAMENTS DIRECTORS

43. The Conference of National Armaments Directors (CNAD) is the senior NATO committee responsible for promoting cooperation between countries in the armaments field. Working under the aegis of the Defence Investment Division at NATO HQ in Brussels, the CNAD’s role is to help NATO countries in defence planning, and encourage standardisation and interoperability. The CNAD also acts as an advisory body to the North Atlantic Council (NAC).

44. The CNAD meets twice a year in a plenary session, every two weeks in a permanent session and once a month with NATO partners. The CNAD considers political, economic and technical aspects of the development and procurement of equipment for NATO forces. The CNAD is chaired by the Assistant Secretary General for Defence Investment. The National Armaments Directors meet during the plenary sessions. At NATO HQ, the National Armaments Directors are permanently represented by National Armaments Directors’ Representatives.

45. The CNAD has several subordinate groups, including the main armaments group (Army, Air Force and Naval Armaments) and the NATO Industrial Advisory Group (see below). Moreover, the CNAD governs several more specific groups, most importantly on Ballistic Missile Defence; Alliance Future Surveillance and Control (AFSC); Joint Intelligence, Surveillance and Reconnaissance; Alliance Ground Surveillance; and Airborne Warning & Control.

46. The CNAD has a very close dialogue and coordinates with NATO Military Authorities and ACT. The main armaments groups and specific groups also work closely with the NATO S&T community when its expertise is needed. Recent examples include NATO S&T support for:

- AFSC capability;
- NATO Future Soldier Systems;
- Capability development in anti-submarine warfare and naval mine countermeasures;
- Multinational effort on Cooperation on Multinational Maritime Multi Mission Aircraft Capabilities;
- The use of several emerging technologies in the air domain, including new modelling and simulation tools; cyber defence; big data; artificial intelligence; and unmanned aerial systems;
- Further elaboration of the 2017 CNAD Framework to Facilitate Innovation in order to increase awareness of and access to innovative solutions.

D. NATO INDUSTRIAL ADVISORY GROUP

47. The NATO Industrial Advisory Group (NIAG) is a high-level consultative and advisory body of senior industry representatives under the CNAD. Its role is to facilitate Alliance armaments cooperation; advise on the industrial and technological base; and support capability development. The NIAG also provides a forum for an open exchange of views between industry and NATO.

48. The NIAG is composed of high-level industrial representatives from Allied countries. It consists of a plenary body, which meets three times per year; specific advisory groups; and a permanent liaison representation to CNAD groups and other NATO structures.

49. The NIAG fulfils its advisory function by conducting an annual programme of about ten studies. These studies are carried out by NIAG Study Groups made up of industrial experts assigned by their respective companies through national NIAG delegations. The Study Groups
issue reports and brief the relevant NATO structures. Since its inception, the NIAG have delivered more than 200 studies, covering a wide spectrum of topics. In 2017, studies on Degraded Visual Environment for helicopter navigation, Big Data Analytics as well as NATO Defensive Aids Systems in the air domain had significant S&T dimensions.

50. Engagement with the NATO S&T community, in particular the STO, mainly occurs through these Study Groups and focuses on technologies at a higher readiness level. However, ad hoc engagements also take place. For example, NIAG participates in the 2018 von Karman Horizon Scan on quantum capabilities and will join the Scan on optronic 3D imaging systems if it goes forward. It has also worked with the STO on the Alliance Future Surveillance Capability working group and engages in specific CPoW work.

E. EMERGING SECURITY CHALLENGES DIVISION

51. The Emerging Security Challenges Division at NATO HQ addresses non-traditional risks and challenges. While mostly focused on policy, the Division has two work strands engaged in S&T related work.

52. Defence Against Terrorism Programme of Work: Since 2004, NATO has run a Defence Against Terrorism Programme of Work (DAT PoW) which aims to rapidly identify, develop and deliver innovative technical and conceptual counter-measures in the protection of forces, infrastructure and civilians. DAT PoW is executed with NATO common funding. DAT PoW works under three capability umbrellas: incident management; force protection and survivability; and network engagement. Key topics have in the past included projects focused on countering improvised explosive devices (IED) and mortar attacks, precision air drop technologies and harbour and port protection. With NATO’s increasing focus on counter-terrorism in recent years, DAT PoW was reinforced in 2017 by taking on the C-IED and chemical, biological, radiological and nuclear (CBRN) programme of work formerly executed by the CNAD. In 2017, the lion’s share of activities was in counter-IED (C-IED) and explosive ordnance disposal, aircraft survivability, defence against CBRN weapons, biometrics and special operation forces.

53. Science for Peace and Security: The roots of NATO’s Science for Peace and Security (SPS) programme seek to increase dialogue and practical cooperation between Allies and partner countries in the fields of scientific research, technological innovation and knowledge exchange. As any project requires at least one non-NATO partner country, it is thus primarily a tool for partnership. The programme is funded from NATO’s civilian budget. It offers four grant mechanisms: multi-year research projects, advanced research workshops, advanced training courses and advanced study institutes. SPS key priorities revolve around NATO’s emerging or new security challenges (see above); NATO operations and missions; and human and social aspects of security. In the last five years, more than 450 collaborative activities were initiated under the SPS programme. In 2017, 65 activities were held or were ongoing.

F. COMMITTEE OF THE CHIEFS OF MILITARY MEDICAL SERVICES

54. The Committee of the Chiefs of Military Medical Services (COMEDS) is NATO’s senior body on military health. The COMEDS seeks improvement in coordination, standardisation and interoperability in military medicine as well as in information sharing between Allies and partners. The Chairman of the COMEDS convenes a plenary session twice a year.

55. While the COMEDS focuses on medical support for operations, it does engage in S&T-related efforts and interfaces with other stakeholders in the NATO S&T community. COMEDS and medical advisors from the International Military Staff and ACT also support capability development and in this context work together with the NATO S&T community when
appropriate. The COMEDS also has a Futures Advisory Board, in which the STO and ACT are represented, in order to support preparations for future military medical challenges.

G. CONSULTATION, COMMAND AND CONTROL BOARD

56. Another NATO body that touches upon S&T work is the NATO Consultation, Command and Control (C3) Board, which reports to and advises the NAC, the Defence Planning Committee and the CNAD. The C3 Board focuses on information sharing and interoperability, including on issues such as cyber defence, information assurance and joint intelligence, surveillance and reconnaissance. It meets twice a year in plenary sessions and regularly in permanent sessions at NATO HQ. The C3 Board has four multinational panels where NATO S&T is implicated at times, for example by providing support through the STO:

- the Communication and Information Services Capability Panel;
- the Navigation and Identification Capability Panel;
- the Civil/Military Spectrum Capability Panel; and
- the Information Assurance and Cyber Defence Capability Panel.

H. NATO COMMUNICATIONS AND INFORMATION AGENCY

57. The NATO Communications and Information Agency (NCIA) was created in 2012 through the merger of several agencies and became a customer-funded agency. The Agency’s mission is to guard NATO’s networks; offer timely support during operations; deliver consultation, command and control technology throughout NATO; and support Allies and Partners in their development of capabilities in the fields of command, control, communications, computers, intelligence, surveillance and reconnaissance.

58. The S&T related work that the NCIA undertakes represents only a small percentage of its revenue. The bulk of this work is centred on information analysis and decision support; communications and cyber; and joint intelligence surveillance and reconnaissance. However, the Agency is expanding into data science, artificial intelligence and big data analytics, in line with one of the three STO themes. Recent highlights in the NCIA’s S&T work include efforts on a Future Deployable Capability (information technology asset); an Afghan Public Opinion Analysis with data going back to 2008; a Federated Mission Networking capability; an artificial intelligence and big data analysis project; work on mission data from Afghanistan; and support for the Joint Intelligence, Surveillance and Reconnaissance initiative under the CNAD. Moreover, the NCIA takes part in a small number of STO CPoW activities.

IV. INITIAL THOUGHTS ON THE WAY FORWARD

59. This draft report has underlined that Allied governments and parliaments must ensure that the Alliance stays ahead and maintains the S&T edge. The urgency of this strategic challenge is great. As US Congressman and former STC General Rapporteur Tom Marino wrote in 2017: “NATO’s technological edge is eroding. Therefore, to safeguard our freedom and shared values, strategic defence R&D policy decisions are necessary and urgent” (NATO PA, 2017b).

60. To meet the challenge, it is essential, first, that Allies live up to the Wales Defence Investment Pledge and move towards spending a minimum of 2% of Gross Domestic Product on defence and more than 20% of defence budgets on major equipment, including related R&D. Your Rapporteur welcomes that Allies have committed themselves to delivering annual national plans which detail how they intend to meet the Defence Investment Pledge in three major areas: cash, capabilities, and contributions. Your Rapporteur is looking forward to gathering more information and seeing progress on these national plans after decisions are made at the 2018
NATO Summit. However, she laments the fact that these national plans will not be made public. Lawmakers and citizens of the Alliance need to know if NATO and Allies are achieving their commitments and goals. Currently, public NATO reporting on defence expenditures only has four very broad categories which make it hard to understand whether the Alliance is on track in a number of areas. This includes defence S&T investment, which is a non-visible part of ‘equipment’ expenditure. In other words, in NATO’s reporting, a dollar spent on buying off-the-shelf artillery is counted in the same way as a dollar spent on artificial intelligence research. Your Rapporteur believes that more transparency is needed.

61. Second, it is also essential that Allies adapt to the new S&T landscape at the national level, as business as usual is no longer viable. Your Rapporteur thus welcomes recent national initiatives to spur defence technological innovation, for example a new Defence Innovation Agency to be established in France. A third aspect to make NATO fit for purpose on defence S&T and R&D is to increase the added value of NATO. Your Rapporteur believes that much work needs to be done in this area.

62. This draft report has laid out NATO’s role in maintaining the S&T edge and mapped the NATO S&T community’s contribution to this effort. On the basis of this draft and additional research, your Rapporteur will present concrete and realistic policy proposals on how to advance NATO S&T and strengthen its contribution to maintaining NATO’s S&T edge.

63. The NATO S&T community recognises the challenge. The proposed 2018 revision of the NATO S&T Strategy (approved by the STB and currently under consideration at NATO HQ) identifies several areas where NATO S&T needs to be strengthened. It calls for NATO S&T to:

- Improve situational awareness of S&T knowledge, technology and innovative developments;
- Forge and nurture effective cooperation with traditional and non-traditional partners;
- Promote prototyping and technology demonstrations to accelerate capability development;
- Enhance NATO S&T’s input in national and NATO-level decision making;
- Focus on Alliance needs to support capability development by refining STO Priorities and Initiatives;
- Enhance the national network of experts working with the NATO S&T community;
- Intensify strategic communications to deliver advice, products and situational awareness;
- Improve the programmes of work rooted in high-priority technologies and operational challenges; and
- Promote coherence by connecting national and NATO-level S&T capacities.

64. Your Rapporteur will examine how the NATO S&T community plans to tackle these problems, but she will also expand the line of questioning. She would not like to give premature answers before she has finished her consultations. However, here are examples of the types of questions she would like to answer:

- How do we evaluate if Allies and NATO can maintain the S&T edge through technological innovation?
- How can NATO S&T become more agile in responding to today and tomorrow’s challenges, and quickly and efficiently insert and integrate technological innovation into the armed forces?
- How can members of the S&T community at the NATO level better connect amongst themselves to increase synergies?
- How can the added value of NATO S&T to Allied armed forces be reinforced?
- How can the NATO S&T community be diversified in terms of profiles, sectors and gender representation to better reflect demographic trends?
- How can NATO S&T better support national parliamentarians in their work on defence and security at the national level?
- Should the Alliance define target specific budget levels for defence S&T and R&D to complement the Wales Investment Pledge?
- Are staffing and funding levels as well as organisational structures of NATO S&T adequate to face the challenge?
- How can the organisational culture across the Alliance be changed to an innovative mindset that accepts risks as inherent but necessary?

65. Your Rapporteur is looking forward to a fruitful discussion at the Spring Session in Warsaw, Poland, where she hopes to gather additional input from Committee members.
Sources:

The draft report draws extensively on publicly available information from NATO’s and NATO structures’ websites; NATO PA and NATO briefings; STC visits; and informal discussions with NATO S&T stakeholders. For more information, please contact the Committee Director.

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