NATO
OTAN

S&T

CSO

2022

COLLABORATIVE PROGRAMME OF WORK

NATO Science and Technology Organization

ACKNOWLEDGEMENTS

PREFACE

Mr. John-Mikal STØRDAL, (NATO)
Director, Collaboration Support Office, NATO Science & Technology Organization

ACTION OFFICER

Mr Jonas JUHLIN (NATO),
Staff Officer – Operations and Coordination Office, Collaboration Support Office, NATO Science & Technology Organization

Lt Col Marek DOBEK (POL),
Staff Officer – Plans & Coordination, Chief of Staff Office, Collaboration Support Office, NATO Science & Technology Organization

CONTRIBUTION & SUPERVISING

Mr Álvaro MARTIN BLANCO (NATO),
Operations and Coordination Office, Collaboration Support Office, NATO Science & Technology Organization

Col Laura REGAN, PhD (USA),
Assistant Chief Of Staff (ACOS)/Head of Operations and Coordination Office, Collaboration Support Office, NATO Science & Technology Organization

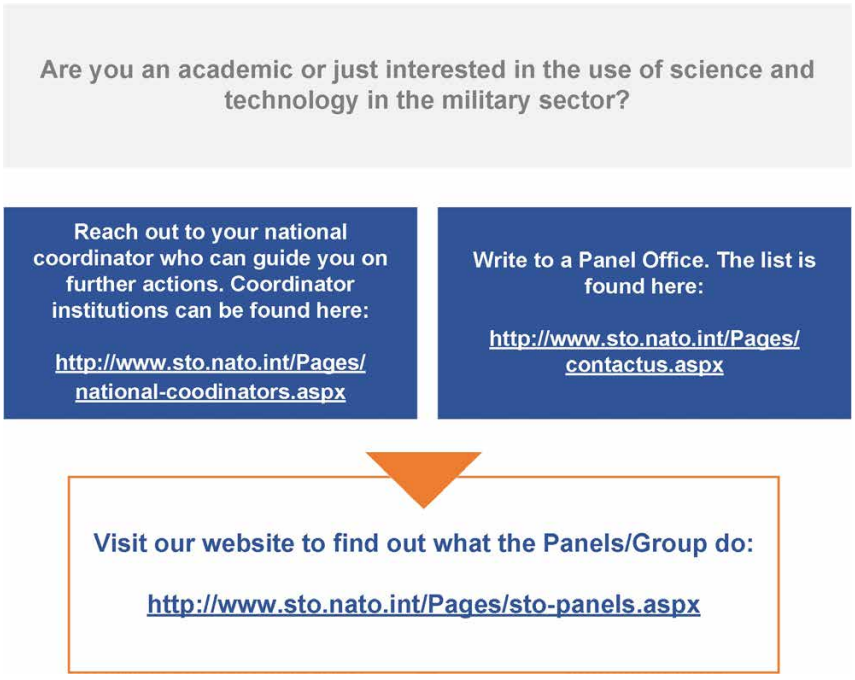
INTERESTED IN JOINING US?

Whether you are a government representative, a military member, a specialist from the industry, or an academic interested in any of our research topics, you can join our activities. There are two required steps in order to be a part of the CSO activities:

1. The first step is to contact your national coordinator.

The national coordinator is an individual designated by the nation to facilitate his/her nation's participation in the STO. The list of institutions responsible for national coordination can be found on our website: https://www.sto.nato.int/Pages/national-coordinators.aspx

You can reach your national coordinator by going through the CSO at mailbox@cso.nato.int. After you reach out to a national coordinator, they can provide you with more details on how your country is involved in activities and put you in contact with national representatives within a panel.



Where to Find the Points of Contact

2. Contact Panel/Group Executive/Assistant

If you know which panel you are interested in, you can directly contact the Panel/Group Office. They will give you directions on how to join activities. Panel/Group contact information can be found here: https://www.sto.nato.int/Pages/contactus.aspx

ISBN: 978-92-837-2388-2

TABLE OF CONTENTS

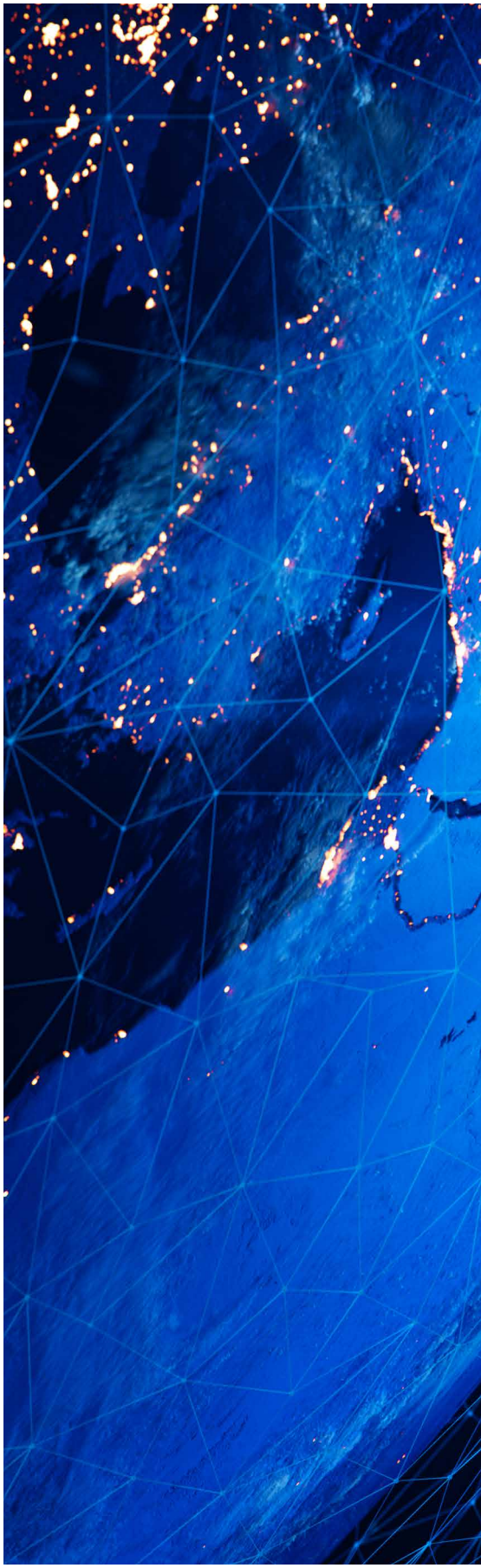


TABLE OF CONTENTS

LIST OF TABLES:

LIST OF FIGURES:

PREFACE

As we start a new year, it is my great pleasure to present in this publication the NATO Science & Technology Organization's (STO) Collaborative Programme of Work (CPoW) and budget for 2022. I hope you will find it to be of value.

Through major investments over time in Science and Technology (S&T)-related Research and Development (R&D), like-minded democracies have held a leading position in the world and used this advantage to secure and develop their common values and way of life. These efforts have given billions of people the chance for a better life. From a defence and security perspective, NATO has been a leader in this and has long relied on an unrivalled S&T edge to fulfil its tasks. We live in a time where S&T cooperation between NATO Allies and Partners is more necessary than ever to meet the defence and security challenges of today and tomorrow. At the last NATO Summit in Brussels in June 2021, our Heads of State and Government pledged to maintain the technological edge of the Alliance. We all recognize that this will be a challenge and hard work.

S&T is not a goal in-and-of itself, but a critical key enabler in developing and delivering cutting-edge capabilities to ensure military advantage and provide security and resilience. S&T not only fosters prosperity in our societies but also protects the sovereignty of our democracies.

My guiding principle is a clear focus on the future. It is always tempting to use the shield of sentimentality to protect previously battle-winning, but now outdated capabilities. Such sentimentality risks the lives of our warfighters. The future operating environment will not be limited by lines on maps or by physical geography. We will be confronted by complex and integrated challenges below and above the threshold of armed conflict. These challenges will test our approach and target our most vulnerable areas.

Our historic technological advantage is increasingly challenged by targeted investments in S&T and capabilities designed to counter our strengths. We have the "Sputnik-moment" of our time right now. It is more important than ever for the Alliance to stay ahead of our potential peer competitors and adversaries in leveraging new and disruptive technologies and enhancing our ability to meet new threats. Nations, therefore, have to step up investments in S&T related R&D, not only military R&D, but also in universities and civilian laboratories, as well as update approaches to development and strengthen collaboration. We must spend more and spend better.

Through the CPoW, with low bureaucracy, **we are together empowering the NATO's technological edge** and multiplying the value of National S&T investments through knowledge and resource sharing. As an example, the UK participates in some 70% of the CPoW and, according to their own estimates, benefits from a financial leverage of some 10:1 from this co-operation and overall engagement in the STO. In other words, for the resources they contribute, their return on investment is estimated to be ten-fold in terms of the benefits they receive from this collaboration through knowledge gained and access to facilities and equipment.

I am proud to say that the NATO STO, through the Collaboration Support Office (CSO) in Paris, is facilitating the largest and most vibrant scientific network for defence and security in the world. In our network, around 5,000 scientists, engineers, and analysts from more than 40 different countries are engaged in nearly 300 carefully selected R&D projects using science and technology to solve real problems. The CPoW leverages scientists, engineers and analysts from government, research institutes, academia and industry and is highly appealing. The network has steadily grown with the number of projects, more than doubling since 2012.

The "cornerstone" of the STO is the CPoW and the collaborative business model, which describes and structures the cooperative research between Nations in detail. This publication details the publicly releasable portion of the CPoW, including a list of all ongoing projects. The goal of this document is to help inform and expand knowledge to a broad audience while also stimulating further engagement within the CPoW.

2022 will inevitably be impacted by the continuing COVID-19 pandemic and travel restrictions. Our network of scientists, engineers, and analysts were only partially able to meet physically in 2021 and much of the research was conducted wholly or partially in the virtual domain. Hybrid meetings are in demand and we are consciously working on improving these capabilities for the entire network.

I would also like take the opportunity to recognize that the core of the CPoW business is managed by the STO Scientific and Technical Committees (STCs), the 6 Panels and Group. The entire CPoW network benefits and appreciates their leadership, which is typically in addition to their normal demanding professions, duties and responsibilities. I warmly thank these volunteers and their Nations for the exceptionally fine work they do in guiding the CPoW.

John-Mikal Størdal

Director, STO Collaborative Support Office

1. WE ARE THE SCIENCE AND TECHNOLOGY ORGANIZATION

SCIENCE AND TECHNOLOGY ORGANIZATION (STO): WHO ARE WE?

Science and Technology (S&T) research has a rich and persistent history within NATO and celebrates its 70th anniversary in 2022. The predecessor to the STO, the Advisory Group for Aerospace Research and Development (AGARD), was formed in 1952 and served as a testbed for scientific cooperation among the early NATO Nations. Since then, NATO S&T research has broadened in scope and the STO network has grown into the largest international network of defence and security scientists, engineers, and analysts in the world.

The STO is a NATO subsidiary body created to meet the collective S&T needs of NATO. The STO takes its authority from the 2012 Charter of the NATO Science and Technology Organization and is guided by the 2018 NATO Science & Technology Strategy and well as the 2016 NATO Science & Technology Board STO Corporate Strategy. According to the STO Corporate Strategy:

Von Karman and the NATO Team

> *"The STO plans and delivers a Programme of Work (PoW) that covers a broad spectrum of defence and security related S&T. The STO PoW contributes to capability development, supports threat mitigation, and provides advice to decision makers. The STO welcomes participants and contributors from Allied and Partner Nations, coming from government, industry, or academia. In pursuing this mission, the STO positions S&T to the strategic advantage of Nations and NATO, thereby supporting the core tasks of the Alliance."*

HOW ARE WE ORGANISED?

Within the NATO organizational structure, the STO falls under the North Atlantic Council (NAC) and reports to both the NAC Military Committee and the Conference of National Armament Directors. The STO is governed by the Science & Technology Board (STB). Comprised of senior national defence S&T leaders, the STB is responsible for developing and maintaining the strategic guidance for S&T in NATO, promoting synergies across stakeholders while respecting their individual responsibilities and authorities. The STB exercises governance through the following executive bodies which lead the organisation:

- **The Office of the Chief Scientist (OCS)** provides executive and administrative support to the Chief Scientist to exercise his/her role as a Chair of the Science and Technology Board and as the primary Scientific Advisor for NATO. The OCS promotes the exploitation of the results generated within the CPoW to numerous internal stakeholders and partners.
- **The Collaboration Support Office (CSO)** provides executive and administrative support to the activities within the Collaborative Programme of Work (CPoW), maintains an active network of approximately 5,000 scientists, engineers, and analysts and manages six Technical Panels and one Group that organise technical activities.
- **The Centre for Maritime Research and Experimentation (CMRE)** organises, conducts scientific research and technology development, and delivers innovative and field-tested S&T solutions in the maritime domain to address the defence and security needs of the Alliance.

The STO PoW is comprised of two primary components, which follow two different business models:

1. The Collaborative Programme of Work (CPoW) managed by the Collaboration Support Office, which follows a collaborative business model where scientists, engineers, and analysts are resourced by their Nations or organizations; and
2. The Centre for Maritime Research and Experimentation programme of work, which follows and in-house delivery business model where research is customer funded.

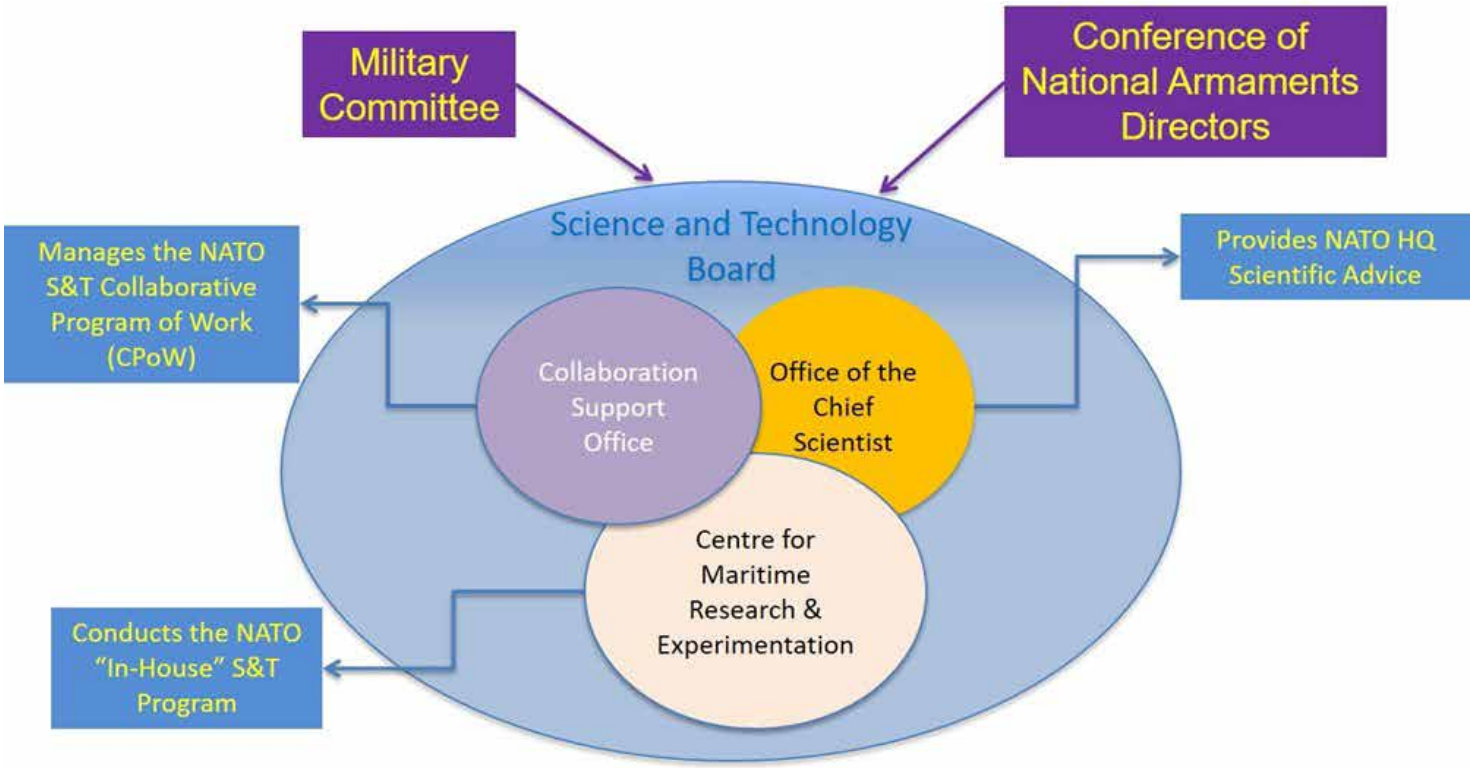


Figure 1: STO Business Model

HOW DOES CSO FUNCTION?/HOW DO WE STRUCTURE OUR WORK IN CSO?

The CSO provides NATO Nations and Partners Nations with a technical forum whereby scientists, engineers, and analysts can define, conduct and promote cooperative research and information exchange. The CSO runs its many activities through a collaborative business model, in which the STO provides a forum whereby NATO Nations and partner Nations elect to use their national resources to define, conduct and promote cooperative research and information exchange. The CSO does not perform in-house research itself, but instead, facilitates collaborative research amongst the Nations. This business model acts as a force and resource multiplier maximizing Nations' return on investment. The international collaborative programme of work is carried out in 7 different technical areas. These technical areas are represented by 6 Panels and 1 Group running their scientific efforts within several types of scientific activities (see Chapter 3).

ACTIVITY LIFECYCLE

The Panels/Group take the initiative to create technical activities based upon guidance from the Nations, and initiatives from the Panels/Group scientific community. The Panels/Group usually meet twice a year (in spring and fall) during Panel (Group) Business Meetings (BM) which are medium-scale 2 to 3-day events. Technical activities are organized in teams of national experts with clearly defined scopes and products as goals at the end of the activity.

The activity lifecycle is depicted in the image below:

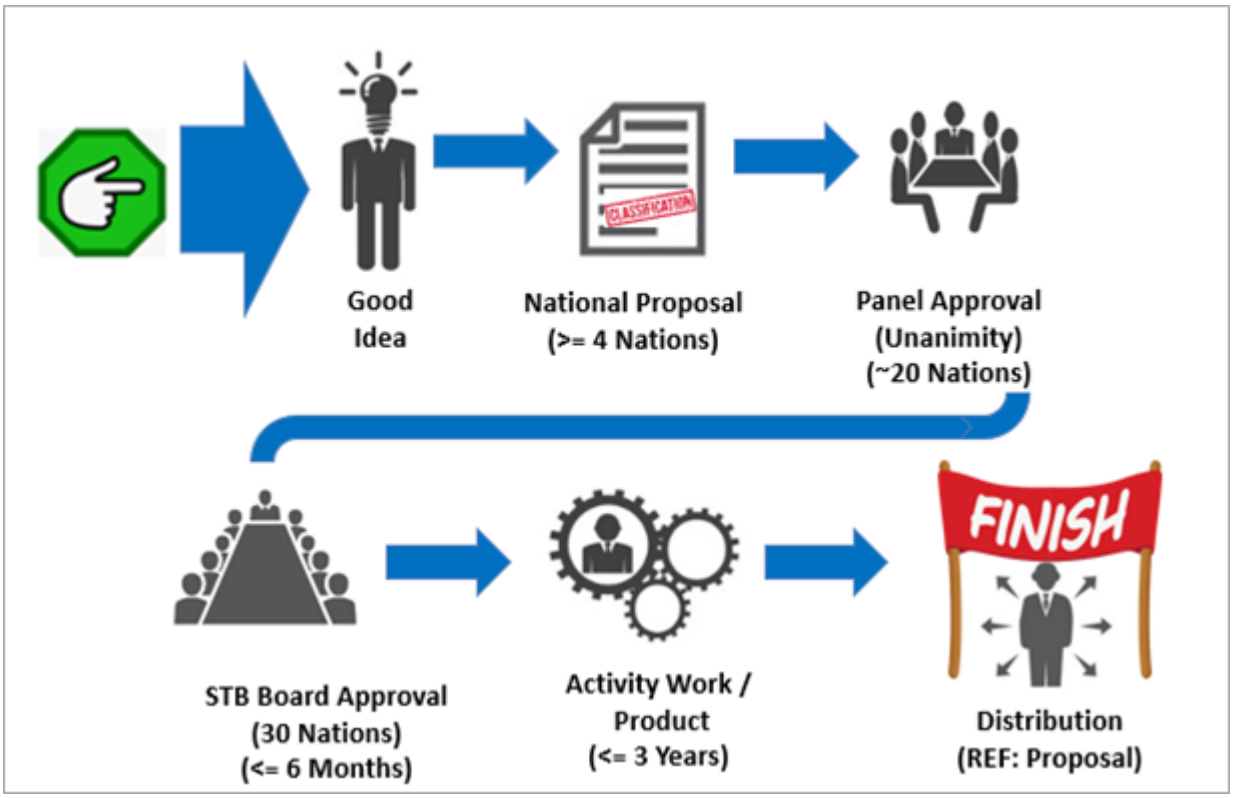


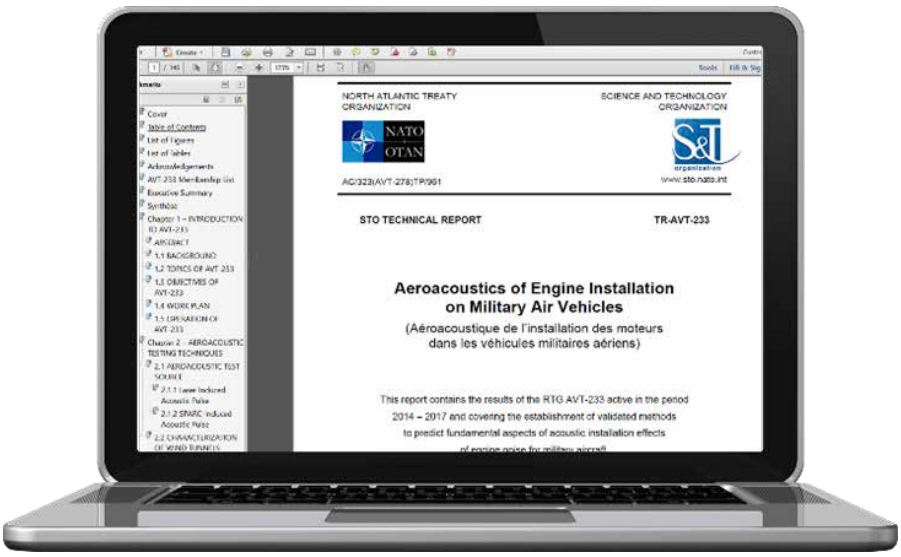
Figure 2: Activity Life Cycle

Ideas for new activities may originate from the Nations, the scientists/engineers/analysts within the STO network, Panel/Group Members or NATO bodies. However, it is mandatory that each activity be supported by a minimum of 4 Nations before being initiated.

The activity ideas are presented in the form of Technical Activity Proposals (TAP) which are presented to the Panels/Group for decision during Business Meetings (BM). The TAP must be endorsed unanimously by the Panel/Group.

After the BM, the new TAPs are submitted to the STB for approval through a 3-week silence procedure. Following the silence procedure approval, the activity can begin.

Depending on the activity type, the outcomes of the completed activity could be a technical report, cooperative demonstration of technology or a meeting proceedings.



All unclassified STO scientific publications are available on our website at: www.sto.nato.int

2. S&T STRATEGY, PRIORITIES, STRATEGIC INITIATIVES AND EMERGING & DISRUPTIVE TECHNOLOGIES: WHAT, WHY AND HOW

The Collaborative Programme of Work (CPoW) is a tool designed to answer the Nations' needs and the NATO requirements within the field of defense and security S&T research. Therefore, its construct is based on the strategic orientation provided by the Nations, the Panels/Group during their business meetings, and the higher NATO centralized organization. Ultimately, the Nations, through the S&T Board (STB), remain the collective authority deciding on how the CPoW should develop.

As a first reference, the NATO S&T Strategy provides the overarching guidance to steer the NATO S&T community's efforts in a coherent direction, establishing broad goals, defining lines of effort (LoEs) and investment areas. In this three-tier vision, the five LoEs drive the Strategy. The LoEs set the level of ambition to include the following:

1. Stay at the forefront of S&T to outperform our competitors;
2. Recognize partnerships as a strength;
3. Encourage technical demonstrations to reduce the gap between research and actual delivery of capabilities;
4. Aim at improving the Alliance decision-making, in all compartments (operations, planning, etc.); and
5. Concentrating the efforts on Nations and NATO crucial requirements to achieve visible and valuable results.

This Strategy appeals to pragmatism, efficiency, the will to share and cooperate, and lastly excellence.

A visionary document, the NATO S&T Strategy is complemented by a more practical document, the NATO S&T Priorities guidance, linking the strategic thoughts to actionable S&T priorities. Anticipating foreseeable military requirements the NATO S&T Priorities guidance, serves to steer medium- to long-term S&T planning across the NATO S&T community and to inform smart investment decisions in Nations. The Priorities are currently organized in 10 S&T Areas[1], broken down into 42 specific Targets of Emphasis (ToEs). These ToEs serve as key driving references, either to inspire new activities, or to verify that the envisaged new projects are consistent with the NATO S&T Priorities. The current NATO S&T Priorities were adopted in 2017.

Aside from the S&T Priorities that provide valuable orientation to develop standard CPoW activities, the STB acknowledged the need for more tailored tools and procedures to focus on specific strategic cross-domain areas, topics or problems. The Strategic Initiatives address this need. Their purpose is to focus the attention of the NATO S&T community on important emerging technical challenges and opportunities, to address them from a comprehensive perspective, and to achieve results that are beyond the reach of individual stakeholders or specialized Panels and Group. In a practical sense, they help create communities of interest in specific domains across the whole S&T community, and they capitalize on, orient, and bring coherence to the Panels and Group activities while dealing with strategic S&T matters. The Von Karman Horizon Scanning (VKHS) studies, in particular, aim to deliver short-term focused studies (usually 1-year long studies) to enlighten senior leadership on emerging and/or disruptive S&T issues.

The above-mentioned set of guiding documents, tools and procedures provide the STO community with the relevant and necessary means and frameworks to address the increasing emphasis that the NATO political and military leadership places on Emerging and Disruptive Technologies (EDTs). In October 2019, the Alliance Defense Ministers approved a (classified) Roadmap document that now focuses on eight separate EDTs. In 2022, the STO community

1 Precision Engagement, Advanced Human Performance & Health, Cultural, Social & Organizational Behaviors, Information Analysis & Decision Support, Data Collection & Processing, Communications & Networks, Autonomy, Power & Energy, Platforms & Materials, Advanced Systems Concepts.

will concentrate on developing knowledge and understanding of these EDTs, combined in clusters that associate S&T areas with operational functions. The 2022 Plans & Program Workshop (P&PW) will include a CPoW stock-taking session to not only review the ongoing and planned work related to current EDTs for topical breadth, scientific depth, and programmatic health but review work not related to current EDTs to identify possible topical clusters that will require concerted effort across the CPoW in the near-term.

The NATO S&T Strategy, the S&T Priorities, the Strategic Initiatives, and the Emerging and Disruptive Technologies Roadmap, supplemented by the future Roadmap Implementation Strategy, are key strategic guidance to address vital National S&T requirements. In 2022, they will find practical application through the work achieved during the P&PW and the Panels/Group Business Meetings, to successfully frame and execute the CPoW.

3. THE STO PANELS, GROUP AND ACTIVITIES

The success of the CPoW hinges upon effective project management of the technical activities. The six Technical panels responsible for a wide range of research activities and a Group specializing in modelling and simulation are the lifeblood of the CPoW and comprise the scientific and technical committees. These Panels/Group are comprised of national and NATO Body representatives as well as recognized world-class scientists, engineers and analysts. They are responsible for proposing and managing the scientific work programme. In addition to providing critical technical oversight, they also provide a key link to military users and other NATO entities.

The current Level 2 committee structure consists of the following six Panels and one Group:

- Applied Vehicle Technology (AVT)
- Human Factors and Medicine (HFM)
- Information Systems Technology (IST)
- System Analysis and Studies (SAS)
- Systems Concepts and Integration (SCI)
- Sensors and Electronics Technology (SET)
- NATO Modelling and Simulation Group (NMSG)

Each Panel/Group's programme of work is carried out by Technical Teams made up of national experts. Prior to launching a Technical Team, when a Panel/Group believes that a particular expertise is required to assist or advise it on the technical merit or feasibility of a specific proposal, an **Exploratory Team (ET)** is established. Therefore, ETs are CSO's instrument to carry out a feasibility/pilot study to establish whether it is worth starting a bigger activity.

During the BM, each NATO nation in the Panel/Group is polled to determine if it is willing to allocate resources and participate in a future ET on the topic. If the Panel/Group supports the initiative, the ET finalizes the TAP and submits it to the Panel/Group Office for revision. The ET step is sometimes omitted if the idea has strong support and can go straight into a Technical Activity It is, however, an essential probative instrument for young/new scientist who wish to scope their proposal for a Technical Team.

Technical Teams are assigned by the Panels/Group to perform specific tasks such as:

- Research Task Group (**RTG)** – study group, up to 3 years
- Specialists' Team **(ST)** – quick reaction;
- Research Workshop (**RWS**)– selected participation, 2-3 days
- Research Symposia (**RSY**) – more than 100 people, 3-4 days
- Research Specialist Meeting (**RSM**) – up to 100 people, 2-3 days
- Research Lecture Series (**RLS**) – junior and mid-level scientists
- Research Technical Course (**RTC**)
- Support Project **(SP)**
- Long-Term Scientific Study **(LTSS)**
- Multinational exercise **(MNE)**
- Military Application Study **(MAS)**
- Advanced Guidance for Alliance Research and Development **(AG – AGARDographs)**

A Research Task Group (RTG) technical team activity allows researchers in different nations to work together in order to solve a particular scientific research and technology development problem. RTGs are sponsored by the Panel/Group to meet the needs of the nations and NATO. RTGs are chartered for a maximum of three years after the initial meeting. Among the activities conducted during an RTG, **a Cooperative Demonstration of Technology (CDT)** may be organized. The findings will be documented in an STO publication (Technical Report or Technical Memoranda).

A Research Lecture Series (RLS) technical team activity disseminates state-of-the-art scientific knowledge among junior and mid-level scientists, engineers and analyst in militarily-relevant domains that are not taught in universities. An RLS is a two-day educational event that is normally organized at three different locations. RLSs are combined with an STO publication (Educational Notes), which will be made available before the first RLS session.

A Research Technical Course (RTC) is an educational technical team activity aimed at transferring practical knowledge and recent field developments through on-site instructor training or lectures to military decision makers. The material is tailored to a specific/specialized audience and is generally more operational in nature than RLS. An RTC can be offered up to a maximum of four times lasting from one to three days. A STO publication is not always provided for a RTC.

A Research Workshop (RWS) technical team activity facilitates intensive information exchange and focused discussion on a specific topic among a limited number of invited experts. The prime purpose of a RWS is to enhance the capability of the NATO S&T community to respond adequately to the military requirements of NATO. A RWS (generally not more than 30 participants) is a two to three-day event with no prescribed format. A RWS results in an STO publication (Meeting Proceedings).

A Research Specialists' Meeting (RSM) technical team activity promotes exchange of state-of-the-art knowledge among an audience of specialists on an important scientific or applied topic. The prime purpose of a RSM is to enhance the capability of the NATO S&T community to respond adequately to the military requirements of NATO. An RSM is a medium-scale (usually less than 100 participants), two to three-day event with invited speakers. Communications are primarily via invited keynote addresses and via oral presentations of authors invited by the Programme Committee. RSMs should include a roundtable discussion. An RSM results in an STO publication (Meeting Proceedings).

An AGARDograph (Advanced Guidance for Alliance Research and Development – AGARD) pertains to a single, clearly defined technical subject and comprises material generally agreed to be of lasting interest and value to the technical and war fighter communities represented throughout NATO. The AG material may be the work of a single author or be the coordinated and edited contributions of several authors. An AG team is chartered for a maximum of three years.

A Long-Term Scientific Study (LTSS) technical team activity provides recommendations to NATO and National Authorities from the assessment of the impact on military operations that might be expected from developments in science and technology over both the medium- and long-term (typically 10–20 years). This typically includes how emerging technologies, systems and methods may affect tactical concepts and doctrines. An LTSS is chartered for three years after the initial meeting. Among the activities conducted during an LTSS, a brainstorming meeting, called a **Multinational Exercise (MNE),** is organized. A LTSS results in an STO publication (Technical Report) and in presentations to various NATO or national authorities.

A Military Application Study (MAS) technical team activity is a short-term rapid-reaction study that assesses the application of technology to operational procedures to solve operational and equipment deficiencies.

4. STRUCTURE OF 2022 COLLABORATIVE PROGRAMME OF WORK

As of 1 January 2022, the total number of ongoing activities in the STO CPoW is 283. This figure represents the sum of the number of activities that started before 2022 and will be still active in 2022 as well as number of new activities that will begin in 2022.

Table 1: 2022 STO CPoW Composition including ETs and SPs (as of 1 January 2022*)

ACTIVITY TYPE		PANEL GROUP							TOTAL
		AVT	HFM	IST	NMSG	SAS	SCI	SET	
Task Group	**RTG**	33	43	21	17	25	30	42	**211**
Agardograph	**AG**	-	-	-	-	-	3	-	**3**
Long-Term Scientific Study	**LTSS**	2	1	-	-	-	-	-	**3**
Lectures Series	**RLS**	3	3	-	1	-	2	4	**13**
Specialists' Meeting	**RSM**	-	1	2	-	-	2	4	**9**
Symposium	**RSY**	2	1	2	2	3	1	3	**14**
Technical Course	**RTC**	-	1	-	1	2	-	-	**4**
Workshop	**RWS**	10	1	1	-	1	2	3	**18**
Specialist Team	**ST**	-	1	-	4	2	-	1	**8**
Total STO CPoW		50	52	26	25	33	40	57	**283**
Exploratory Team	***ET***	*10*	*10*	*8*	*2*	*6*	*6*	*7*	***49***
Support Project	***SP***	*8*	-	-	-	*1*	-	-	***9***
Total including ETs and SPs		***68***	***62***	***34***	***27***	***40***	***46***	***64***	***341***

* Formally, Exploratory Teams (ETs) and Support Projects (SPs) are not considered as STO CPoW Technical Teams because their creation doesn't normally require the approval from the Science and Technology Board (STB).

A Panel/Group may set up an Exploratory Team (ET) when it believes that a particular expertise is required to assist or advise the Panel/Group on the technical merit or feasibility of a specific proposal for a technical activity. ETs may also be used to help the Panel/Group develop recommendations on future content of the Panel/Group's Programme of Work.

The STB will approve the Support Programme as part of the STO Collaborative Programme of Work and Budget each year but will not normally be asked to approve individual Support Projects except in one specific case: If a project is anticipated to consume 10 per cent or more of the approved budget for the entire Support Programme, it will be presented to the STB for discussion and approval.

Note: The data presented in this document provides information regarding the ongoing STO CPoW Technical Teams, Exploratory Teams and Support Projects that will be ongoing in 2022. The content of the document is viewed as dynamic in nature. After the Spring Panel and Group Business Meetings the Panels and the Group will endorse new activities that will be submitted to the STB for approval. The number of new activities varies each year.

5. 2022 BUSINESS MEETINGS (PPW/PBM/STB)

All major Science and Technology Organization's business meetings are listed in Table 2.

Table 2: 2022 Business Meetings

2022 PBM/STB/PPW		MEETING DATES	MEETING LOCATION
PPW	**Plans & Programmes Workshop (PPW)**	**15-17 Feb**	**Paris (FRA)**
AVT	Spring PBM	23-27 May	Sibiu (ROU)
	Fall PBM	26-30 Sep	Varna (BGR)
HFM	Spring PBM	11-14 Apr	Bled (SVN)
	Fall PBM	17-21 Oct	Washington DC (USA
IST	Spring PBM	16-20 May	Udine (ITA)
	Fall PBM	3-7 Oct	Stockholm (SWE)
NMSG	Spring BM	9-13 May	Rome (ITA)
	Fall BM	17-19 Oct	Bath (UK)
SAS	Spring PBM	19-22 Apr	Amsterdam (NLD)
	Fall PBM	19-21 Oct	Copenhagen (DNK)
SCI	Spring PBM	9-13 May	Segovia (ESP)
	Fall PBM	TBD	Bucharest (ROU)
SET	Spring PBM	25-27 May	Bled (SVN)
	Fall PBM	12-14 Oct	Interlaken (CHE)
STB	**Spring STB**	21-25 March	Oslo (NOR)
	Fall STB	TBD	TBD

6. APPLIED VEHICLE TECHNOLOGY PANEL (AVT)

Panel Chair: **Mr. Stan COLE (USA)**

Panel Executive: **Dr. David Klassen (DEU)**

Panel Vice-Chair: **Dr. Tom Thorvaldsen (NOR)**

Panel Assistant: **Ms. Aurelie Bertrand (NATO)**

MISSION

The Applied Vehicle Technology Panel strives to improve the performance, reliability, affordability, and safety of vehicles through advancement of appropriate technologies. The Panel addresses platform technologies for vehicles operating in all domains - land, sea, air, and space, for both new and ageing systems.

To accomplish this mission, the members of the AVT community, comprising more than 1,200 participants, exploit their joint expertise in the fields of **(1) Mechanical Systems, Structures and Materials; (2) Propulsion and Power Systems;** and **(3) Performance, Stability and Control, Fluid Physics;** which is augmented by committees bolstering strategic guidance, scientific excellence and bi-national support.

By carrying out biannual Business Meeting weeks including discussions of all of its sponsored activities, the Panel guarantees the use of NATO's, as well as national, resources in the most effective and efficient way. Generating synergies by multi-disciplinary and domain overarching approaches; building productive partnerships by a healthy mix of academic scientists, governmental researchers, military operators and industrial engineers; providing timely and targeted advice to NATO and nations; and striving for scientific excellence are built into the Panel's work ethic.

MAIN INTEREST

The expertise of the Applied Vehicle Technology Panel covers a broad range comprising cross-cutting and technical focus areas. In alignment with its mission statement, the Panel is the STO's focal point for:

- Assessment of and multi-disciplinary cooperation's on Hypersonic Vehicles;
- Further development and integration of Autonomous Vehicles in all domains;
- Screening and evaluation of novel Materials, Structures and Manufacturing Technologies for military applications;
- International collaboration on a Holistic Virtual Design approach for manned and unmanned future Combat Air Platforms;
- Determination and further compiling of innovative Propulsion as well as Power System Technologies for military purposes;
- Coordination and development of a Future Rotorcraft Requirement trade-space including maturing of key technologies;
- Assessment and advancement of Warship and Fleet Design capabilities;
- Standardisation and implementation of a Sustainable Use of Munitions across their life-cycles;
- Evaluation and integration of Software-Based Applications on the design, handling and service of platforms; and
- Sustainment and Life-Cycle Costs considerations of new and aging platforms as well as fleet considerations.

Table 3: AVT Activities Continuing in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
AVT-293	RTG	Effect of Environmental Regulation on Energetic Systems and the Management of Critical Materials and Capability
AVT-298	RTG	Reynolds Number Scaling Effects on Swept Wing Flows
AVT-308	RTG	Cooperative Demonstration of Technology (CDT) for Next-Generation NATO Reference Mobility Model (NG-NRMM)
AVT-309	RTG	Implication of Synthetic Fuels on Land Systems and on NATO Single Fuel Policy
AVT-311	RTG	Availability and Quality Issues with Raw Materials for Rocket Propulsion Systems and Potential Consequences for NATO
AVT-313	RTG	Incompressible Laminar-to-Turbulent Flow Transition Study
AVT-314	RTG	Assessment and reduction of installed propeller and rotor noise from unmanned aircraft
AVT-315	RTG	Comparative Assessment of Modeling and Simulation Methods of Shipboard Launch and Recovery of Helicopters
AVT-316	RTG	Vortex Interaction Effects Relevant to Military Air Vehicle Performance
AVT-317	RTG	Trade-space exploration to support the early stage design of effective & affordable (fleets) of warships
AVT-318	RTG	Low noise aeroacoustic design for turbofan powered NATO air vehicles
AVT-320	RTG	Assessments of Numerical Simulation Methods for Turbulent Cavitating Flows
AVT-329	LTSS	NexGen Rotorcraft Impact on Military Operations
AVT-330	RTG	Impact of underwater dumped munitions and maritime safety, security and sustainable remediation
AVT-331	RTG	Goal-driven, multi-fidelity approaches for military vehicle system-level design
AVT-332	RTG	In-Flight Demonstration (CDT) of Icephobic Coating and Ice Detection Sensor Technologies
AVT-333	RTG	Integration of Propulsion, Power, and Thermal Subsystem Models into Air Vehicle Conceptual Design
AVT-334	RTG	CDT on Augmented Reality (AR) to Enhance Situational Awareness for Armoured Fighting Vehicle Crew
AVT-341	RTG	Mobility Assessment Methods and Tools for Autonomous Military Ground Systems
AVT-342	RTG	Interoperability of Additive Manufacturing in NATO operations
AVT-343	RTG	Novel Materials to Mitigate Rare Earth (RE) Criticality in High Speed Motors
AVT-344	RTG	Assessment of Micro Technologies for Air and Space Propulsion
AVT-345	RTG	Unified Tactical Missile Kinetic Performance Model
AVT-346	RTG	Predicting Hypersonic Boundary-Layer Transition on Complex Geometries

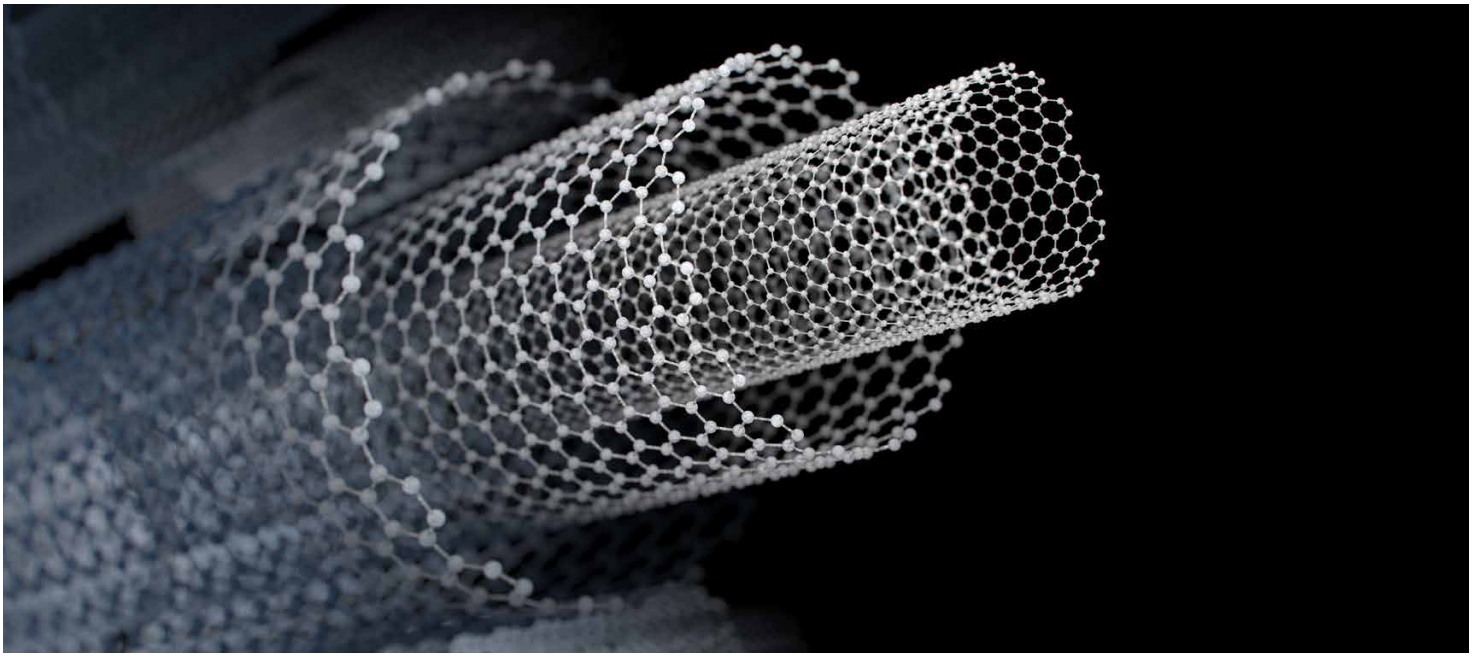
AVT-347	RTG	Large-Amplitude Gust Mitigation Strategies for Rigid Wings
AVT-348	RTG	Assessment of Experiments and Prediction Methods for Naval Ships Maneuvering in Waves
AVT-349	RTG	Non-Equilibrium Turbulent Boundary Layers in High Reynolds Number Flow at Incompressible Conditions
AVT-350	RTG	Innovative Control Effectors for Manoeuvring of Air Vehicles – Advanced Concepts
AVT-351	RTG	Enhanced Computational Performance and Stability & Control Prediction for NATO Military Vehicles
AVT-352	RTG	Measurement, Modeling and Prediction of Hypersonic Turbulence
AVT-353	RWS	Artificial Intelligence in Cockpits for UAVs
AVT-354	RWS	Multi-fidelity methods for military vehicle design
AVT-358	RLS	Advanced computational fluid dynamics methods for hypersonic flows
AVT-359	LTSS	Impact of Hypersonic Operational Threats on Military Operations and Technical High Level Requirements
AVT-360	RWS	Environmentally Compliant Approaches to Maintenance and Overhaul of Military Vehicles
AVT-361	RWS	Certification of Bonded Repair on Composite Aircraft Structures
AVT-364	RWS	Environmental Regulation on Energetic Systems and its Impact on Critical Munitions Materials and Capability
AVT-366	RWS	Use of Computational Fluid Dynamics for Design and Analysis: Bridging the Gap Between Industry and Developers
AVT-SP-002	SP	Turbulence and the Aerodynamic Optimization of Nonplanar Lifting Systems
AVT-SP-003	SP	Investigation of sub-idle gas turbine performance
AVT-SP-004	SP	Assessment of environmental and toxicological impacts associated with ammunition: life-cycle approach to assist the REACH regulation
AVT-SP-005	SP	Measurement of soil mechanical properties related to the trafficability of military vehicles on typical Estonian soils
AVT-SP-006	SP	Development of Simulation Model for selecting optimum Maintenance Strategy of Combat Vehicles
AVT-SP-007	SP	Novel Active Fire Modelling and Prediction methods using Manned and Unmanned Aircraft Vehicles
AVT-SP-008	SP	Determination of the trafficability of military vehicles in typical forests
AVT-SP-009	SP	Evaluation of Hybrid Electric Propulsion Technologies for Unmanned Aerial Vehicles in Military Applications

Table 4: AVT Activities Starting in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
AVT-362	RTG	Water Sampling, Monitoring and Control/Remediation for Live-Fire Military Ranges
AVT-363	RTG	Improving the Understanding of Risks from Exposure to Munition Combustion Products
AVT-367	RTG	Sea-Ice Collision Risk Prediction and Mitigation for Naval Ships
AVT-369	RSY	Digital Twin Technology Development and Application for Tri-Service Platforms and Systems
AVT-371	RWS	Materials and technologies for electro-optical camouflage (Cross-Panel)
AVT-372	RWS	Military value of graphene technologies
AVT-373	RWS	Emerging technologies for proactive corrosion maintenance
AVT-374	RWS	More Electric Gas Turbine Engines for Aircraft, Rotorcraft and UAVs
AVT-375	RLS	Munition Health Management Lecture Series: Implementation Challenges
AVT-376	RTG	Methodology for Tactical Missile IR Signature Predictions
AVT-377	RLS	Introduction to Quantum Computing in Fluid Dynamics

Table 5: AVT Activities Awaiting Publication

ACTIVITY	ACTIVITY TYPE	TITLE
AVT-356	RSY	Physics of Failure for Military Platform Critical Subsystems



7. HUMAN FACTORS AND MEDICINE PANEL (HFM)

Panel Chair: **Dr. Janet BLATNY (NOR)**

Panel Vice-Chair: **Dr. Patrick MASON (USA)**

Panel Executive: **Lt Col Erik LAENEN (NLD)**

Panel Assistants: **Ms. Marie LINET (NATO)**
Ms. Monika VAVRIKOVA (NATO)

MISSION

The mission of the Human Factors and Medicine Panel is to provide the science and technology base for optimising health, human protection, well-being and performance of the human in operational environments with consideration of affordability. This involves understanding and ensuring the physical, physiological, psychological and cognitive compatibility among military personnel, technological systems, missions, and environments. This is accomplished by exchange of information, collaborative experiments and shared field trials.

MAIN INTEREST

Combat Casualty Care; Science and technology (S&T) development in the field of combat casualty care must change and innovate on pace with and synchronous with the advancement of weapon systems and battlespace tactics, techniques, and procedures that will create novel military operational environments. Current combat casualty care and medical planning guidelines are based on rapid evacuation to damage control surgery and critical care. Future operational environments will considerably affect NATO forces' ability to adhere to these guidelines and medically evacuate casualties to provide life, limb, and eyesight saving treatments in a timely manner.

Chemical, Biological and Radiological Defence; Major changes in the security policy and the geopolitical and military situation as well as evolving agent and weapon technologies influence the chemical, biological, radiological and nuclear (CBRN) threat and defence. Consequently, CBRN defence requires closer collaboration between military and civilian sectors. Based on the threat out to 2030, S&T areas that can support CBRN defence need to be identified.

Human-Autonomy Teaming; Based on progress in Robotics, Artificial Intelligence and Human Performance Modelling, Human-Agent-Robot Teamwork (HART) systems are being developed and tested in which humans and autonomy dynamically adjust and cooperate to accomplish a joint objective, often in shared spaces. In these systems, team member's responsibilities and commitments are managed such that the human and automation jointly enhance performance and manage contingencies.

Table 6: HFM Activities Continuing in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
HFM-240	RLS	Mild Traumatic Brain Injury: Post Concussive Symptoms in a Deployed Setting
HFM-274	RTG	The Impact of Hypobaric Exposure on Aviators and High-Altitude Special Operations Personnel
HFM-277	RTG	Leadership Tools for Suicide Prevention
HFM-281	RTG	Personalized Medicine in Mental Health and Performance
HFM-283	RTG	Reducing Musculo-Skeletal Injuries
HFM-285	RTG	Speech Understanding of English language in Native and non-Native speakers/listeners in NATO with and without Hearing Deficits
HFM-290	RTG	Advances in Military Personnel Selection
HFM-292	RTG	Understanding and Reducing Skill Decay
HFM-294	RTG	Big Data In The Military: Integrating Genomics into the Pipeline of Standard-care Testing & Treatment
HFM-295	RTG	Sexual Violence in military
HFM-297	RTG	Assessment of Augmentation Technologies for Improving Human Performance
HFM-298	RTG	Injury Thresholds of Pulsed High Power Radiofrequency Emissions
HFM-299	RTG	Pulmonary Screening and Care in Aviators
HFM-301	RTG	Military Diversity: Ethnic Tolerance and Intolerance
HFM-304	RTG	Factors Impacting Ethical Leadership
HFM-305	RTG	Synthetic Biology in Defence: Opportunities and Threats
HFM-306	RTG	Translating Medical Chemical Defence Research Into Operational Medical Capabilities Against Chemical Warfare Agent Threats
HFM-307	RTG	Integrating Gender and Cultural Perspectives in Professional Military Education Programmes
HFM-308	RTG	Optimizing Human Performance in NATO SOF Personnel Through Evidence-Based Mental Performance Programming
HFM-310	RTG	Human Performance and Medical Treatment and Support During Cold weather Operations
HFM-311	RTG	Cognitive Neuroenhancement: Techniques and Technology
HFM-312	RTG	Unexplained Physiologic Events in High-Performance Aircraft
HFM-313	RTG	Re-introduction of phage therapy in military medicine
HFM-314	RLS	Aircrew Neck Pain Prevention and Management Lecture Series

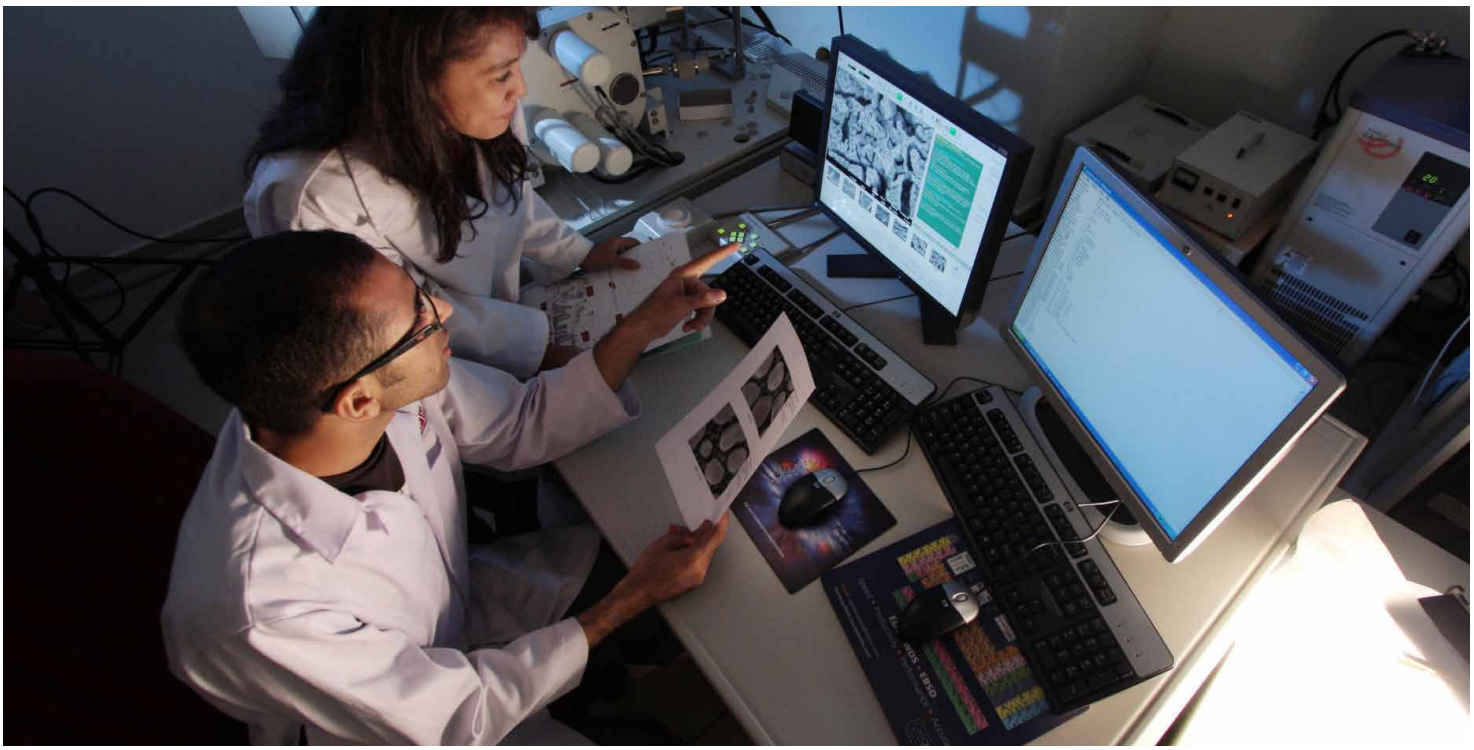
HFM-316	RTG	Expert panel for state of the art cardiovascular risk assessment in aircrew and other high risk occupations.
HFM-317	LTSS	Solutions for Combat Casualty Care
HFM-318	RTG	Personnel Retention in the Armed Forces
HFM-319	RTG	Measuring the Cognitive Load on the Soldier
HFM-320	RTG	Fatigue Management in Aircrew
HFM-325	RTG	Performance Nutrition for Fresh Feeding during Military Training and Operations
HFM-326	RTG	Diet Supplementation for Military Personnel
HFM-327	RTG	Development of a NATO STANREC for Physiological Status Monitoring to Mitigate Exertional Heat Illness.
HFM-328	RLS	Collaborations between Military & Civilian Personnel in Defence Organizations
HFM-329	RTG	A psychological guide for leaders across the deployment cycle.
HFM-330	RTG	Human Systems Integration for Meaningful Human Control over AI-based systems
HFM-331	RTG	Biomedical Bases of Mental Fatigue and Military Fatigue Countermeasures
HFM-332	RTG	Development and Implementation of Autonomous Transport and Medical Systems for Casualty Evacuation
HFM-338	RTG	Development of military loading exposure guidelines for prevention of chronic traumatic encephalopathy
HFM-342	RTG	C2 Capability Lifecycle Governance
HFM-343	RTG	Digital Teaching Networks: Fostering digital collaboration among teachers, trainers, instructors, and coaches in the military
HFM-344	RTG	Human Impact Exposure onboard High Speed boats
HFM-AVT-340	RTG	Neuroscience-based Technologies for Combat-oriented Crew Cockpit Design and Operations

Table 7: HFM Activities Starting in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
HFM-341	RTG	Validation of Modeling and Simulation Methodologies for Human Lethality, Injury and Impairment from Blast-Related Threats
HFM-345	RTG	Operations Security and Susceptibility to Influence in the Information Environment
HFM-347	RTG	Military Service Member and Veteran Domestic Radicalization
HFM-349	RSY	Human Performance and Medical Treatment and Support During Cold Weather Operations
HFM-350	RTC	Aerospace Medicine: New Technologies-New Approach RAMS USAF/NATO STO HFM
HFM-MSG-346	RTG	Assessment of Factors Impacting Cybersickness
HFM-NMSG-354	RTG	Study, Design, Building and Deployment of a CBRN XR Training Platform
HFM-SCI-351	ST	Verification in Trust Enabled Regimes (VITER)
SET-HFM-314	RWS	Multi-Omic Data Sciences Research Workshop

Table 8: HFM Awaiting Publication

ACTIVITY	ACTIVITY TYPE	TITLE
HFM-SET-339	RSM	Scientific and technological trends allow for new approaches addressing CBRN challenges
HFM-322	RWS	Meaningful Human Control of AI-based Systems: Key Characteristics, Influencing Factors and Design Considerations



8. INFORMATION SYSTEMS TECHNOLOGY PANEL (IST)

Panel Chair: **Dr. Nikolai STOIANOV (BGR)**

Panel Vice-Chair: **Mr. Antoine SMALLEGANGE (NLD)**

Panel Executive: **Mr. Alain JOLIY (NATO)**

Panel Assistant: **Ms. Armelle DUTRUC (NATO)**

MISSION

The Information Systems Technology Panel (IST) is one out of seven Scientific and Technical Committees whose role it is to implement, on behalf of the Science & Technology Board, the STO Mission with respect to Information Systems Technology.

The mission of the IST Panel is to advance and exchange techniques and technologies in order to improve C3I systems, with a special focus on AI, Interoperability and Cyber Security, and to provide timely, affordable, dependable, secure and relevant information to war fighters, planners and strategists.

MAIN INTEREST

The advancement and exchange of techniques and technologies to provide timely, affordable, dependable, secure and relevant information to war fighters, planners and strategists, as well as enabling technologies for modelling, simulation, and training are the focus of this Panel.

The scope of responsibility of the IST Panel covers the fields of Information Warfare and Assurance, Information and Knowledge Management, Communications and Networks, and Architecture and Enabling Technologies.

Thus, the IST Programme of Work is organized under three Focus Groups: **Information and Knowledge Management (IWA)**, **Architecture and Intelligence Information Systems (AI2S),** and **Communications & Networks (COM),** to which the activities of the Panel are attached.

Table 9: IST Activities Continuing in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
IST-161	RTG	Efficient Group and Information Centric Communications in Mobile Military Heterogeneous Networks
IST-162	RTG	Cyber Monitoring and Detection Capability for Military Systems
IST-163	RTG	Deep Machine Learning for Cyber Defense
IST-168	RTG	Adaptive Information Processing and Distribution to Support Command and Control
IST-169	RTG	Robustness and Accountability in Machine Learning Systems
IST-171	RTG	FMN Cloud-based Coalition Security Architecture
IST-172	RTG	Airborne Beyond Line of Sight Communication Network
IST-174	RTG	Secure Underwater Communications for Heterogeneous Network-enabled Operations
IST-175	RTG	Full Duplex Radio Technology for Military Applications
IST-176	RTG	Federated Interoperability of Military C2 and IoT Systems

IST-177	RTG	Social Media Exploitation for Operations in the Information Environment
IST-179	RTG	Interoperability for Semi-Autonomous Unmanned Ground Vehicles
IST-180	RTG	Network Management & Cyber Defense (NMCD) for Federated Mission Networking (FMN)
IST-181	RSM	Terahertz-band Communications and Networking
IST-184	RTG	Visual Analytics for Complex Systems
IST-185	RSM	Communication Networks and Information Dissemination for the Tactical Edge
IST-187	RTG	5G Technologies Application to NATO Operations
IST-188	RTG	Applying and Validating the Cyber Security Risk Assessment Process for Military Systems
IST-189	RTG	Hybrid Military and Commercial SATCOM Networks
IST-191	RWS	Rescue Systems for Broken Trust
IST-192	RTG	ANTICIPE*@STJU-22
IST-193	RTG	Edge Computing at the Tactical Edge

Table 10: IST Activities Starting in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
IST-194	RTG	Adaptive Networks at the Tactical Edge
IST-195	RSY	Societal challenges for Operations in the Information Environment
IST-196	RTG	Cyber security in virtualized networks

Table 11: IST Activities Awaiting Publication

ACTIVITY	ACTIVITY TYPE	TITLE AWAITING PUBLICATION
IST-190	RSY	AI, ML and BD for Hybrid Military Operations (AI4HMO)

9. NATO MODELLING AND SIMULATION GROUP (NMSG)

NMSG Chair: **Dr. Robert SIEGFRIED (DEU)**

NMSG Vice-Chair: **Ms. Julie TREMBLAY-LUTTER (CAN)**

MSCO Head: **CDR Alvaro HERRAIZ-SOLLA (ESP)**

MSCO Technical Officer: **Mr. Adrian VOICULET (NATO)**

MSCO Assistant: **Mrs. Renata Danauske (NATO)**

MISSION

The NATO Modelling and Simulation Group (NMSG) is the STO Scientific and Technical Committee in which all NATO Modelling and Simulation (M&S) stakeholders and subject matter experts meet to coordinate and oversee the implementation of the NATO M&S Master Plan (NMSMP).

The NMSMP is a NAC-approved NATO policy document that provides strategic vision and guidance for coordinating and utilizing M&S in NATO. The NATO M&S vision is "*to exploit M&S to its full potential across NATO and the Nations to enhance both operational and cost effectiveness*".

The mission of the NMSG is to promote cooperation among Alliance bodies, NATO, and partner nations to maximize the effective utilization of M&S. This includes M&S standardization, education, and associated science and technology. The NMSG, as nominated by the Conference of National Armaments Directors (CNAD), is the delegated tasking authority for standardization in the NATO modelling and simulation domain.

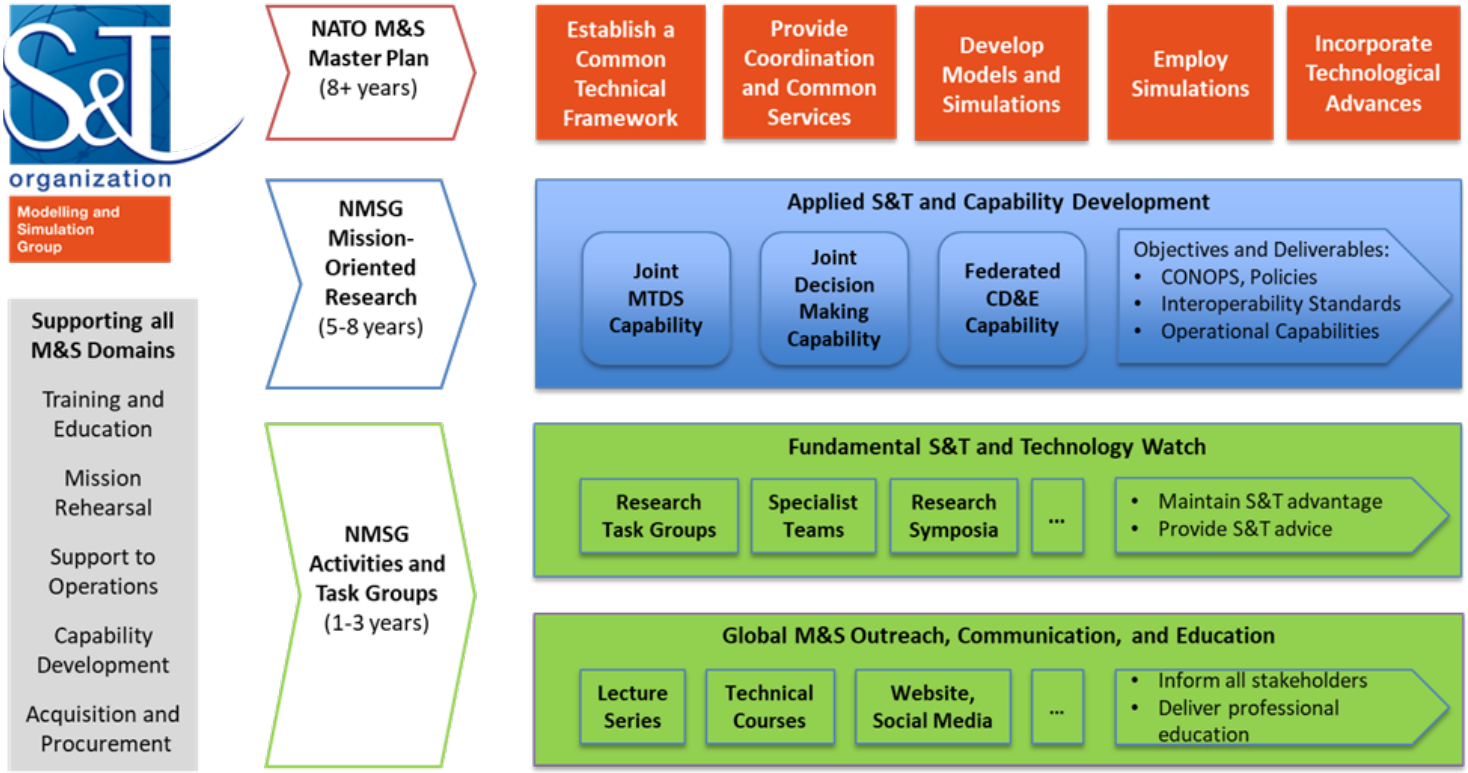


Figure 3: NMSG Mission Oriented Research

MAIN INTEREST

The NMSMP articulates the NATO vision and guiding principles regarding the use of M&S in support of the NATO mission, discusses the impact that achieving this vision will have on NATO M&S application areas and identifies the governance mechanisms and bodies, and the primary NATO M&S stakeholders.

Under the umbrella of establishing a common technical framework, increasing interoperability and developing models, simulations and standards for M&S, the main current and future focus areas of work are: Education and Training, decision making, AI & BD, cyber defence and acquisition.

With the mission to investigate, plan, update and propose the future Programs of Work, the NMSG has three permanent sub-groups, the Military Operational Requirements Subgroup, the M&S Standards Subgroup and the Planning and Programmes Committee.

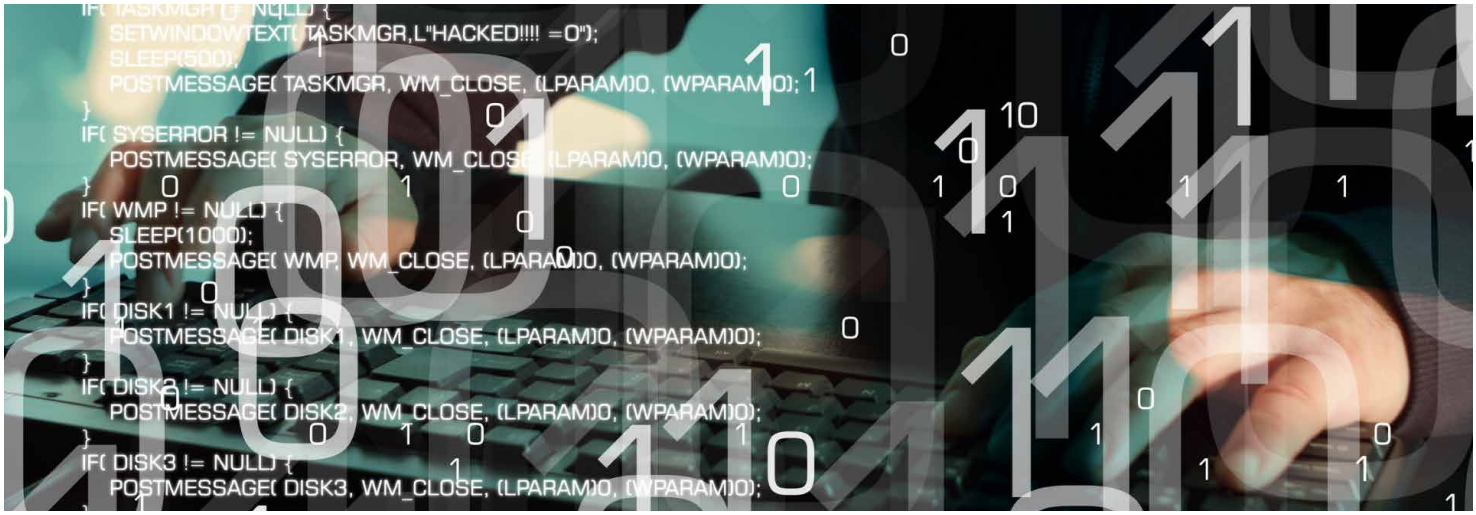


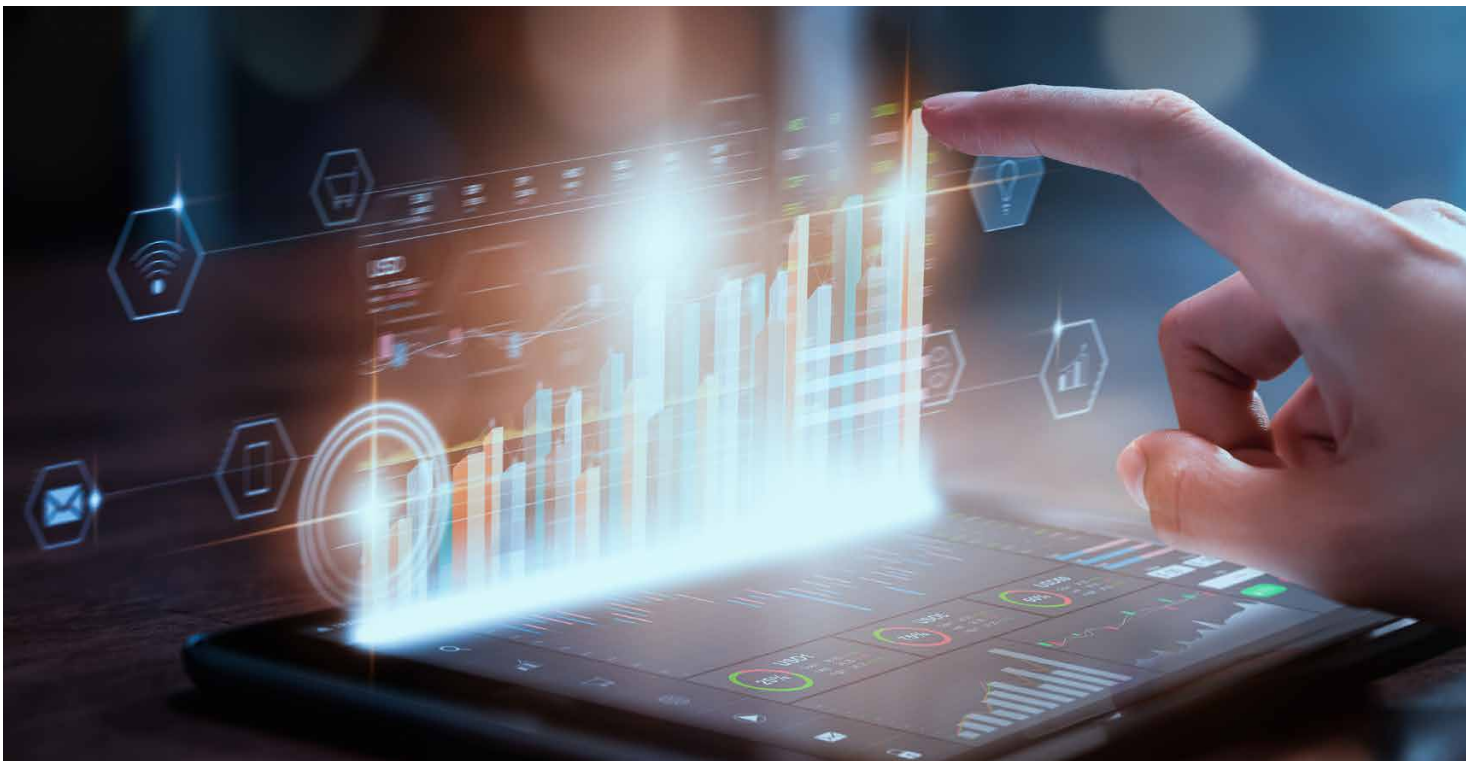
Table 12: NMSG Activities Continuing in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
MSG-164	RTG	Modelling and Simulation as a Service – Phase 2
MSG-165	RTG	Incremental Implementation of Mission Training through Distributed Simulation for Joint and Combined Air Operations
MSG-172	RTG	NATO Modelling and Simulation Master Plan Implementation Update
MSG-173	RTG	Simulation for Training and Operation Group – Next Generation (STOG-NG)
MSG-174	RTG	Urban Combat Advanced Training Technology Live Simulation Standards (UCATT-LSS) - 2
MSG-179	RTG	Modelling and Simulation for Acquisition
MSG-180	RTG	Implementation of Live Virtual Constructive – Training (LVC-T) in the Maritime Domain
MSG-181	RTG	Physics-Based Electro-Optic/Infrared Simulations – Best Practice Recommendations for Decision Support
MSG-186	RTG	Multi-Dimensional Data Farming
MSG-187	RTG	Space Weather Environmental Modelling (SWEM)
MSG-190	RTG	NATO M&S Professional Certification

MSG-191	RTG	NATO Standards for Federated Simulation and Services for Integration, Verification and Certification
MSG-193	ST	Modelling and Simulation Standards in Federated Mission Networking (FMN)
MSG-194	RTC	Employing the C2-Simulation Interoperation (C2SIM) Standard for Coalition Military Operations and Exercises
MSG-195	RTG	Modelling and Simulation as a Service – Phase 3
MSG-198	ST	Composable Human Behaviour Representation in Constructive Simulation Systems
MSG-SAS-178	RTG	Using Simulation to Better Inform Decision Making for Warfare Development, Planning, Operations and Assessment

Table 13: NMSG Activities Starting in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
MSG-197	RSY	NMSG Annual Symposium 2022
MSG-199	ST	Defining the NMSG and M&S COE Cooperation Framework
MSG-200	RTG	Modelling Cyber Domain Entities and Events within Distributed Simulations
MSG-201	RTG	Modelling and Simulation in Federated Mission Networking (FMN)
MSG-202	RTG	NATO Modelling and Simulation Resources/Standards Support Team - III
MSG-203	RLS	The Role of Modelling and Simulation to Support Current and Future NATO Operations
MSG-204	ST	NMSG support to Distributed Synthetic Training (DST) A2CD2 efforts
MSG-196	RSY	MSG/MSCO Support to International Training & Education Conferences IT2EC, I/ITSEC and CA2X2 Forum 2022



10. SYSTEM ANALYSIS AND STUDIES PANEL (SAS)

Panel Chair: **Mr. Espen SKJELLAND (NOR)**

Panel Vice-Chair: **Mrs. Donna WOOD (CAN)**

Panel Executive: **LT COL Spencer TIMMONS (USA)**

Panel Assistant: **Mr. Jeroen GROENEVELT (NATO)**

MISSION

The System Analysis and Studies (SAS) panel – NATO STO's expert panel for analytical advice – conducts studies and analysis for better decisions in strategy, capability development, and operations within NATO, NATO Nations, and partner Nations. Key drivers in the SAS panel's work are the exploitation of new technologies, new forms of organization, and new concepts of operation.

Currently, the SAS panel consists of 43 senior scientific representatives from 23 NATO Nations, 2 Partnership for Peace Nations, 1 Global Partner, and 4 NATO organizations. The SAS panel leverages analysts and scientists from academia, government, and industry to conduct research.

MAIN INTEREST

The focus of the Panel is on undertaking Operations Analysis activities related to challenges in the evolving strategic environment and the responses that both individual nations and NATO as a whole are making to tackle them. The research can be clustered into 4 focus areas: Policy and Strategy Decision Support, Operations Decision Support, Capability and Investment Decision Support, and Development and Maintenance of Analysis Capabilities.

The development and maintenance of analysis capabilities forms the basis of the Panel work and is essential to provide NATO with innovative and academically sound analytical capabilities that will ensure informed defence decision making. Activities include the development of analytical methods to address upcoming security challenges, information exchange on OA modelling concepts and best practice, research into new methodological approaches, and the development and exchange of models.

The Panel leverages its broad range of analysis capabilities to provide decision support at all levels and in different areas. To illustrate, the Panel identifies and assesses the impacts of geo-political drivers, regional contexts, futures, and technology changes to support policy and strategy decisions. It conducts analysis to improve operational tactics, training and procedures as well as develops better methods to support operational planning. Finally, it supports the development of systems, force element and enabler capability options, including the collection and collation of cost and performance data and defining the necessary missions for these individual systems and capabilities.

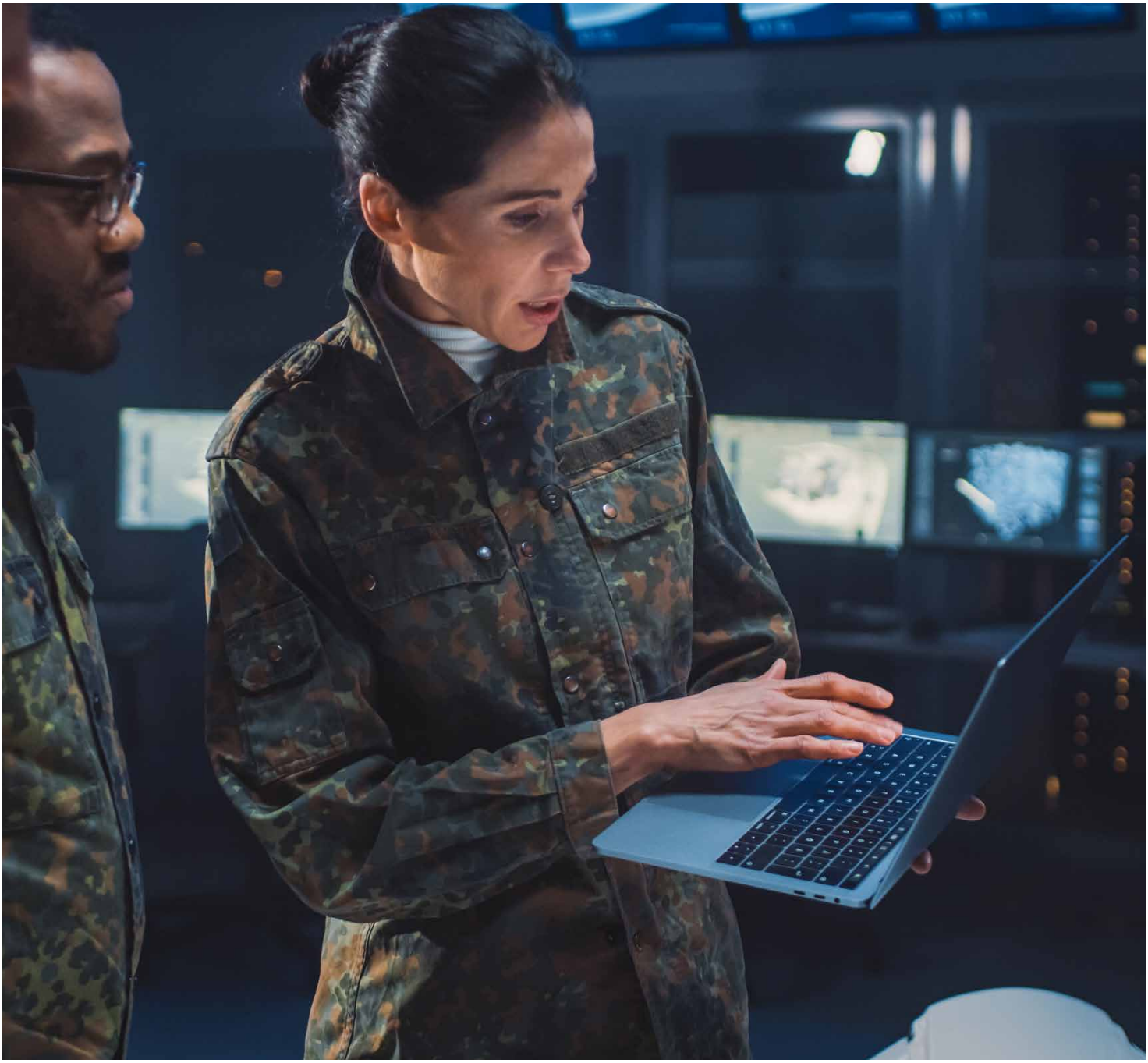
The main source for new research projects are proposals made by NATO Nations represented at the SAS panel. The SAS panel also addresses requests for such analysis and studies from a variety of other sources. These include the Science and Technology Board (STB) and other NATO bodies, such as the NATO Military Committee, the Conference of National Armament Directors (CNAD) with its Main Armaments Groups and the NATO Industrial Advisory Group (NIAG), Allied Command Operations (ACO), Allied Command Transformation (ACT) and the NATO Communications and Information Agency (NCIA).

Table 14: SAS Activities Continuing in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
SAS-124	RTG	How could Technology Development Transform the Future Operational Environment
SAS-136	RTG	Optimization of Investment in Simulation-Based Military Training
SAS-140	RTG	Directed Energy Weapons Concepts and Employment
SAS-143	RTG	Agile, Multi-Domain C2 of Socio-Technical Organizations in Complex Endeavors
SAS-144	RTG	Code of Best Practice for Conducting Survey Research in a Military Context
SAS-145	RTG	Soldier System Weapon & Equipment Assessment Tool (SWEAT)
SAS-147	RTG	Analysis of Anti-Access Area Denial (A2/AD)
SAS-149	RTC	Basics of complex modern urban functions and characteristics
SAS-151	RTG	Solutions Enabling Intermediate Force/Non-lethal Weapon Contributions to Mission Success
SAS-152	RTG	Conceptual framework for Comprehensive National Defence System
SAS-153	RTG	Best practices on Cost Analysis of Information And Communication Technology
SAS-154	RTG	Future Strategic Environment Assessment: Framework for Analysis
SAS-156	RTG	Developing a Standard Methodology for Assessing Multinational Interoperability
SAS-157	RTG	Automation in the Intelligence Cycle
SAS-158	RTG	Employing AI to Federate Sensors in Joint Settings
SAS-159	RTG	How could Technology Development Transform the Future Operational Environment
SAS-160	RTG	Ethical, Legal and Moral (ELM) impacts of novel technologies on NATO's operational advantage – the "ELM Tree"
SAS-161	RTG	Military Aspects of Countering Hybrid Warfare: Experiences, Lessons, Best Practices
SAS-163	RTG	Energy Security in the Era of Hybrid Warfare
SAS-164	RTG	21st Century Force Development
SAS-165	RSY	Assessing the Implications of Emerging Technologies for Military Logistics
SAS-166	RTG	Wargaming Multi-Domain Operations in an A2/AD Environment
SAS-167	RTG	Assessing the value of cyber operations in military operations
SAS-168	RTG	Coalition Sustainment Interoperability Study
SAS-170	ST	Distributed Wargaming for a COVID 19 World
SAS-172	RTG	Multi-Domain Operations Wargame
SAS-IST-162	ST	A Hackathon to determine how large exercise datasets can be used to reconstruct operational decision making to improve training and analysis value
SAS-IST-171	RTG	C2 services in Multi Domain Operations for Federated Mission Networking (FMN)
SAS-ORA	RSY	(Annual) Operations Research and Analysis Conference
SAS-SP-001	SP	Develop the ability of the Croatian Armed Forces to conduct war games at the operational and military strategic levels of warfare/operations

Table 15: SAS Activities Starting in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
SAS-149	RTC	Basics of complex modern urban functions and characteristics
SAS-173	RTG	Military Medical, Readiness and COVID-19: Best Practices and a Framework for Force Planning
SAS-174	RSY	Are the major weapon platforms obsolete?
SAS-175	RWS	Integration of Unmanned Systems (UxS) into operational units
SAS-176	RTC	Taking FATE on the road
SCI-SAS-351	RTG	Alliance Space Deterrence Framework



11. SYSTEMS CONCEPTS AND INTEGRATION PANEL (SCI)

Panel Chair: **Dr. Karin STEIN (DEU)**

Panel Vice-Chair: **Mr. Allan CHAN (USA)**

Panel Executive: **LT COL Roderick BENNETT (USA)**

Panel Assistant: **Ms. Carlotta ROSSI (NATO)**

MISSION

The mission of the Systems, Concepts and Integration (SCI) Panel is to advance knowledge concerning advanced system concepts, integration, engineering techniques and technologies across the spectrum of platforms and operating environments to assure cost-effective mission area capabilities. Integrated defence systems, including air, land, sea, and space systems (manned and unmanned), and associated weapon and countermeasure integration are covered. Panel activities focus on NATO and national mid- to long-term system level operational needs.

MAIN INTEREST

The scope of Panel activities covers a multidisciplinary range of theoretical concepts, design, development, and evaluation methods applied to integrated defence systems. Areas of interest include:

- Integrated mission systems including weapons and countermeasures
- System architecture/mechanisation
- Vehicle integration
- Mission management
- System engineering technologies and testing

Table 16: SCI Activities Continuing in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
SCI-287	RTG	Assessment Methods for Camouflage in Operational Context
SCI-294	RTG	Demonstration and Research of Effects of RF Directed Energy Weapons on Electronically Controlled Vehicles, Vessels and UAVs
SCI-301	RTG	Defeat of Low Slow and Small (LSS) Air Threats
SCI-302	RTG	DIRCM Concepts and Performances
SCI-304	RTG	Optimised and Reconfigurable Antennas for Future Vehichle Electronic Counter Measures
SCI-305	RTG	Flight Test Technical Team (FT3)
SCI-307	RTG	FAMOS Framework for Avionics MissiOn Systems
SCI-310	RTG	Expanded Countermeasure Methods against IR Anti-Ship Threats in Varied Parameter and Scenario Engagements Using all-digital Tools Sets
SCI-311	RTG	Collaborative Space Domain Awareness Data Collection and Fusion Experiment
SCI-312	RTG	EO-IR Countermeasures
SCI-314	AG	Ground and Flight Test Methods Used to Assure Aeroelastic Stability of Fixed Wing Aircraft - AG-300 V.35
SCI-315	AG	Flight Testing of Helmet Mounted Displays - AG-300 V.36
SCI-316	RTG	High Energy Laser Weapons: Quantifying the Impact of Atmospherics and Reflections
SCI-317	RLS	Hands-on with JANUS: Understanding, Implementing and Using the first Digital Underwater Communications Standard
SCI-320	RTG	Scientific Support to NNAG Above Water Warfare Capability Group
SCI-321	RTG	UAV Applications for Military Search
SCI-322	RTG	Scientific Support to NATO Aerospace Capability Group 3 Sub-Group 2 (ACG3/SG2) on Suppression of Enemy Air Defence (SEAD)
SCI-324	RWS	Realization and Evaluation of Robotic Multispectral Decoys for Land Equipment
SCI-325	RTG	Methods of Identifying and Evaluation the Camouflage and Deceptive Properties of the Military Equipment in Land Field Trials
SCI-326	RTG	Electronic Support (ES) Techniques Enabling Cognitive Electronic Warfare (EW)
SCI-327	RTG	Countermeasure Concepts against Anti-Aircraft Dual band EO/IR Imaging Seekers
SCI-328	RSY	Flight Testing of Unmanned Aerial Systems (UAS)
SCI-329	RSM	Capabilities for Sensing, Search, and Surveillance in the Arctic
SCI-332	RTG	Radio Frequency-based Electronic Attack to Modern Radar
SCI-333	RTG	Multi-sensor Fusion Architecture for the Detection of Person-borne-Improvised Explosive Devices (PB-IEDs)
SCI-334	RTG	Evaluation of Swarm System for Military Applications
SCI-337	RWS	Combination of Field Measurements and M&S Assessment Methods

SCI-338	AG	AG-300-V.37 Flight Testing of Unmanned Aerial Vehicles
SCI-340	RLS	HEL Weapon Technology, Opportunities, and Challenges
SCI-342	RTG	Explosive Ordnance Disposal (EOD) Tele-manipulation Robot Technology Roadmap Development
SCI-343	RTG	Enabling Federated, Collaborative Autonomy
SCI-344	RTG	Future Multi-sensor Threat Defeat Concepts
SCI-346	RTG	Space Risk Assessment Matrix (S-RAM)
SCI-347	RTG	SMART IED Threat Mitigation Technology Assessments SMiTMiTA
SCI-348	RTG	Real-time Coalition Electromagnetic Battle Management (EMBM)
SCI-349	RTG	Heterogeneous Data-Driven Space Domain Decision Intelligence
SCI-350	RTG	NATO Alliance SmallSat Constellation Effort (ALLSAT)
SCI-SET-323	RSM	Above Water EO/IR Signature Requirements from an Operational Perspective

Table 17: SCI Activities Starting in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
HFM-SCI-351	ST	Verification in Trust Enabled Regimes (VITER)
SCI-352	RTG	Flight Test Technical Team (FT3)
SCI-SAS-351	RTG	Alliance Space Deterrence Framework
SET-SCI-297	RSM	Space Sensors and Space Situational Awareness

12. SENSORS AND ELECTRONICS TECHNOLOGY PANEL (SET)

Panel Chair: **Mr. Frank VAN DEN BOGAART (NLD)**

Panel Vice-Chair: **Dr. Alexandre JOUAN (CAN)**

Panel Executive: **LT COL Isidoro MARCONE (ITA)**

Panel Assistant: **Ms. Alicia MAHARAJ (NATO)**

MISSION

The mission of the Sensors and Electronics Technology (SET) Panel is to foster co-operative research, the exchange of information, and the advancement of science and technology among the NATO Nations in the field of sensors and electronics for defence and security. The SET Panel addresses the development and enhancement of both passive and active sensors, as well as electronic technology capabilities, multi-sensor integration and fusion as they pertain to Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR), Remote Sensing, Electronic Warfare (EW), Communications, and Navigation. To fulfil this mission, the SET Panel is organized into three Focus Groups: Radio-Frequency Technology (RFT); Optical Technology (OT); and Multi-Sensors & Electronics (MSE).

MAIN INTEREST

The research activities of the SET Panel predominantly address topics related to target signatures, propagation and battlespace environments, electro-optic (EO)/radio-frequency (RF)/acoustic/magnetic sensors, antennas, signal and image processing, components, sensor hardening, electromagnetic compatibility and any other phenomena associated with sensors and electronics that may assist NATO war-fighters during future warfare and peace-keeping scenarios.

In principle, the Focus Groups are addressing the following domains:

1. **Multi Sensors and Electronics:**
   - Sensing for ISR;
   - C-IED;
   - Swarms; and
   - Navigation.

2. **Radio Frequency Technology:**
   - Radar (including Active, Passive, SAR, Noise, Cognitive, Multi-and Bi-static, Multi-function, SW Defined);
   - ATR/NCTR;
   - Radar Imaging;
   - Radar Signatures; and
   - Spectrum Management.

3. **Optical Technology:**
   - Infrared and Spectral Sensing;
   - Laser Radar Technology;
   - Performance Modeling; and
   - Target Signatures.

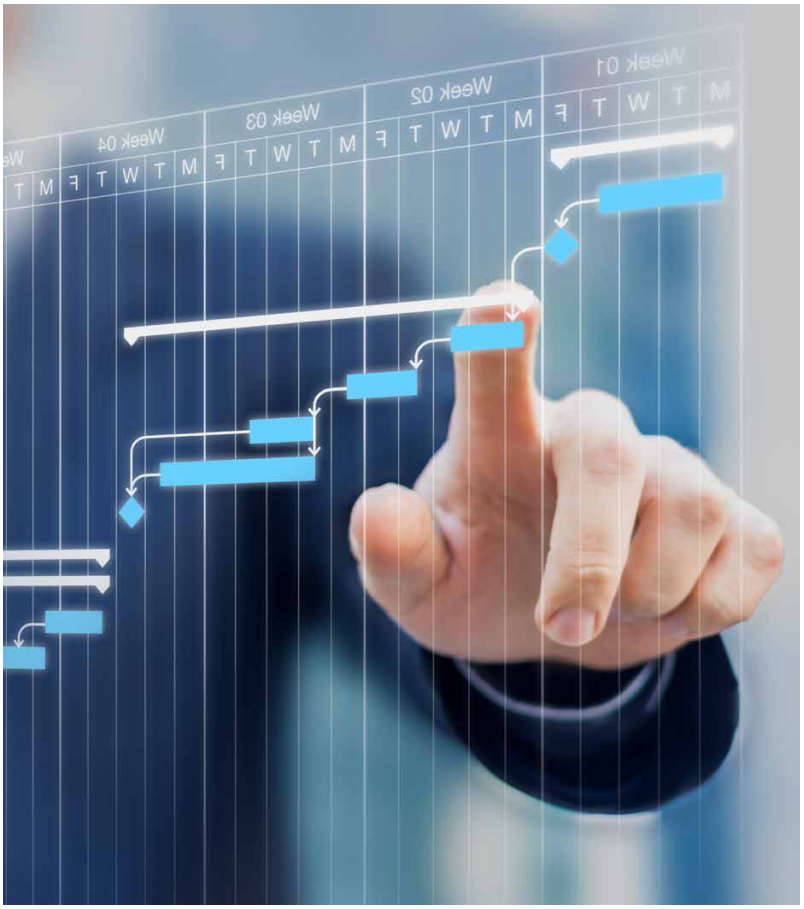


Table 18: SET Activities Continuing in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
SCI-346	RTG	Space Risk Assessment Matrix (S-RAM)
SET-242	RTG	Passive Coherent Locators on Mobile Platforms
SET-246	RTG	Short Wave Infrared Technology: a standardized irradiance measurement and compatibility model to evaluate reflective band systems
SET-249	RTG	Laser Eye Dazzle Threat Evaluation and Impact on Human Performance
SET-251	RTG	Ship Radar Signature Management Benefit to Ships
SET-252	RTG	Development of a validation model of a stealth UCAV
SET-256	RTG	Interoperability & Networking of Disparate Sensors and Platforms for ISR Applications
SET-257	RLS	Compressive Sensing Techniques for Radar and ESM Applications
SET-258	RTG	DMPAR Deployment and Assessment in Military Scenario
SET-260	RTG	Assessment of EO/IR Technologies for Detection of Small UAVs in an Urban Environment
SET-263	RTG	Swarms Systems for Intelligence Surveillance & Reconnaissance
SET-264	RSY	Quantum Position Navigation and Timing for NATO platforms
SET-266	RTG	Multi-functional EO/IR sensors for counter-surveillance
SET-268	RTG	Bi-/Multi-static radar performance evaluation under synchronized conditions
SET-269	RTG	EO/IR Ship Signature Dynamics
SET-270	RTG	Overcoming the Technical Barriers that Inhibit use of Fuel Cells for Dismounted Soldier Applications
SET-271	RTG	Airborne Maritime Radar Based Submarine Periscope Detection and Discrimination at High Grazing Angles
SET-272	RTG	Automated Scene Understanding for Battlefield Awareness
SET-274	RLS	Cooperative Navigation in GNSS Degraded and Denied Environments
SET-276	ST	Quality Assurance and Assessment Team for SPS on Detection of Explosives and firearms to counter TERrorism (DEXTER)
SET-278	RTG	Machine Learning for Wide Area Surveillance
SET-279	RTG	Space-based SAR and Big Data Technologies to support NATO Operations
SET-280	RTG	Phenomenology and Exploitation of CMs
SET-283	RTG	Advanced Machine Learning ATR using SAR/ISAR data

SET-284	RSM	Enhanced Situation Awareness using Active-Passive Radar Systems in Military Scenarios
SET-285	RTG	Multifunction RF Systems
SET-286	RTG	Acoustic and Seismic Sensing of Threats in Urban Environments
SET-287	RTG	Characterization of Noise Radar
SET-288	RTG	Integrating Compressive Sensing and Machine Learning Techniques for Radar Applications
SET-289	RWS	Nanotechnology for Optics & Infrared Photo Detection
SET-290	RLS	AI for Military ISR Decision Makers
SET-291	RTG	Sensitivity of EO TDAs to Environmental Factors
SET-292	RTG	Enhanced Raman Spectroscopy for Defense Applications
SET-293	RTG	RF Sensing for Space Situational Awareness
SET-294	RTG	Advanced Mid-Infrared Laser Technology
SET-295	RTG	Radar Signature Measurements of Maritime Platforms
SET-296	RTG	Radar against Hypersonic Threats
SET-298	RSM	Electronic Attack and Protection for Modern Active/Passive Netted Radars
SET-299	RLS	Passive Radars - Technology and Applications
SET-300	RTG	3D Active and Passive EO/IR Sensing for Urban Operations
SET-301	RTG	SimPL Simulation of Low Photon Lidar
SET-302	RTG	Cognitive Radar
SET-303	RTG	Military Applications of Extreme Laser Fields
SET-304	RTG	Modeling, Measuring and Mitigating Optical Turbulence: M3T
SET-305	RTG	Improved Field of View for Night Vision Goggles – Technical Challenges, Concepts, Performance Assessment
SET-306	RTG	Improved Panoramic Situational Awareness for Vehicle Platforms – Technical Challenges, Concepts, Performance Assessment
SET-307	RTG	Advanced radar techniques for robust situation awareness and threat assessment considering Class I UAS in complex environments
SET-308	RWS	Trends in Ultrashort Pulse Laser Source Technology Improvements
SET-SCI-297	RSM	Space Sensors and Space Situational Awareness

Table 19: SET Activities Starting in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
SET-309	RTG	NATO PNT Open System Architecture & Standards to Ensure PNT in NAVWAR Environments
SET-310	RTG	Assessment of EO/IR Compressive Sensing and Computational Imaging Systems
SET-311	RSY	10th Military Sensing Symposium (MSS)
SET-312	RSM	Distributed Multi-Spectral/Statics Sensing
SET-313	RTG	Advanced Methods for Hyperspectral Data Exploitation
SET-HFM-314	RWS	Multi-Omic Data Sciences Research Workshop
SET-315	RSY	Detection, Tracking, ID and Defeat of Small UAVs in Complex Environments
SET-316	RTG	Realistic Trace Explosives Test Standards for Evaluation of Optical Sensors in Relevant Scenarios
SET-317	RTG	Multi-dimensional/Multi-platform Radar Imaging

13. STO EVENTS IN 2022 CPOW

Among the various types of activities administered by the Collaboration Support Office, there are several types aimed at promoting exchange and dissemination of state-of-the-art knowledge amongst targeted audiences on an important scientific or applied topic. These are: Lecture Series, Technical Courses, Symposia, Workshops and Specialists' Meetings.

Visit our website at: www.sto.nato.int
to learn about STO Events we organize.

13.1 LECTURE SERIES IN 2022

A **Research Lecture Series (RLS)** technical team activity aims at disseminating state-of-the-art scientific knowledge among junior and mid-level scientists, engineers and analyst in military-relevant domains that are not taught in universities. A RLS is a two-day educational event that is normally organized at three different locations. RLSs can include a roundtable discussion. RLSs are combined with an STO publication (Educational Notes), which will be made available before the first RLS session.

Table 20: 2022 Lecture Series

MONTH	ACTIVITY	TYPE	TITLE	MEETING DATE	MEETING LOCATIONS	DISTRIBUTION AND PARTNER PARTICIPATION
2Q 2022	SET-274	RLS	Cooperative Navigation in GNSS Degraded and Denied Environments	Early 2022 TBC	Dayton (USA) Linkoping (SWE) Zagreb (HRV)	STO EOPs + PfP +Contact
3-4Q 2022	SCI-340	RLS	HEL Weapon Technology, Opportunities, and Challenges	Mid to late 2022 TBC	PRT, BEL, CAN, AUS - TBC	STO EOPs
3-4Q 2022	SET-257	RLS	Compressive Sensing Techniques for Radar and ESM Applications	Mid to late 2022 TBC	Ottawa, (CAN) Naples (ITA) Warsaw (POL)	STO-EOPs + PfP
October-November	SET-290	RLS	AI for Military ISR Decision Makers	Oct-Nov 2022 TBC	Wachtberg (DEU) Rome (ITA) Stockholm, SWE	STO EOPs + PfP
4Q 2022 or 2023	SET-299	RLS	Passive Radars - Technology and Applications	Late 2022 or 2023 TBC	Varna (BGR) Budapest (HUN) Atlanta (USA)	STO EOPs + PfP
TBD	AVT-358	RLS	Advanced computational fluid dynamics methods for hypersonic flows	TBD	TBD	
TBD	AVT-375	RLS	Munition Health Management Lecture Series: Implementation Challenges	TBD	TBD	STO EOPs + GP
TBD	AVT-377	RLS	Introduction to Quantum Computing in Fluid Dynamics	TBD	TBD	STO EOPs + Contact
TBD	HFM-240	RLS	Mild Traumatic Brain Injury: Post Concussive Symptoms in a Deployed Setting	TBD	TBD	STO EOPs + GP + Contact
TBD	HFM-314	RLS	Aircrew Neck Pain Prevention and Management Lecture Series	TBD	TBD	STO EOPs
TBD	HFM-328	RLS	Collaborations between Military & Civilian Personnel in Defence Organizations	TBD	TBD	STO EOPs + PfP + MD + ICI + GP + Contact
TBD	MSG-203	RLS	The Role of Modelling and Simulation to Support Current and Future NATO Operations	TBD	TBD	STO EOPs
TBD	SCI-317	RLS	Hands-on with JANUS: Understanding, Implementing and Using the first Digital Underwater Communications Standard	TBD	TBD	STO EOPs + PfP + MD

13.2 TECHNICAL COURSES IN 2022

A Research Technical Course (RTC) is an educational technical team activity aimed at transferring practical knowledge and recent field developments through on-site instructor training or lectures to military decision makers.

Table 21: 2022 Technical Courses

MONTH	ACTIVITY	PANEL	ACTIVITY TYPE	TITLE	MEETING DATE	MEETING LOCATIONS	DISTRIBUTION AND PARTNER PARTICIPATION
March	HFM-350	HFM	RTC	Aerospace Medicine: New Technologies-New Approach RAMS USAF/NATO STO HFM	21-25 Mar	Garmisch Partenkirchen (DEU)	STO EOPs + PfP + MD + ICI + GP + Contact + Other
TBD	MSG-194	MSG	RTC	Employing the C2-Simulation Interoperation (C2SIM) Standard for Coalition Military Operations and Exercises	TBD	TBD	STO EOPs + PfP + GP
TBD	SAS-149	SAS	RTC	Basics of complex modern urban functions and characteristics	TBD	TBD	STO EOPs + PfP + GP
TBD	SAS-176	SAS	RTC	Taking FATE on the road	TBD	TBD	STO EOPs + PfP + MD + GP

13.3 SYMPOSIA IN 2022

A Research Symposium (RSY) technical team activity aims at promoting exchange of state-of-the-art knowledge among a wide audience on an important scientific or applied topic. The prime purpose of a RSY is to enhance the capability of the NATO S&T community to respond adequately to the military requirements of NATO. An RSY is a large-scale (100+ participants), three-to-four day event. Communications are primarily via invited Keynote Addresses and via oral and poster presentations of submitted papers, screened and selected for presentation by the Programme Committee as generated from a Call for Papers. An RSY results in an STO publication (Meeting Proceedings).

Table 22: 2022 Symposia

MONTH	ACTIVITY	PANEL	ACTIVITY TYPE	TITLE	MEETING DATE	MEETING LOCATIONS	DISTRIBUTION AND PARTNER PARTICIPATION
March	SET-264	SET	RSY	Quantum Position Navigation and Timing for NATO platforms	28-31 Mar 2022	Avignon (FRA)	STO EOPs
March	SET-311	SET	RSY	10th Military Sensing Symposium (MSS)	28-31 Mar 2022	Avignon (FRA)	STO EOPs + PfP
March	SAS-165	SAS	RSY	Assessing the Implications of Emerging Technologies for Military Logistics	March 2022	TBD	STO EOPs
IT2EC: 26-28 April **CA2X2**: Sep-Oct **I/ITEC:** Nov-Dec	MSG-196	MSG	RSY	MSG/MSCO Support to International Training & Education Conferences IT2EC, I/ITSEC and CA2X2 Forum 2022	**IT2EC:** 26-28 April **CA2X2**: Sep-Oct **I/ITEC:** Nov-Dec	**IT2EC:** London (UK) **CA2X2**: Rome (ITA) **I/ITEC:** Orlando (USA)	STO EOPs + PfP + GP
May	SCI-328	SCI	RSY	Flight Testing of Unmanned Aerial Systems (UAS)	10-11 May 2022	Segovia (ESP)	STO EOPs + PfP + MD
October	IST-195 (AI2S)	IST	RSY	Societal challenges for Operations in the Information Environment	3-7 October (probably 4-5 October, TBC)	Stockholm, (SWE)	STO EOPs
October	HFM-349	HFM	RSY	Human Performance and Medical Treatment and Support During Cold Weather Operations	17-18 October	Washington DC (USA)	STO EOPs + PfP + MD ICI + GP + Other
October	MSG-197	MSG	RSY	NMSG Annual Symposium 2022	20-21 Oct 2022	BATH, UK	STO EOPs + PfP + GP + Other Partners

TBD	AVT-369	AVT	RSY	Digital Twin Technology Development and Application for Tri-Service Platforms and Systems	TBD	TBD	STO EOPs
TBD	SAS-174	SAS	RSY	Are the major weapon platforms obsolete?	TBD	TBD	STO EOPs
TBD	SAS-ORA	SAS	RSY	(Annual) Operations Research & Analysis Conference	TBD	TBD	STO EOPs
TBD	AVT-356	AVT	RSY	Physics of Failure for Military Platform Critical Subsystems	TBD	TBD	STO EOPs

SYMPOSIA 2022 ADVERTISEMENTS

HFM-349 Symposium on Human Performance and Medical Treatment during Cold Weather Operations

Point of contact: hfm@cso.nato.int

Synopsis:

Access to the Arctic is increasing due to climate change. Military monitoring of Arctic regions by NATO nations will be required, however, in the foreseeable future unmanned surveillance technologies will not replace the need for human military presence in this austere environment.

Military operations in cold climates necessitates innovative modifications to the practice of medicine. New concepts will be explored and tested to prevent and treat non-freezing injuries (whole body cooling or "hypothermia") and freezing injuries (traditionally known as "frostbite" – where the peripheral tissue freezes and causes permanent damage).

Parallel long-range preventive solutions to Arctic / cold medicine including human nutrition and human performance enhancement technologies (ranging across advanced techniques, technologies and advanced textiles) will also be explored and tested in laboratory settings, and in coordinated and collaborative field trials.

The purpose of this symposium is to:

1. Share and disseminate the research and experience from soldiers operating in cold environments.
2. Help to improve treatment and prevention of cold-related injuries through shared research.
3. Discussion on special requirements to related medical equipment.
4. The conference proceedings with all the papers presented during the symposium will be published.

SCI-328 Symposium on lessons learned from flight testing of UAVs in NATO

Time: 10-11 May 2022

Place: Segovia (ESP)

Point of contact: SCI@cso.nato.int

Synopsis:

Unmanned Air Systems (UAS's) are being more widely used by NATO in many of the major conflict areas in the world. In addition to Intelligence, Surveillance, and Reconnaissance (ISR) purposes, UAS's are also employed for weaponized attacks, suppression of enemy air defense and as decoys for denial and deception purposes. When UAS's are employed in a "swarming" concept for offensive and defensive purposes, this changes the game for modern warfighting. Thousands of mini or even micro UAS's can easily destroy even the most sophisticated and advanced weapon systems. Their major advantage of being small, light, cheap and even disposable, but intelligent and autonomous make them superior to today's major conventional weapons. Autonomy and autonomous systems will be the key player in the upcoming decades. UAS have become an inevitable means for the modern war fighter.

The purpose of this symposium is to:

1. Share and disseminate the experience and the lessons learned from flight testing of UAVs among different NATO nations.
2. Help to improve, shorten and reduce the time and the risks involved in NATO flight testing of their own UAS.
3. The conference proceedings with all the papers presented during the symposium will be published.

AVT-356 Symposium on methodology on preventive and predictive maintenance of military equipment

Point of contact: AVT@cso.nato.int

Synopsis:

There is a need to continuously improve sustainment of ageing aircraft through characterization and creation of physics-based material failure models. This is also fundamental to enabling a family of limited function, rapidly produced, low cost, attritable and autonomous UAVs by trading pristine component manufacturing to one that allows increased imperfection. Further still, physics-based failure models will play a vital role to additively manufactured parts that have larger fractions of voids and microstructural anomalies. A new physics-based failure understanding for designs, materials, and manufacturing will be required for advancements in all of these areas.

The purpose of this symposium is to:

1. Identify common interests as well as opportunities and challenges in physics-based life quantification methods to address rapidly changing needs for conventional materials as well as new materials operating in extreme environments.
2. Illustrate how an understanding of the physics of failure could bring about improved attritable propulsion and air vehicles that provide new capability to the warfighter, quicker and in a more reliable way.
3. Outline new physics-based approaches to predict the remaining useful life of fielded and future propulsion and airframe systems.

IST-195 Exploring and Understanding Information Environment Threats to Democracy

Point of contact: IST@so.nato.int

Synopsis:

The information environment (IE) is an active battlespace where societal beliefs, attitudes and behaviours at the local, regional and national level can have a profound impact on outcomes; impacts ever more critical and challenging in today's global landscape. Strategies and tactics aim to polarize opinions, undermine social cohesion and disrupt and/or corrupt autonomy and legitimacy of democratic processes. Protecting NATO countries' interests against information operations in the IE requires a concerted effort by not only Whole of Government in partnership with Industry and Academia, but also between NATO member countries and our ally partners. In the Defence Community, key requirements include maintaining understanding, tracking, and situational awareness of adversarial strategies, tactics, strength and vulnerabilities in the IE, as well as the developing effective approaches to countering.

The purpose of this symposium is to:

1. Understanding what are IE threats to democracy.
2. Understanding measurement of effectiveness – what is it to be victorious in the IE.
3. How to conduct proactive maneuvers and defensive activities.
4. The conference proceedings with all the papers presented during the symposium will be published.

MSG-196 The International Training Technology Exhibition & Conference (IT2EC)

Point of contact: MSG@cso.nato.int

Synopsis:

The International Training Technology Exhibition & Conference (IT2EC) is the leading European event for users, providers, manufacturers, academics and designers of equipment, services and simulation to meet and present new ideas on training and education to an international audience. IT2EC provides NATO an opportunity to inform attendees at this major European conference on current Alliance M&S activities. It also provides the Modelling and Simulation Coordination Office (MSCO) a key opportunity to keep in contact with ongoing initiatives in M&S in Europe.

The purpose of this symposium is to:

1. Showcasing NMSG activities relevant to the themes of the respective events.
2. Testing interoperability of M&S technologies.
3. Disseminating the findings of the NMSG activities.
4. Advertise ongoing NATO M&S activities.

SAS-165 Re-shaping Military Logistics with Emerging Technologies

Point of contact: SAS@cso.nato.int

Synopsis:

Logistics is of vital importance for any military operation. Without it, operations could not be carried out and sustained. This is especially evident with NATO's out-of-area operations. Logistics also forms a significant cost burden. Interoperability of technologies enables burden sharing. Logistics concepts need to adapt both to the use of new technologies and to changing operational contexts:

- Ability to operate in both NATO's core area of operations and out of area.
- Ability to undertake both discrete operations and operate in a state of constant competition.
- Operation in urban environments.

As well as the conducting of operations, new and emerging technologies can have wider military implications. These include how emerging technologies can affect the logistic organisations themselves, existing and planned acquisitions programs and education & training.

The purpose of this symposium is to:

1. Share and review work being undertaken in this area; studies, events, exercises, road maps, strategies.
2. Understand the extent to which changes in provision of logistics support in the Civil sector can be applied in a Defence and Security context.
3. Share knowledge of how Operational Research & Analysis (OR&A) is being used to identify the benefits, costs and risks of innovative and emerging technologies.
4. Understand and develop follow-on opportunities for Logistics OR&A collaboration and to avoid duplication of effort.

13.4 WORKSHOPS IN 2022

A **Research Workshop (RWS)** technical team activity aims at facilitating intensive information exchange and focused discussion on a specific topic among a limited number of invited experts. The prime purpose of a RWS is to enhance the capability of the NATO S&T community to respond adequately to the military requirements of NATO. A RWS (generally not more than 30 participants) is a two to three-day event with no prescribed format. A RWS results in an STO publication (Meeting Proceedings).

Table 23: 2022 Workshops

MONTH	ACTIVITY	ACTIVITY TYPE	TITLE	MEETING DATE	MEETING LOCATIONS	DISTRIBUTION AND PARTNER PARTICIPATION
January	SET-308	RWS	Trends in Ultrashort Pulse Laser Source Technology Improvements	23 Jan 2022	San Francisco (USA)	STO EOPs + PfP
April	AVT-371	RWS	Materials and technologies for electro-optical camouflage (Cross-Panel)	26-28 Apr 2022	Torino (ITA)	STO EOPs
April	AVT-353	RWS	Artificial Intelligence in Cockpits for UAVs	26-28 Apr 2022	Torino (ITA)	STO EOPs
May	AVT-366	RWS	Use of Computational Fluid Dynamics for Design and Analysis: Bridging the Gap Between Industry and Developers	23-27 May 2022	Sibiu (ROU)	STO EOPs
September	AVT-372	RWS	Military value of graphene technologies	26-30 Sep 2022	Varna (BGR)	STO EOPs
September	AVT-373	RWS	Emerging technologies for proactive corrosion maintenance	26-30 Sep 2022	Varna (BGR)	STO EOPs
September	AVT-354	RWS	Multi-fidelity methods for military vehicle design	26-30 Sep 2022	Varna (BGR)	STO EOPs
September	AVT-360	RWS	Environmentally Compliant Approaches to Maintenance and Overhaul of Military Vehicles	26-30 Sep 2022	Varna (BGR)	STO EOPs
September	AVT-364	RWS	Environmental Regulation on Energetic Systems and its Impact on Critical Munitions Materials and Capability	26-30 Sep 2022	Varna (BGR)	STO EOPs

October	AVT-361	RWS	Certification of Bonded Repair on Composite Aircraft Structures	18-20 Oct 2022	Amsterdam (NLD)	STO EOPs + PfP
October	AVT-374	RWS	More Electric Gas Turbine Engines for Aircraft, Rotorcraft and UAVs	18-20 Oct 2022	Amsterdam (NLD)	
Fall	SET-289	RWS	Nanotechnology for Optics & Infrared Photo Detection	Fall 2022 TBC	Paris (FRA)	STO EOPs + PfP
TBD	IST-191 (IWA)	RWS	Rescue Systems for Broken Trust	TBD	TBD	STO EOPs + PfP +
TBD	SAS-175	RWS	Integration of Unmanned Systems (UxS) into operational units	TBD	TBD	STO EOPs
TBD	SCI-324	RWS	Realization and Evaluation of Robotic Multispectral Decoys for Land Equipment	TBD	TBD	STO EOPs + PfP
TBD	SCI-337	RWS	Combination of Field Measurements and M&S Assessment Methods	TBD	Boston (USA) TBC	STO EOPs + PfP
TBD	SET-HFM-314	RWS	Multi-Omic Data Sciences Research Workshop	TBD	TBD	STO EOPs + PfP

13.5 SPECIALISTS' MEETING IN 2022

A Research Specialists' Meeting (RSM) technical team activity aims at promoting exchange of state-of-the-art knowledge among an audience of specialists with invited speakers on an important scientific or applied topic. The prime purpose of a RSM is to enhance the capability of the NATO S&T community to respond adequately to the military requirements of NATO. A RSM is a medium-scale (usually less than 100 participants), two to three-day event. Communications are primarily via invited Keynote Addresses and via oral presentations of authors invited by the Programme Committee. RSMs should include a roundtable discussion. A RSM results in an STO publication (Meeting Proceedings).

Table 24: 2022 Specialists' Meeting

MONTH	ACTIVITY	PANEL	TYPE	TITLE	MEETING DATE	MEETING LOCATIONS	DISTRIBUTION AND PARTNER PARTICIPATION
January	IST-185 (COM)	IST	RSM	Communication Networks and Information Dissemination for the Tactical Edge	19-20 Jan	Virtual via WebEx	STO EOPs
1-2 Q 2022	IST-181 (COM)	IST	RSM	Terahertz-band Communications and Networking	1-2 Q 2022	TBD	STO EOPs
May	SET-284	SET	RSM	Enhanced Situation Awareness using Active-Passive Radar Systems in Military Scenarios	12-13 May 2022	Gdynia (POL)	STO EOPs + PfP
May	SET-312	SET	RSM	Distributed Multi-Spectral/Statics Sensing	23-24 May 2022	Bled (SVN)	STO EOPs + PfP
September	SCI-329	SCI	RSM	Capabilities for Sensing, Search, and Surveillance in the Arctic	6-8 Sep 2022	Greenland (DNK)	STO EOPs + PfP + GP
October	SET-SCI-297	SET	RSM	Space Sensors and Space Situational Awareness	10-11 Oct 2022	Interlaken (CHE)	STO EOPs + PfP

14. EXPLORATORY TEAMS

Exploratory Teams (ETs) may be established when a Panel/Group believes that a particular expertise is required to assist or advise the Panel/Group on the technical merit or feasibility of a specific proposal for a technical activity. ETs may also be used to help the Panel/Group develop recommendations on future content of the Panel/Group's Programme of Work.

Table 25: Exploratory Teams Continuing in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
AVT-ET-215	ET	Thermal and Environmental Barrier Coatings for Military Aircraft Engines
HFM-ET-166	ET	Evaluation of Treatments of Post-amputation Phantom Limb Pain
HFM-ET-186	ET	Microbiome Applications in Human Health and Performance
HFM-ET-189	ET	Workforce Analytics Exchange: Standards for Military Personnel Data
HFM-ET-190	ET	Psychosocial Factors of Unconventional Warfare
HFM-ET-191	ET	Treatment Challenges with Combined Injuries
HFM-ET-192	ET	Blast Exposure Monitoring in Military Training and Operations (BEMMTO)
HFM-ET-193	ET	Skills and chill pills: Navigating the cyber-social information environment
HFM-ET-194	ET	Effectiveness of Legacy and Next-Gen Personal Protect Equipment Against Current and Emerging Blast Threats
IST-ET-116	ET	Formal modelling of military cryptographic key-management (COMSEC) processes
IST-ET-117	ET	Data Hiding in Information Warfare Operations
IST-ET-118	ET	Complementary use of symbolic and sub-symbolic AI methods
IST-ET-119	ET	Causal Reasoning
IST-ET-120	ET	RF finger printing of Drones
MSG-ET-052	ET	Common Framework for the assessment of XR Technologies for Use in Training and Education
MSG-ET-053	ET	Allied Interoperability and Standardization Initiatives for Digital Twins
SAS-ET-EY	ET	Proactive Manoeuvres in the Information Environment-StratCom
SAS-ET-FA	ET	Lessons Learned (LL) Ontology technologies – Improvements to Sharing and Searching
SAS-MSG-ET-EZ	ET	Intermediate Force Capabilities (IFC) Wargaming-M&S Integration
SCI-ET-055	ET	Air Platform Generic Self-Defence

ACTIVITY	ACTIVITY TYPE	TITLE
SCI-SET-ET-057	ET	Experimental analysis of combined, multistatic RF/EO data for improved Space Situational Awareness (SSA)
SET-ET-121	ET	Design Space Exploration for Autonomous Sensing
SET-ET-122	ET	Advanced Methods for Hyperspectral Data Exploitation
SET-ET-124	ET	Evaluation Framework for Multi-sensor Tracking and Fusion Algorithms

Table 26: Exploratory Teams Starting in 2022

ACTIVITY	ACTIVITY TYPE	TITLE
AVT-ET-217	ET	Dynamic Reconfigurable Mission Planning for Improved Readiness of Autonomous Military Vehicles
AVT-ET-218	ET	Cold spray technology for repair and improvement of military aircraft structures and components
AVT-ET-219	ET	Maintenance Modeling in UxV Design for Improved Readiness and Endurance
AVT-ET-220	ET	Novel Materials and Manufacturing in Military Air Vehicle Design
AVT-ET-221	ET	Sustainable Aviation Fuels (SAF) in a Military Context
AVT-ET-222	ET	Energetic Materials : Higher Performance and Operational Field
AVT-ET-222	ET	Progressive Rotorcraft Propulsion Alternatives
AVT-ET-224	ET	Emerging Activities for Wind Tunnel Wall Boundary Simulations
AVT-ET-225	ET	Reynolds Number Effects on Combat Aircraft External Aerodynamics
AVT-HFM-ET-216	ET	Human Systems Integration of Augmented Reality for Land Platforms in combat environments
HFM-ET-195	ET	Pre-Symptomatic Detection of Biological Exposures
HFM-ET-197	ET	Gender, Peace and Sustainable Security
IST-ET-121	ET	Behavior profiling in IoT
IST-ET-122	ET	Designing resilient autonomous vehicles
SCI-ET-061	ET	High Power Microwaves and Directed Energy Weapons
SCI-IST-ET-060	ET	Overview of Maritime Situational Awareness activities within STO, ACT, CMRE, and the Nations
SCI-SET-ET-059	ET	CCDs Technologies to counter Artificial Intelligence Targeting Systems
SET-ET-127	ET	Development of Standardized Targets for Military Search
SET-HFM-ET-125	ET	Ground Chemical Contamination Detection and Avoidance
SET-HFM-ET-126	ET	Nanopore Sequencing for Biological Identification

15. EMERGING AND DISRUPTIVE TECHNOLOGIES

Eight highly interrelated S&T areas are now considered to be a major strategic disruptor over the next 20-years. These S&T areas, also recognized as Emerging and Disruptive Technologies (EDTs), are either currently in nascent stages of development or are undergoing rapid revolutionary development. **The EDTs are: Space, Big Data, Artificial Intelligence, Autonomy, Hypersonics, Quantum, Biotechnology and Novel Materials**. Several of the CPoW activities directly align with at least one EDT.

Figure 4: EDT Matrix

16. CROSS-PANEL ACTIVITIES

Cross-panel activities are a joint venture between two or more Panels/Group where different researchers collaborate by combining their unique set of specialist skills to tackle a multidisciplinary problem. Cross-panel activities bring together diverse perspectives, approaches to problem solving, and subject matter expertise to create unique synergies applied towards increasingly complex operating environment concerns. Within the CPoW, cross-panel activities are not a goal in-and-of themselves, but are instead an additional tool to meet National S&T needs.

Table 27: Cross-Panel Activities 2022

ACTIVITY	ACTIVITY TYPE	TITLE
HFM-AVT-340	RTG	Neuroscience-based Technologies for Combat-oriented Crew Cockpit Design and Operations
HFM-MSG-346	RTG	Assessment of Factors Impacting Cybersickness
HFM-NMSG-354	RTG	Study, Design, Building and Deployment of a CBRN XR Training Platform
MSG-SAS-178	RTG	Using Simulation to Better Inform Decision Making for Warfare Development, Planning, Operations and Assessment
SAS-IST-171	RTG	C2 services in Multi Domain Operations for Federated Mission Networking (FMN)
SCI-SAS-351	RTG	Alliance Space Deterrence Framework
HFM-SET-339	RSM	Scientific and technological trends allow for new approaches addressing CBRN challenges
SCI-SET-323	RSM	Above Water EO/IR Signature Requirements from an Operational Perspective
SET-SCI-297	RSM	Space Sensors and Space Situational Awareness
SET-HFM-314	RWS	Multi-Omic Data Sciences Research Workshop
SAS-MSG-ET-EZ	ET	Intermediate Force Capabilities (IFC) Wargaming-M&S Integration
SCI-IST-ET-060	ET	Overview of Maritime Situational Awareness activities within STO, ACT, CMRE, and the Nations
SCI-SET-ET-059	ET	CCDs Technologies to counter Artificial Intelligence Targeting Systems
SET-HFM-ET-125	ET	Ground Chemical Contamination Detection and Avoidance
SET-HFM-ET-126	ET	Nanopore Sequencing for Biological Identification
HFM-SCI-351	ST	Verification in Trust Enabled Regimes (VITER)
SAS-IST-162	ST	A Hackathon to determine how large exercise datasets can be used to reconstruct operational decision making to improve training and analysis value

17. CPOW IN NUMBERS

TRENDS IN CPOW, 2012 – 2021

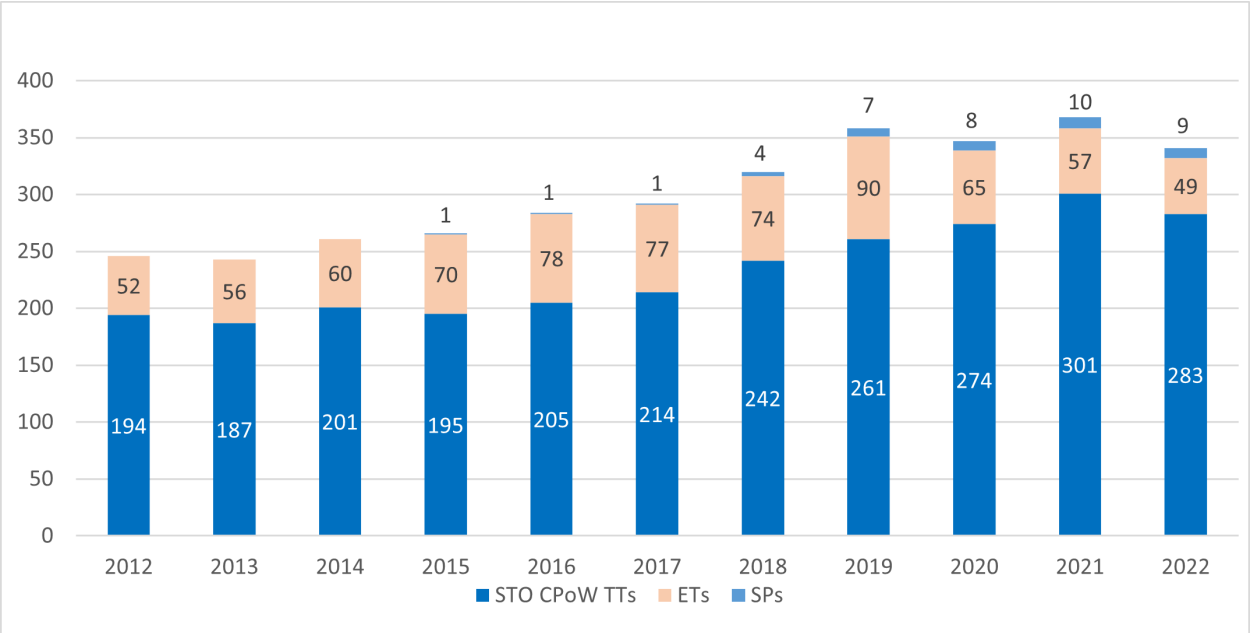


Figure 5: 10 Year Overview of the STO CPoW TTs, ETs and SPs

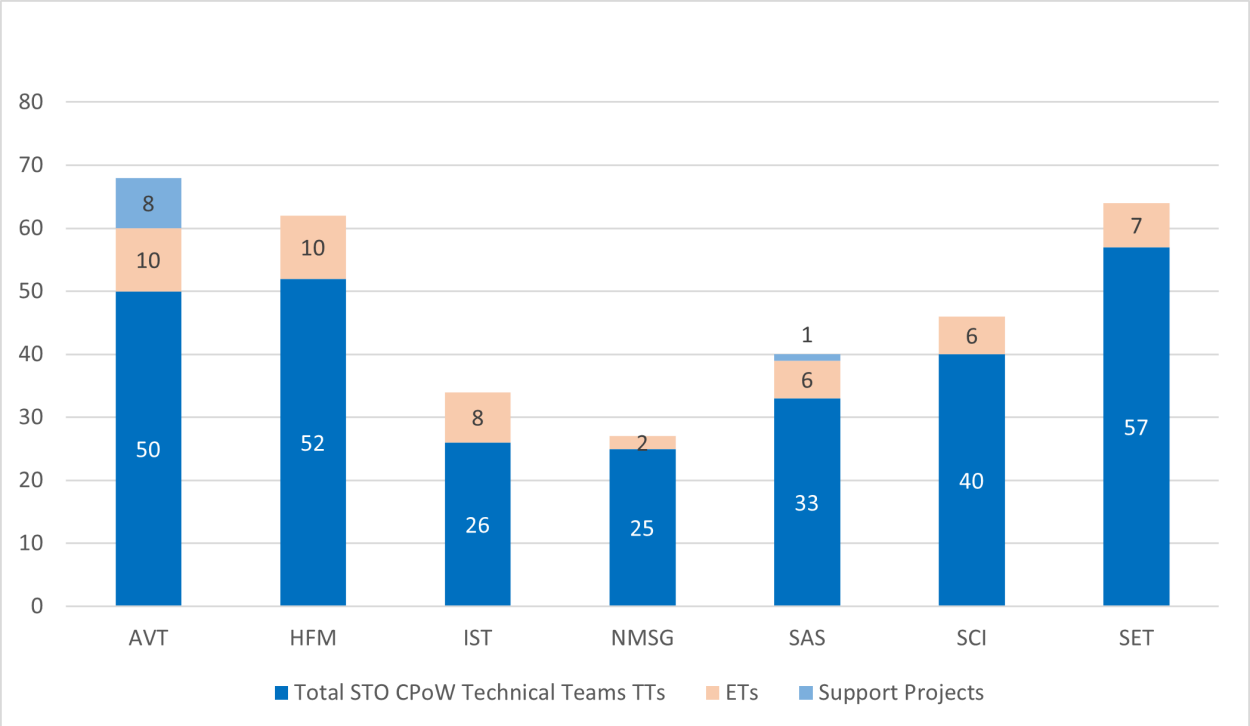


Figure 6: Overview of the 2022 STO CPoW TTs, ETs and SPs per Panel and Group

ENGAGEMENT IN THE 2022 STO CPOW

Table 28: Participation, Involvement and Leadership of NATO Allies and EOPs within the 2022 STO CPoW

		PARTICIPATION	INVOLVEMENT	LEADERSHIP
ZONE	COUNTRY	MEMBERS	ACTIVITES	MEMBERS
NATO	Albania	1	1	
NATO	Belgium	65	55	6
NATO	Bulgaria	7	9	1
NATO	Canada	248	167	54
NATO	Croatia	19	11	
NATO	Czech Republic	33	31	5
NATO	Denmark	55	43	4
NATO	Estonia	30	20	1
NATO	France	213	120	11
NATO	Germany	460	218	56
NATO	Greece	12	15	
NATO	Hungary	11	7	
NATO	Italy	211	113	11
NATO	Latvia	9	10	
NATO	Lithuania	12	8	
NATO	Luxembourg	1	1	
NATO	Netherlands	289	183	42
NATO	Norway	157	112	14
NATO	Poland	102	56	3
NATO	Portugal	27	21	3
NATO	Romania	19	24	1
NATO	Slovakia	4	4	
NATO	Slovenia	19	18	
NATO	Spain	58	37	1
NATO	Turkey	284	116	6
NATO	United Kingdom	489	205	51
NATO	United States	786	226	100
NATO	Montenegro			
NATO	Iceland			
NATO	North Macedonia			
EOP	Australia	88	61	2
EOP	Finland	93	70	4
EOP	Japan	2	3	
EOP	Sweden	163	111	12

ACRONYMS AND ABBREVIATIONS

(C)-IEDs	(Countering) Improvised Explosive Devices
(NG)-NRMM	(Next-Generation) NATO Reference Mobility Model
A2/AD	Anti-Access/Area Denial
ACG3/SG2	Aerospace Capability Group 3 Sub-Group 2
ACO	Allied Command Operations
ACT	Allied Command Transformation
AFSC	Allied Future Surveillance & Control
AG	AGARDograph – Advanced Guidance for Alliance Research and Development
AI	Artificial Intelligence
AI & BD	Artificial Intelligence and Big data
AI2S	Architecture and Intelligence Information Systems
AR	Augmented Reality
ATR	Automatic/Assisted Target Recognition
AVT	Applied Vehicle Technology Panel
BD	Big Data
BEMMTO	Blast Exposure Monitoring in Military Training and Operations
BM	Business Meeting
C2	Command and Control
C3I	Command, Control, Communications and Intelligence
CA2X2	Computer Aided Analysis, Exercise, Experimentation Forum
CAX	Computer Assisted Exercise Forum
CBRN	Chemical, Biological, Radiological and Nuclear
CC&D	Camouflage, Concealment and Deception
CCDO	Camouflage, Concealment, Deception and Obscuration
CDT	Cooperative Demonstration of Technology
CIS	Communication and Information Systems
CMRE	Centre for Maritime Research and Experimentation
CMs	Counter-Measures
CNAD	Conference of National Armament Directors
COM	Communications & Networks
COMEDS	Committee of Chiefs of Military Medical Services in NATO
COMSEC	Communications Security
CPoW	Collaborative Program of Work
CSO	Collaboration Support Office
D&D	Denial and Deception
DECS	Distributed Engine Control Systems
DEW	Directed Energy Weapons
DEXTER	Detection of Explosives and firearms to counter Terrorism
DFS	Data Farming Services
DIRCM	Deployability and Mobility
DM	Deployable Multi-band Passive/Active Radar
DMPAR	Deployable Multi-band Passive/Active Radar
EDTs	Emerging and Disruptive Technologies
ELM	Ethical, Legal and Moral
EO	Electro-Optical
EO/IR	Electro-Optic and Infrared
EOD	Explosive Ordnance Disposal
EOP	Enhanced Opportunity Partner
EO-TDAs	Electro-Optical Tactical Decision Aids
ES	Electronic Support
ET	Exploratory Team
EW	Electronic Warfare
FATE	Futures Assessed alongside socio-Technical Evolutions
FMN	Federated Mission Networking
FT3	Flight Test Technical Team
GNSS	Global Navigation Satellite Systems
HART	Human-Agent-Robot Teamwork
HEADSTART	Hybrid/Electric Aircraft Design and Standards, Research and Technology
HEL	High-Energy Laser
HFM	Human Factors and Medicine Panel
HLTCs	High Level Technical Concepts
HMP	Health, Medicine & Protection
HQ	Headquarter
HSB	Human Systems & Behavior
I/ITEC	Interservice/ Industry Training, Simulation and Education Conference
ICI	Istanbul Cooperation Initiative

IED	Improvised Explosive Device
IMS	International Military Staff
IoT	Internet of Things
IR	Infrared
ISAR	Inverse Synthetic Aperture Radar
ISR	Intelligence, Surveillance and Reconnaissance
IST	Information Systems Technology Panel
ISTAR	Target Acquisition and Reconnaissance
IT2EC	International Training Technology Exhibition & Conference
IWA	Information and Knowledge Management
JANUS	Multiple-Access Acoustic Protocol
LoEs	Lines of Effort
LSS	Low Slow and Small
LTSS	Long-Term Scientific Study
LVC	Live Virtual Constructive
LVC-T	Implementation of Live Virtual Constructive – Training
M&S	Modelling and Simulation
M3T	Modelling, Measuring and Mitigating Optical Turbulence
MAS	Military Application Study
MCDC	Multinational Capability Development Campaign
MD	Mediterranean Dialogue
ML	Machine Learning
MNE	Multinational Exercise
MSaaS	Modelling and Simulation as a Service
MSCO	Modelling and Simulation Coordination Office (CSO)
MSE	Multi-Sensors & Electronics
MSG	Modelling and Simulation Group
NAC	North Atlantic Council
NATO	North Atlantic Treaty Organization
NAVWAR	Navigation Warfare
NCIA	NATO Communications and Information Agency
NCTR	Non-cooperative target recognition
NG	Next-Generation
NIAG	NATO Industrial Advisory Group
NMCD	Network Management & Cyber Defense
NMSG	NATO Modeling and Simulation Group
NMSMP	NATO M&S Master Plan
NNAG	NATO Naval Armaments Group
NR	NATO Restricted
NRMM	NATO Reference Mobility Model
NS	NATO Secret
NU	NATO Unclassified
OA	Objective Area
OCS	Office of the Chief Scientist
OPSEC	Operations Security
OT	Optical Technology
PACVD	Plasma Assisted Chemical Vapor Deposition
PB-IEDs	Person-borne-Improvised Explosive Devices
PBM	Panel (Group) Business Meeting
PE	Peacetime Establishment
PfP	Partnership for Peace
PNT	Positioning, Navigation and Timing
PPW	Plans and Programmes Workshop
RAM	Risk Assessment Matrix
RE	Rare Earth
REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
RF	Radio-Frequency
RFT	Radio-Frequency Technology
RLS	Research Lectures Series
RSM	Research Specialist's Meeting
RSY	Research Symposia
RTC	Research Technical Course
RTG	Research Task Group
RWS	Research Workshop
SAR	Synthetic Aperture Radar
SAS	System Analysis and Studies Panel
SATCOM	Satellite Communications
SCI	Systems Concepts and Integration Panel
SEAD	Suppression of Enemy Air Defence
SET	Sensors and Electronics Technology
SimPL	Simulation of Low Photon Lidar
SMiTMiTA	Smart IED Threat Mitigation Technology Assessments
SOF	Special Operations Forces
SP	Support Project
SPS	Self-Protection System
S-RAM	Space-Risk Assessment Matrix
ST	Specialist Team

STANAG	NATO Standardization Agreement
STANREC	Standardization Recommendation
STB	Science and Technology Board
STO	Science & Technology Organization
STOG	Simulation for Training and Operation Group
STOG-NG	Simulation for Training and Operation Group – Next Generation
SW	Spectrum Width
SWEM	Space Weather Environmental Modelling
SYU	Selectable Yield Unitary
TAP	Technical Activity Proposal
ToE	Target of Emphasis
TRL	Technology Readiness Level
TTs	Technical Teams
TW	Technology Watch (Card)
UAS	Unmanned Aerial Systems
UAV	Unmanned Aerial vehicle
UAxS	Unmanned Autonomous Systems
UCATT	Urban Combat Advanced Training Technology
UCATT-LSS	Urban Combat Advanced Training Technology Live Simulation Standards
UCAV	Unmanned Combat Aerial Vehicle
UU	Public Released
VIRIN	Visual Information Record Identification Number
VKHS	Von Karman Horizon Scanning
VKI	Von Karman Institute

This page is intentionally left blank