



NATO UNCLASSIFIED
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+ NIAG Distr.

CONFERENCE OF NATIONAL ARMAMENTS DIRECTORS (CNAD)

Proposals for Advisory Studies by the NIAG in Budget Year 2023

Note by the Vice-Chair

1. NIAG studies constitute a key mechanism by which industry advice supports the work of the CNAD, CNAD sub-groups, ACT and wider NATO activities.
2. The preparation of the 2023 NIAG study programme went through a series of established activities¹ (study proposals formulation, agreement and priority assignment within each study sponsor entity, NIAG Roundtable) and has now passed a key milestone with the agreement of study priorities across the entire portfolio by CNAD Main Group Chairs.
3. Unless the CNAD Secretary hears to the contrary by **17:30 hrs on Thursday, 12 January 2023**, it will be assumed that the CNAD has approved the proposed NIAG studies programme for 2023 as set out in Annexes 1 and 2.

(signed) Robert WEAVER

Annex 1: List of proposed NIAG studies for 2023
Annex 2: Description of proposed studies for 2023

2 Annexes

Action Officer: JS VAUTIER (x6924)
Original: English

¹ NIAG-D(2022)0004-REV2 – NIAG Handbook



LIST OF PROPOSED NIAG STUDIES FOR THE CALENDAR YEAR 2023

Nr	Sponsor	Study Title	Open to
1	NAAG/MILENG WG	Identify solutions to fulfil NATO MILENG capability targets on counter-mobility (CMob) requirements, by the provision of CMob assets and by the development of innovative CMob solutions	Allies (INV) + IP
2	NAAG/JCG SBAMD	Counter Rockets, Artillery and Mortar (C-RAM) Technologies and Required Capabilities (C-RAM Technology and Required Capabilities)	Allies (INV) + SWI
3	NAFAG/ACG2	Collaborative Environment for the Next Generation of Combat Air Platforms and Weapons	Allies (INV) + AUS, SWI
4	NAFAG/ACG3	SEAD Capabilities Required in 2030	Allies (INV) + AUS, NZL, SWI
5	NNAG/AWWCG	Area Threat Evaluation and Weapon Assignment (TEWA)	Allies (INV)
6	NAFAG/NNAG	Advanced/Novel Electronic Attack Capabilities	Allies (INV)
7	AVC-C3B	Precision Approach & Landing Systems – Future Technologies	Allies (INV) + IP + EU, EDA, EUROCONTROL, MD Countries, Malta, Colombia, ICAO, IATA, FAA, CANSO

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ANNEX 1
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Nr	Sponsor	Study Title	Open to
8	C3B	Zero-Trust Architecture for federated environments	Allies (INV) + IP
9	CNAD	How to Enhance Secure, Resilient and Sustainable Availability of Strategic Materials and Microelectronics Essential to Allied Capability Development and Delivery	Allies (INV)
10	CNAD	Ensuring Allied Capabilities Adaptation in the context of Climate Change	Allies (INV) + IP
TOTAL BUDGET(*): <u>2.650 M (to be confirmed)</u>			

(*) Each NIAG study budget is determined considering both length/complexity of the study but also the number of participants to ensure a fairly comparable level of effort per participant across the NIAG studies portfolio. The budget for each study will therefore be confirmed after the exploratory group meeting has taken place.

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ANNEX 1
AC/259-D(2022)0069 (INV)

Reserve list (in priority order):

Nr	Sponsor	Study Title	Open to Partners
1	NAAG	Modularity in the Design of Multinational Rotorcraft	IP
2	NNAG/AWWCG	Specialised Unmanned Surface Vessel for ASuW/AAW Force Protection	IP
3	NNAG/SDCG	AI Support to Internal Battle Damage in Warships	IP
4	NAFAG/JCGISR	Implementation of 5G Networks on NATO C2 Systems (JC2COI, supported by JCGISR)	Allies (INV)
5	NAFAG/JCGVL	Improving Mission Planning to increase Mission Effectiveness and Survivability	IP
6	C3B	Development of a Service Catalog to identify possible commercial Satellite-as-a-Service capabilities and standards in a hybrid architecture	Allies (INV) + AUT, AUS, IRL, JPN, NZL, ROK, SWI

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**DESCRIPTION OF PROPOSED NIAG STUDIES FOR
CALENDAR YEAR 2023**

Nr. 1 NAAG/MILENG WG

1. Title of the Proposed Study:

Identify solutions to fulfil NATO MILENG capability targets on counter-mobility (CMob) requirements, by the provision of CMob assets and by the development of innovative CMob solutions.

2. Brief Description of Proposed Study:

Conduct a study to identify best solutions to:

- a. Improve multinational interoperability of current and future CMob technologies and equipment.
- b. Rapidly upgrade already existing CMob assets within NATO such as making them reusable, cost effective, autonomous, non-manpower consuming, more effective in terms of deterrence.
- c. Investigate innovative CMob solutions, both lethal and non-lethal.
- d. Discover potential industrial technologies with a balance between efficiency and cost effectiveness.
- e. Enhance understanding of the physical environment (geomatics) to posture the CMob efforts.
- f. Recommendations to improve doctrinal preparation and execution of CMob.

3. Background:

NATO is currently facing capability gaps. One of those gaps is the capability to fulfil the NATO targets with respect to CMob in terms of quality, quantity and rapid deployability. The challenges of NATO regarding CMob are as follows:

- a. **Lack of Assets.** This shortage is due to different reasons such as:
 - (1) Widespread budgetary constraints and frequent delays in upgrading and replacing existing systems.
 - (2) The removal of anti-personnel mines from service in accordance with national and international law and policy combined with the decreasing use of anti-tank mines.

This represents a significant reduction in NATO's ability in Force Protection (FP) and CMob. NATO currently lacks the combined capability to achieve a decisive barrier to enable a credible deterrent.

b. Reduced Land Forces. Most NATO Nations have seen continued downscaling of Land Forces. This negatively affects the ability for preparation and execution of CMob.

c. Extended Area of Operations. The reduction in Land Forces and the extended area of responsibility (AOR) lead to operate dispersed. Scalable CMob capabilities are required to enable these dispersed operations and warfighting at scale in a 360-degree approach.

d. Increased necessity of CMob. Given the recent developments on NATO's Eastern flank, it is clear that there is a need of effective CMob in terms of quantity, quality and rapid deployability.

e. Geomatics. A geotechnical understanding of the battlespace enables the ability to leverage natural ground conditions, or direct human intervention to limit manoeuvrability.

f. Obsolete doctrine. CMob planning is doctrinally Cold War focused and not agile. As an example, the Barrier planning is a very complicated and time-consuming process.

4. Objectives of the Study:

The objective of the study is to identify solutions to increase the capability and improve the interoperability of the current and future CMob assets and systems.

a. The objectives of the study are to:

- (1)** Examine existing CMob capabilities and the interoperable use of these capabilities in NATO in order to understand the combined achievable effect.
- (2)** Examine innovative technologies that are available or in development which would better utilise this equipment to achieve CMob effects.
- (3)** Examine and make recommendations for the rapid deployable and "non-manpower consuming" obstacle systems which are able to delay, disrupt or destroy the enemy by the reinforcement of the operating environment / terrain.
- (4)** Examine geomatics which would enable scalable CMob obstacles.
- (5)** Define how in concert existing technologies, geomatics and doctrinal changes could be employed to enable scalable CMob obstacles.

b. The operational scenarios to be considered are the following:

(1) NATO has to provide support in Article 3 and 5 operations, additionally in response to a national request. Due to that, NATO needs to be able to hinder an adversary's manoeuvre through reinforcing the physical environment.

(2) NATO also focuses on non-Article 5 operations which include specific types of operations, such as counter-terrorism, disaster relief and peace support.

(3) NATO's capability codes² needs to be taken into consideration for both current and future CMob capabilities;

(4) NATO's Capability of conducting counter-mobility tasks, to support the combat unit's ability to block, fix, disrupt and turn enemy movements within its Area of Operations, including deliberate or/and rapid emplacement of effectors (such as mines) and/or other anti-armour vehicle obstacles.

c. The scope of this NIAG Study is to focus on the examination of existing and future solutions to deliver CMob capabilities while maintaining compliance with international regulations.

The study is required to examine the following:

(1) Provide an overview on what effectors and obstacle systems are currently available to manufacture and available in inventory of participating NATO nations,

(2) Examine innovative CMob solutions that are available or can be developed by leveraging latest technologies and new solutions (medium-, long- term).

(3) Provide an assessment on procurement costs if nations decide to invest on new CMob assets.

(4) Ensure that any solution conforms with international regulations. This includes compliance with the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction of 1997 (aka Ottawa Treaty).

(5) Provide the pros and cons of proposed systems in terms of technological risk, cost, and time.

(6) Investigate the potential for autonomous/unmanned systems.

e. The required outputs of the study are the following:

(1) A summary of current availability of CMob systems available commercial off the shelf (COTS) with indicative costs.

(2) An assessment of timescale to deliver innovative CMob systems.

(3) A maturity assessment of novel material development.

(4) Recommendation on what novel materials are considered the most practical to utilise in terms of cost, performance and time.

² Bi-SC Capability Codes and Capability Statements (CC&CS), 22 Jan 2020, 'MILENG-CS-COY'

- (5) Assessment of CMob related emerging technologies with respect to tactical obstacles³ in the civilian sector that could be utilised by Military Engineers.
- (6) Assessment and recommendations on improvements to the storage, maintenance, transportation and sustainment of current and new CMob assets/capabilities.
- (7) Assessment the cost/benefit of fully/semi-autonomous CMob assets/systems.
- (8) Assessment on the potential to generate interoperable systems across manufacturers.

5. Alternative Solution Options:

A review of alternate solutions to mines might be critical to delivering increased capacity. It is important that alternative solutions comply with international regulations.

6. Active Companies with Proper Experience: The following list of companies likely to have a contribution to this study is not exhaustive and final.

a. Croatia:

DOKING - Contact: info@dok-ing.hr

b. France:

(1) **CNIM:** POC is Aymeric PELOUX. (aymeric.peloux@cnim.com)

(2) **CILAS:** POC is Laurent TARD.

Email address: tard@cilas.com (www.cilas.com)

c. The Netherlands:

REASeuro – (<https://reaseuro.nl/>)

(1) Arjan Driessen - Manager Business Development

Email: A.Driessen@reaseuro.com

(2) Thijs van Meegen - Director REASeuro Competence Centre

Email: T.vanMeegen@reaseuro.com

(3) Ad van Riel – CEO

Email: a.vanriel@reaseuro.com

d. Poland:

(1) **BELMA S.A.** – contact: bze@belma.com.pl

(2) **NITRO-CHEM S.A.** – contact: kancelaria@nitrochem.com.pl

e. Spain:

General Dynamics European Land Systems – Santa Barbara Sistemas. Contact:

³ Tactical obstacles are aimed to shape enemy maneuver and prevent enemy from gaining a position of advantage.
(See NATO STANAG 2394.)

(1) Victor Lopez Benitez (Dtor. Comercial) - victor.lopezbeneitez@gdels.com ; Tlf.: 0034915850383

(2) Carlos Gil Gil (Dtor. Ingeniería Vehículos blindados) – carlos.gil@gdels.com

(3) Modesto Martinez Daimiel (Senior Manager International Business & Services Overseas) - modesto.martinez@gdels.com

Tlf.: 0034915850143

f. United Kingdom: Defence Science and Technology Laboratory (DSTL) have run a Novel Barriers Programme for innovative non-explosive barriers, 4 companies were short listed:

(1) **Azur Innovation** (enquiry@azurinnovation.com)

(2) **QinetiQ**

(3) **Synbiosys Ltd** (info@synbiosys.co.uk)

(4) **Autonomous Devices Ltdi** (info@autonomousdevices.co.uk)

g. United States:

(1) **Black Security Prodcuts. LLC**

POC: Jan Pol, Business Development

Cell: +31.6.20.39.24.24

Office: +1.512.926.0800

Email: Jan@BlackSP.com

(2) **Northrop Grumman**

(3) **Textron Systems**

h. Finland:

(1) **Raikka:** Contact: helsinki@raikka.fi

(2) **Forcit:** Contact: forcit@forcit.fi

7. NATO Priority:

HIGH. Lack of CMob capabilities and current doctrinal employment of capabilities does not provide Land Forces with the means to achieve CMob at scale in a 360-degree approach and there is need for new solutions and procurements.

8. Intended Follow on to the Study:

a. Improve the interoperability of capability sharing and planning across NATO to enable CMob activities.

b. Provide common training opportunities for all NATO nations on the emplacement of the most common CMob systems in order to enhance MILENG capability.

c. Develop / improve NATO's understanding of geomatics.

d. Revise NATO Allied Joint and Tactical Publications to inform and direct CMob activities to enable scalable solutions.

e. Refer to and build on the NIAG Study Group 174 project (SG 174 Area Access Control).

9. Other NATO Bodies Involved in the Related Area of Work:

- a. Military Engineering Working Group (MILENG WG),
- b. Military Engineering Centre of Excellence (MILENG COE),
- c. Joint Geospatial Standards Working Group (JGSWG),
- d. Joint Non-Lethal Weapons Working Group (JNLWWG),
- e. Integrated Capability Group Indirect Fire (ICGIF),
- f. NATO Support and Procurement Agency (NSPA).

10. Current Industrial Involvement with the Sponsor Group: Nil.

11. Proposed Start Date: February 2023.

12. Desired Completion Date: January 2024.

13. Study Classification: NATO UNCLASSIFIED, releasable to IP.

14. Study Open to Partner Industries: IP

15. Final Report Releasable to: Allies (INV) + IP

16. Sponsoring Group and International Staff Point of Contact:

- a. Military Committee Land Standardization Board Military Engineering Working Group (MCLSB MILENG WG), Materiel Panel (reporting to the NATO Army Armaments Group)
- b. NATO Army Armaments Group (NAAG) Secretary
- c. IMS Advisor

Nr. 2 NAAG/JCG SBAMD

1. Title of the Proposed Study: Counter Rockets, Artillery and Mortar (C-RAM) Technologies and Required Capabilities (C-RAM Technology and Required Capabilities).

2. Brief Description of Proposed Study: The study will identify and assess the technologies and system integration requirements needed to develop and field a viable C-RAM capability in the near to mid-term.

3. Background: Alliance has struggled with developing and fielding a full C-RAM capability. Early efforts date back to the time of the Iraq War with the fielding of sense and warn systems being deployed to protect static operating bases. In the intervening time there have been significant improvements in sensor and effector technologies that can result in the ability to provide significantly enhanced force protection capabilities. The RAM threat is generally viewed as being a segment of the total air and missile defence threat spectrum. However, the actual threat itself, rockets, artillery, and mortars projectiles are significantly different physically from fixed and rotary wing platforms, cruise, and ballistic missiles. The resulting C-RAM capability is expected to require special sensors and effectors to counter threat. These sensors and effectors would augment the sensors and effectors in air and missile defence units, not replace or substitute for them. The integration of the C-RAM capability into the existing VSHORAD and SHORAD units with the list force structure impact is an important factor.

4. Objectives of the Study:

- a. The objective of the study is to evolve a C-RAM capability construct that may be integrated into existing very short and short range air defence systems to enable the enhanced unit to counter aerial threats, to include C-sUAS as well as C-RAM and other aerial threats. Today an effective C-RAM capability does not exist and is a force protection gap. This gap must be mitigated as shown by events in Ukraine.
- b. The scenarios required to support this study are currently available and were developed during the conduct of several SBAMD/GBAD NIAG studies. Special C-RAM vignettes will be developed as required.
- c. The study will formulate a C-RAM system construct composed of C-RAM capability unique sensors and effectors linked with a C2 capability that can be seamlessly integrated into nation's existing very short range and short range air defence systems.
- d. The study will address the following:
 - i. The study will develop a C-RAM system construct. The system construct will be supported by a matrix of sensors and their technical capabilities and when the capability will reach TRL 7 or higher.

- ii. The system construct will also be supported by a mix of effector capabilities that can be employed to kill the RAM threat. The effector TRL will be identified and an estimate of when the effector technology will reach TRL 7 or higher.
 - iii. The C-RAM system communication, command and control architecture will be defined, to include the interface protocols required to integrate in the air defence command and control center.
 - iv. The study will perform C-RAM capability versus manpower requirements and document the trade-offs.
- e. The study will fully address the questions above and document the analysis and rationale for the conclusions reached and the recommendations contained in the final report.

5. Alternative Solution Options: Yes

6. Active Companies with Proper Experience: There are extensive major aerospace companies and as small and medium enterprises located in the NATO and Partner nations having the technology and capability to make a positive contribution to this study. The listing of individual companies identified by the Sponsor would not be known or all inclusive. The NIAG national heads of delegation have the list of companies in their nation that they have authorized to participate in NIAG studies. This list may or may not include the company point(s) of contact.

7. NATO Priority: C-RAM is a NATO High Visibility Program and is an important and integral element of the NATO Surface Based Air and Missile Defence program of work currently designed a high priority program.

8. Intended Follow on to the Study: The results of the study support select nations in the acquisition of a C-RAM capability, as well as supporting the NATO community in the identification of enhanced force protection technology development and integration. The study results may also support anticipated Emerging Disruptive Technology activities within NATO Headquarters.

9. Other NATO Bodies Involved in the Related Area of Work: There are several NATO organizations and agencies involved or interested in the C-RAM topic, to include ACO, ACT, IMS, AIRCOM, DI (Multinational Programs), and NSPA (Project Management/Contracting).

10. Current Industrial Involvement with the Sponsor Group: Sponsor's past NIAG studies over several years have consistently attracted 25 to 50 companies from 10 to 18 nations. This study is expected to see the same level of interest and participation.

11. Proposed Start Date: April/May 2023

- 12. **Desired Completion Date:** June 2024
- 13. **Study Classification:** up to NATO Restricted
- 14. **Study Open to Partner industries:** Invitees and Switzerland. Participation by other nations will be considered by the Sponsor prior to the NIAG Exploratory Group meeting.
- 15. **Final report releasable to:** Allies (INV) + Switzerland.
- 16. **Sponsoring Group Point and IS Point of Contact:**
Sponsor: Dr. Leigh Moore, Chairman JCG SBAMD.
Staff Advisor: Mr. Henning Anderson, DI.

Nr. 3 NAFAG/ACG2

1. Title of the Proposed Study: Collaborative environment for the next generation of Air Combat platforms and weapons.

2. Brief Description of Proposed Study: A collaborative environment is one in which the capacities of the constituent weapon systems (to include networked enabled weapons) are mutually reinforced throughout the whole array of basic combat functions (detecting, classifying, decision-making, engaging/firing, risk assessing) in order to secure a unique performance capacity, which exceeds that of all the systems working separately. The next generation of Air Combat platforms (Next Generation Air Dominance, Tempest, Future Combat Aircraft System, Next Generation Rotorcraft, etc...) will need to re-shape how collaboration takes place in future Air Combat. This study will provide NATO Defence Planners with information on how to use current and future technologies to create a collaborative environment for the next generation of Air Combat platforms and weapons with a focus on multi-domain operations and interoperability with NATO's Joint Intelligence, Surveillance, and Reconnaissance (JISR) and Alliance Future Surveillance and Control (AFSC) programmes.

3. Background: The future Air Combat environment will be highly contested and there will be a need for increased interoperability between different air assets. One of the most important aspects of this interoperability will be data interoperability architectures which, according to NIAG SG 257, should be based on Open Systems Architecture aligned with NATO Architectural Framework (NAFv4+) and NATO ISR Interoperability Architecture (NIIA) standards. The use of commercial cloud-based technologies and Cloud Native Computing Foundation (CNCF) standards will be more prevalent when the next generation of Air Combat platforms and weapons enter service and should influence this study.

4. Objectives of the Study:

- a. This NIAG proposal requests Industry support in identifying the technologies and standards, which should be used to ensure a collaborative environment for NATO's next generation of Air Combat platforms and weapons.
- b. The operational scenario used in this study should include next generation Air Combat platforms as well as any platform (land- or sea-based) that can deliver networked enabled weapons.
- c. The study should focus on a combat cloud that will enable these assets to operate in a multi-domain environment when they enter service.
- d. When examining the connections with networked enabled weapons, the study should provide recommendations on how a mesh network (MANET) would be fielded and how an inflight target update from a third party controller would be conducted given the latency challenges created by increased network traffic in a multi-nodal network as well as how an AI-enabled sensor on a NEW would communicate within this mesh network, with latency and data traffic challenges in mind. Study focus areas would also be network security, protocols, data tagging and packaging, as well as recommendations on existing mesh technology for inclusion in NATO STANAGs.

5. Alternative solution Options: Yes

6. Active Companies with Proper Experience: No active companies identified.

7. NATO Priority: High

8. Intended Follow on to the Study: Incorporate any recommendations into the Programmes of Work of the sponsoring group as well as any other interested groups.

9. Other NATO Bodies Involved in the Related Area of Work: NAAG, NNAG, C3B, and JAPCC.

10. Current Industrial Involvement with the Sponsor Group: SG257, NATO's Targeting and Interoperability Challenges for Networked Enabled Weapons (NEW) in the 2035 Threat Environment, was completed in September 2021 and its conclusions and recommendations should influence this proposed study.

11. Proposed Start Date: Early 2023

12. Desired Completion Date: Early 2024

13. Study Classification: Up to NATO SECRET

14. Study Open to Partner industries: Invitees plus Australia and Switzerland

15. Final report releasable to: Allies (INV) + Australia, Switzerland

16. Sponsoring Group Point and IS Point of Contact: NAFAG/ACG2. IS POC: Mr Alexander DeFazio, defazio.alexander@hq.nato.int, Tel: +32 (0)2 707 3848

Nr. 4 NAFAG/ACG3

1. Title of the Proposed Study: Suppression of Enemy Air Defence Capabilities Required in 2030.

2. Brief Description of Proposed Study: Effective Suppression of Enemy Air Defences (SEAD) against a modern Integrated Air Defence System (IADS) is a complex task which requires a vast set of capabilities to be successful. The NATO SEAD Concept of Employment (CONEMP) condenses the fundamentals of SEAD into four key principles: Diversity of Effects; Survivable Delivery Systems; Coordinated Information Capture & Distribution, and; Synchronization of Effects.

3. Background: An IADS is the cornerstone of Anti-Access/Area Denial (A2/AD) environments and have developed in sophistication over many decades, exploiting perceived vulnerabilities in the Alliance's reliance on Air Power. A failure to suppress adversary IADS capabilities will usually deny Alliance operations and so it is essential to understand the capabilities required of Allies targeted in the NDPP with providing these capabilities. In 2018, the Conference of National Armaments Directors (CNAD) approved NATO's SEAD Vision Paper in which the SEAD Roadmap was provided in order to ensure the Alliance would have a tailored force able to deliver multiple effects across the full spectrum of air defence weapons, sensors, and networks as part of an integrated NATO capability. The first step of this roadmap was to create a CONEMP that explained the necessary SEAD capabilities required for the Alliance to successfully execute a SEAD campaign in 2030. The next step would be to conduct a Capability Audit to identify which of those capabilities already existed, or would soon exist, in Member States' forces.

4. Objectives of the Study:

- a. This NIAG proposal requests Industry support in identifying the current capabilities that already exist, or will exist by 2030, that support the Fundamentals of SEAD as contained in the NATO SEAD CONEMP.
- b. The operational scenarios to be considered are, in essence, the four fundamentals of SEAD: 1) A blend of disruption, deception, degradation, denial, and destruction effects that will be essential for delivery an effective SEAD mission and the diverse range of effects should be considered together; 2) The biggest challenge to creating an effect is usually the ability to get the delivery mechanism (i.e the platform) into a

position to effectively deliver the SEAD effect. Therefore, system survivability is a critical component of a SEAD capability; 3) Coordination throughout the targeting cycle is critical to being able to deliver any SEAD effect. This places significant reliance on accurate intelligence gathering and its timely distribution to the appropriate NATO force element; 4) The IADS network will have inbuilt redundancy so targeting multiple components in a fast, synchronized, and layered attack is essential to ensure an effect is successful.

- c. The scope of the study should be on those capabilities that support the four fundamentals of SEAD that will be available by 2030.
- d. The study should address those capabilities as described in NATO's SEAD CONEMP.
- e. The study should provide NATO Defence Planners with a list of SEAD Capabilities that are available to Allies today or will be so by 2030.

5. Alternative Solution Options: No

6. Active Companies with Proper Experience: No active companies identified.

7. NATO Priority: High

8. Intended Follow on to the Study: The capabilities provided will be used to inform the next step of the NATO SEAD Roadmap, the Gap Analysis.

9. Other NATO Bodies Involved in the Related Area of Work: NNAG, STB, and JAPCC

10. Current Industrial Involvement with the Sponsor Group: None

11. Proposed Start Date: Early 2023

12. Desired Completion Date: Early 2024

13. Study Classification: Up to NATO SECRET

14. Study Open to Partner industries: Invitees plus Australia, New Zealand and Switzerland

15. Final report releasable to: Allies (INV) + Australia, New Zealand, Switzerland

16. Sponsoring Group Point and IS Point of Contact: NAFAG/ACG3. IS POC: Mr Alexander DeFazio, defazio.alexander@hq.nato.int, Tel, +32 (0)2 707 3848

Nr. 5 NNAG/AWWCG

1. Title of the Proposed Study: The plausibility of Area Threat Evaluation and Weapon Assignment (TEWA) in the Maritime Domain for Allied Maritime Forces

2. Brief Description of Proposed Study:

This study will investigate the feasibility of connecting new and existing systems/applications to provide real time decision support for ships' Operations teams when conducting area air defence. It will specifically look at the following:

- Exploitation of satellite systems both commercial and military to try and identify any form of launch/launch site at sea or on land that may pose a threat to a Maritime Task Force.
- Provide recommendations to the Task Group Commander on tracking, engagement and evasive manoeuvres based on the capabilities and constraints of the warships within a task group.
- Develop an understanding on how area TEWA fits into the wider Joint ISR strategy for NATO and identify synergies. This includes the inclusion of J2 products.

3. Background:

This NIAG study will broaden the scope of traditional missile defence for a maritime task group. Point defence and area defence of a task group have typically been constrained predominantly by the range of a warship's organic sensors. TEWA describes the process of weapon/sensor allocation dependant on the threat, in the past this was done manually, with some warships automating the function in terms of preferred sensor, weapon (hard/soft kill) and reaction. There is already work ongoing amongst allies to understand how to automate this at the force level however, that is still based on organic sensors and perhaps manual correlation of J2/N2 products. The adversaries that NATO could potentially face have an arsenal of missiles with far greater range, which travel at far greater speed, therefore there is now the necessity to provide MTGs on operations with accurate, real time indications and warnings of any missile threat irrespective of range and origin.

4. The Objectives of the study are to:

1. Understand how AI/ML could augment Area TEWA;
2. Determine which warship systems would need to be accessed to enable AI/ML to provide useful decision support;
3. Identify which systems could realistically provide early warnings and the architecture/connectivity required;

4. Identify the security classification challenges of access Combat System data and Platform Management Data.

5. NATO Priority: Maritime Engagement

6. Intended Follow-on to the Study: Development of a concept paper for NATO to factor into future NCS development inc AFSC.

7. Are any other NATO Bodies involved in the related area of work? Not directly, but NATO's IAMD team will benefit from the research.

8. Is there any current Industrial involvement with the Sponsor Group? Not yet.

9. Proposed start date: May 2023.

10 Desired completion date: 24 months after commencement of the study

11. Study Classification level: TBD once fully scoped.

12. Study Open to Partners? No (Invitees only)

13. Final report releasable to: Allies (INV)

14. Sponsoring Group Point of Contact and IS/DI Point of Contact:, ST-MAMD Chairman, Cdr Reijenga (NLD) HRJ.Reijenga@mindef.nl

IS/DI - Mr Sean Trevethan. Trevethan.Sean@hq.nato.int

Nr. 6 NAFAG/NNAG

1. Title of Proposed Study: Investigate the potential of Advanced/Novel Electronic Attack capabilities

2. Brief Description of Proposed Study:

This study will investigate and research the 'art of the possible' when it comes to Electronic Attack (EA). With advances in technology such as directed energy weapons and quantum sensing, this study aims to understand how these technologies could be used to disrupt, deceive and defeat adversary systems.

3. Background:

Electronic attack (EA) is a key component of electronic warfare and includes the set of technologies and methods that use electromagnetic energy or anti-radiation weapons to attack personnel, facilities or equipment. This study should focus on EA's impact on an adversary's use of the electromagnetic spectrum (EMS).

Although Allies that have some electronic attack capabilities already, Russia has demonstrated their advanced electronic warfare capabilities during the conflict in Ukraine. Using UAVs and other platforms, they were able to jam satellite and radio communication as well as perform GPS spoofing. Additionally, they were able to track Ukrainian positions by monitoring their RF transmissions and even send text messages to the Ukrainian soldiers in order to lower moral.

Over the last two decades Allies have invested heavily in Electronic Counter Measures (ECM) and Electromagnetic Support Measures (ESM) with a disproportionate level of investment in offensive EA. Advances in conventional weapons mean that traditional methods of countering threats such as complex guided weapons may not be as effective, however, EA has the potential to offer an alternative.

4. The objectives of the study are to:

1. Investigate the use of AI/ML to create false targets or perform other operations to deceive adversarial forces.
2. Determine amplifier characteristics required to jam/disrupt standard Maritime/Air surveillance/targeting systems.
3. Investigate the plausibility of electronic processing disruption using RF Energy.
4. Identify the security classification challenges of ship integration of modern EA systems.

5. NATO Priority: Electromagnetic Warfare

6. Intended Follow-on to the Study: Development of a concept paper for NATO.

7. Are any other NATO Bodies involved in the related area of work? Not directly, but NATO's IAMD team, STO, and relevant Centres of Excellence will benefit from the research.

8. Is there any current Industrial involvement with the Sponsor Group? Not yet.

9. Proposed start date: May 2023.

10 Desired completion date: 24 months after commencement of the study

11. Study Classification level: TBD once fully scoped.

12. Study Open to Partners? NATO plus Invitees and Australia, New Zealand and Switzerland

13. Sponsoring Group Point of Contact and IS/DI Point of Contact:

EW Syndicate Chair: Mr Bas Nieuwenhuijse (BP.Nieuwenhuijse@mindef.nl)

ACG3 Vice Chair: Maj Erik Bamford (ebamford@mil.no)

IS/DI: Mr Sean Trevethan (Trevethan.Sean@hq.nato.int)

IS/DI: Mr Alex DeFazio (defazio.alexander@hq.nato.int)

Nr. 7 AVC-C3B

1. Title of the Proposed Study: Precision Approach & Landing Systems – Future Technologies

2. Brief Description of Proposed Study: Investigate future technologies that could provide safe & resilient precision approach and landing systems, that could be operated in times of peace, crisis, or possibly war.

3. Background: Allies, Partners, and international aviation users rely on traditional ground-based navigation aides or global navigation satellite systems (GNSS) to make safe approaches to aerodromes during periods of inclement weather. Traditional ground-based navigation aides rely on decades old technologies that are being phased out in some nations, while new and emergent systems reliant on GNSS are susceptible to intentional and accidental disruption.

4. Objectives of the Study:

- a. The objective is to investigate future technologies that could provide safe & resilient precision approach and landing systems, that could be operated in times of peace, crisis, or possibly war. Legacy PALS are being phased out in many areas, and GNSS-based PALS technology, which is easy to spoof or jam, is not as reliable or resilient. PALS are vital during degraded visibility, and disruption to PALS would cripple military aviation and contracted civilian airlift capability.
- b. The operational scenario to be considered is the necessity to land State aircraft, of all configurations, in weather conditions where the pilot cannot observe the runway until they are within ½ nautical mile of the runway, and at an altitude of 200 feet above the ground. This scenario needs to be considered in peacetime, crisis scenarios with possible hybrid warfare situations, as well as conflict, where possible enemy forces could be targeting the aerodrome in question.

- c. The scope is to determine possible future technologies that could support the safe approach and landing of aircraft in the aforementioned scenarios, technology that is more resilient and reliable than existing GNSS-based PALS.
- d. The study should address future technologies that achieve the stated goals, in the full spectrum of activities described.
- e. The study should make recommendations on future technological solutions to achieve the stated safety and resilience goal, as well as provide recommended ways forward in studying/developing these highlighted technologies.

5. Active Companies with Proper Experience: There are no companies in the sponsor entities.

6. NATO Priority: High.

7. Intended Follow on to the Study: Not at this time.

8. Other NATO Bodies Involved in the Related Area of Work: None.

9. Current Industrial Involvement with the Sponsor Group: None

10. Supporting Staff: The IS/DI POC from AER will be available to support the proposal.

11. Proposed Start Date: ASAP

12. Desired Completion Date: Within one year of start date.

13. Study Classification: NATO UNCLASSIFIED, RELEASABLE TO EU, EDA, EUROCONTROL, IP, MD Countries, Malta, Colombia, ICAO, IATA, FAA, CANSO, and Industry Involved in the Study.

14. Study Open to Partner industries: IP

15. Final report releasable to: Allies (INV) + EU, EDA, EUROCONTROL, IP, MD Countries, Malta, Colombia, ICAO, IATA, FAA, CANSO

16. Sponsoring Group and IS Point of Contact:

The NATO Aviation Committee (AVC) and the NATO Consultation, Command, & Control Board (C3B), AVC POC - Stephen HANSON, +32 2707 4255, hanson.stephen@hq.nato.int; C3B POC – Jean-Philippe SAULAY, +32 2707 4309, saulay.jean-philippe@hq.nato.int.

Nr. 8 C3B

1. Title of the Proposed Study: Zero-Trust Architecture for Federated Environments

2. Brief Description of Proposed Study:

Zero Trust Architecture (ZTA) has the potential to reduce risk across enterprise networks by creating discrete, granular access rules for networks, applications, and services. The study will suggest a Zero Trust Interoperability Architecture determining capabilities and integrations that can be used to successfully advance Alliance digital capabilities into an interoperable Zero Trust end state.

3. Background:

Zero trust is an important information security paradigm shift. It adds another layer and might even replace the perimeter defence-in-depth models of the past and assumes an enterprise-owned environment is no more trustworthy than any external environment. Whilst initially zero trust was focused on the network providing micro-segmentation to prevent attacker lateral movement (known as Zero Trust Network Access), it has evolved to become granular and pervasive, providing authentication and assurance between components, including micro-services.

As the benefits of zero trust become increasingly clear, the pervasiveness of this model is evident, relying upon a trusted computing base, data centric controls, and data centric security. As zero trust becomes more pervasive within the enterprise architectures of individual nations and entities, what does that mean for approaches to federate these individual architectures in the context of the Alliance or coalition operations.

4. Objectives of the Study:

The study aims to identify challenges, interoperability requirements, and standardization requirements for implementing ZTAs within individual nations/entities so that they can be federated. The study should develop a federated ZT Reference Architecture or ZT Interoperability Architecture that identifies interoperability points and necessary standards or new standardization requirements. This ZT Reference Architecture should be relevant to the mission/business needs of NATO taking into account the Federated Mission Networking model data flows within the Alliance (to include Nations and the NATO Enterprise).

5. Alternative Solution Options:

If there are multiple existing industry standards for the same Interoperability Point, then these options should be listed together with a SWOT analysis for each option and a recommendation for a preferred solution.

6. **NATO Priority:** TBD

7. **Intended Follow on to the Study:**

Follow activities could include the development of missing ZTA interoperability Standards.

8. **Other NATO Bodies Involved in the Related Area of Work:**

This is linked to Digital Transformation, various C3B and MC activities including Data Centric Security (DCS) initiative.

9. **Current Industrial Involvement with the Sponsor Group:** None

10. **Proposed Start Date:** Jan 2023

11. **Desired Completion Date:** Jan 2024

12. **Study Classification:** Unclassified

13. **Study Open to Partner industries:** Yes (SWI, AUT, AUS, NZL, IRL, JPN, ROK)

14. **Final report releasable to:** Allies (INV) + Partner Nations mentioned above

15. **Sponsoring Group Point and IS Point of Contact:**

Gernot FRIEDRICH, NHQC3S, Friedrich.gernot@hq.nato.int, x5381

Nr. 9 CNAD

1. **Title of the Proposed Study:** How to Enhance Secure, Resilient and Sustainable Availability of Strategic Materials and Microelectronics Essential to Allied Capability Development and Delivery.

2. **Brief Description of Proposed Study:** This study is a direct follow-on to the “NIAG study on enhancing the security and resilience of supply chains essential to Allied capability development and delivery” (SG-274). This initial study, expected to be finalised in March 2023, is set to identify the key challenges and vulnerabilities facing industry, Allies and NATO in securing a resilient supply of identified strategic materials and microelectronics that negatively impact Alliance capability development and delivery. This proposed second related study will build on the conclusions of the first study and focus primarily on ways to manage and reduce those identified supply chain risks and vulnerabilities, and on related possible national, industry and NATO roles. Industry views will inform the CNAD, and potentially other NATO communities, in taking forward work on this subject.

3. Background: Within the context of the CNAD's Strategic Materials and Microelectronics Supply Chain Security and Resilience Action Plan⁴, SG-274 was initiated in 2022 with the broad scope to "describe the most important strategic materials and microelectronics, together with the security, economic, regulatory, technology, environmental, workforce and other considerations most relevant from a defence industry perspective." The initial study effort was identified as the "first phase" in what was expected to be a series of further studies that would build on the findings and recommendations of the previous study efforts.

4. Objectives of the Study:

- a. The key objective of this study would be to outline realistic roles of NATO, Allied governments and industry, in managing and reducing any supply chain disruption with a view to safeguarding short-term availability of strategic materials and components essential to Allied capability development and delivery, and in the longer term, maintaining the necessary level of independence from risks of supply interruption.

- b. In this work, the NIAG SG could:
 - o address any relevant issues associated with the assured supply of strategic materials and components addressed in the NIAG SG-274 study;
 - o identify alternative materials or processes that may be substituted for strategic materials and components that may not be readily and lastingly available to the Alliance for capability development and delivery;
 - o identify the availability and use of strategic materials and microelectronics between commercial and defence sectors;
 - o assess possible mitigation efforts, such as stockpiling and warehousing, or recycling and reprocessing;
 - o document the range of impact if specific strategic materials and components essential to Allied capability development and delivery are not available or if a substitute material cannot be used;
 - o in these efforts, identify any possible realistic added value role for NATO, Allied governments and industry in facilitating the assured availability of supply of strategic materials and components essential to Allied capability development and delivery, acknowledging that this is primarily a national responsibility and a collective commitment rooted in Article 3 of the North Atlantic Treaty.

⁴ AC/259-D(2021)0063-FINAL.

- c. This study builds on the findings and conclusions of the NIAG SG-274 study effort.
- d. This work will be accompanied by recommendations to NATO, Allies and industry - as part of the final report.

5. Alternative Solution Options: Yes. It is expected that there will be multiple methods to address the various strategic materials and components supply issues. The alternatives should be clearly identified, together with the recommended best method by which to proceed and the associated rationale. The alternatives will not reduce the scope of the study, but may in fact expand the level of activity required.

6. Active Companies with Proper Experience: There are extensive major companies and small and medium size enterprises (component and system suppliers in the first, second and third tier of the supply chain), located in the NATO nations, having the technology and capability to make a positive contribution to this study.

7. NATO Priority: High. Alliance assured supply of strategic materials has a direct impact on NATO capability development and delivery within the context of Article 3 of the Washington Treaty. NATO's determination to address this issue is reflected in paragraph 26 of the recently agreed Strategic Concept.

8. Intended Follow on to the Study: Incorporation into the CNAD's Strategic Materials and Microelectronics Supply Chain Security and Resilience Action Plan and its implementation; potential use by other committees conducting work related to supply chain security and resilience (see below). Moreover, as envisioned in the initial SG-274 study proposal, there may be additional follow-on study efforts associated with this activity depending on the outcome of this second study and the evolving political environment surrounding supply chain issues.

9. Other NATO Bodies Involved in the Related Area of Work: Science and Technology Organization, Allied Command Transformation, IS/Defence Policy and Planning Division in support of the Resilience Committee and Defence Policy and Planning Committee (Reinforced), IS/Joint Intelligence and Security Division in support of the Security Committee, NATO HQ Consultation, Command and Control (C3) staff in support of the C3 Board, IS/Emerging Security Challenges in support of the Cyber Defence Committee.

10. Current Industrial Involvement with the Sponsor Group: None, with the exception of the NIAG. Of note, industrial interest in the initial study (SG-274) was registered by 38 companies from 15 nations. This study is expected to see a similar level of interest and participation.

11. Proposed Start Date: May 2023.

12. Desired Completion Date: May 2024.

13. **Study Classification:** NATO Unclassified releasable to Invitees.

14. **Study Open to Partner industries:** No (Invitees only)

15. **Final report releasable to:** Allies (INV)

16. **Sponsoring Group Point and IS Point of Contact:**

Mrs. Alexia Mikhos, International Staff, Defence Investment Division

Nr. 10	CNAD
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1. **Title of the Proposed Study:** Ensuring Allied capabilities' adaptation in the context of climate change

2. **Brief Description of Proposed Study:**

A scoping study to provide industry views on challenges, opportunities, and solutions to maintain NATO's technological edge and increase Allied military capabilities' operational effectiveness in light of climate change, as well as the threats Allied industry faces from a changing climate.

3. **Background:**

At the NATO Summit 2021 Heads of State and Government agreed on the "Climate Change and Security Action Plan" (PO(2021)0204), which identified a number of areas for the Conference of National Armaments Directors (CNAD) to explore. The "Armaments Community Contributions to NATO's efforts on climate change"⁵ established a clear policy within the CNAD substructure, noting climate change's potential to impair the effectiveness of Allies' military capabilities, and the importance of adapting them to the realities of climate change in ways that maintain and enhance operational effectiveness. Allied briefings at a CNAD webinar on Climate and Capabilities⁶ emphasized that failure to adapt capabilities to extreme climate conditions and prepare the future force for sustainable mobility under the global energy transition would have severe negative impacts on Allied forces' effectiveness.

NATO and Allies identify the perspective of industry as being an essential part of the climate change and security conversation within the Alliance. In the CNAD, this means understanding what challenges, opportunities, and solutions industry sees to increasing the operational effectiveness and sustainable mobility of Allied capabilities, in the process

⁵ AC/259-D(2021)0073

⁶ 16 March 2022 – key takeaways captured in "2022 Spring CNAD Plenary PP Item 8B Climate"

mitigating those capabilities' impact on climate change without compromising mission security.

A scoping study by the NIAG would provide a starting point for NATO, Allies, and Partners to inform future work in a variety of fora, including a starting point from which to consider the most fruitful future NIAG studies. It would inform the CNAD Framework for Climate Leadership in its work to provide a cross-cutting, systemic forum for identifying solutions for further work and, in particular, multinational capability development. Additionally, such a study could assist the CNAD in other work strands, including: efforts under the CNAD Framework for innovation, and problems posed to the Defence Innovation Accelerator for the North Atlantic (DIANA)⁷.

4. Objectives of the Study:

Given the large scope for which an industry perspective would be valuable, a series of follow-on funded studies is envisioned, starting with a first phase including the following objectives, to be accompanied with recommendations to NATO, Allies and industry, keeping in mind the CNAD's focus on capability development:

Survey the most immediate solutions available for military forces to pursue operational effectiveness in capabilities while reducing their carbon and environmental impact on, and increasing their adaptation to, climate change⁸;

Consider noting the capability areas/projects within nations and NATO where industry is involved and would recommend consideration of solutions identified as part of the aforementioned survey;

Assess the threats climate change may pose to the defence industry, especially the industrial base (i.e., environmental threats to factories, cyber threats to digitized energy systems, linkages to NIAG work on supply chain security, threats to shipyards and ship repair facilities, etc.);

Identify relevant synergies with and potential contributions from past and current NIAG studies, past and current ACT-NIAG sub-Col on Logistics and Sustainment (L&S) activities, the CNAD's Life Cycle management Group (LCMG) and the Science and Technology Organization (STO);

Close by touching on impacts to the Allied Defence Industrial Base, indicating opportunities for further studies. These could potentially include how industry might mitigate Environment,

⁷ PO(2022)0147 – “The following principles guide DIANA: ...DIANA favours environmentally and energy sustainable solutions and focuses significant efforts on solving climate security challenges...”

⁸ E.g. Green technology; alternative fuels; novel propulsion; new approaches to current capability effects; more energy efficient solutions; reduction of energy demand and increasing energy resilience; equipment for survival in extreme weather conditions – especially heat, wildfires, and drought; operations in the High North; electrification; waste management; etc.

Social, and Corporate Governance (ESG) risks, provide positive contributions to sustainability while minimizing damage to the defence ecosystem's reputation; and

Outline suggestions, depending on the outcome of the first phase and the evolving political environment surrounding the capability and industry aspects, for further studies which could be conducted. As a purely illustrative list these could include, but certainly need not be limited to, such topics as:

- Challenges/barriers/logistical considerations to address in Adopting Green Technologies, Cost-competitive Renewable Energy, Alternative Fuels, and Novel Propulsion⁹ ((awareness, legislative constraints, human resources, re/up skilling, technical support, funds and investments, etc);
- Novel Propulsion and Interoperable Fuels in the Maritime Space;
- Barriers to Widespread Adoption of Sustainable Aviation Fuels;
- Extreme Temperature Survivability Solutions for Platform Crews and Dismounted Infantry; and/or

Key Interoperability Challenges Stemming from the Energy Transition Across the Alliance.

There is capacity to consider alternative study solutions or objectives, at industry's discretion, to achieve this kind of "starting point", consolidated view from industry. Alternatives should be in line with relevant NATO and CNAD policies and direction of travel.

5. Alternative Solution Options:

There is significant opportunity within this study, as it is a scoping exercise, to explore alternative solution options.

6. Active Companies with Proper Experience:

COMPANY	PoC	Email
BAE Systems	David Williams	david.williams26@baesystems.com
Spirit Aerosystems Europe	Patrick Mallon	patrick.mallon@spiritaero.com
Boeing #1	Steve Gillard	steven.j.gillard@boeing.com
PGZ S.A.	Sabina Rutkowska	sabina.rutkowska@pgzsa.pl
PGZ S.A.	Rafal Jedrzejak	rafal.jedrzejak@pgzsa.pl

⁹ E.g. Petroleums, Oils, and Lubricants

NATO UNCLASSIFIED
Releasable to Finland and Sweden

ANNEX 2
AC/259-D(2022)0069 (INV)

Mesodyne	Matt Ellis	ellis@mesodyne.com
BMT Defence & Security UK	Roger Bartlett	Roger.Bartlett@bmtglobal.com
BMT Defence & Security UK	Jake Rigby	jake.rigby@bmtglobal.com
AVL List GmbH	Stefan Szuecs	stefan.szuecs@avl.com
Autonomous Knight	Geoffrey Ejzenberg	geoffrey@autonomousknight.com
Rolls Royce	Carlos Cerezo	Carlos.Cerezo@Rolls-Royce.com
FN Herstal	Georges Franchomme	Georges.Franchomme@fnherstal.com
FN Herstal	Mathieu Ryckewaert	Mathieu.Ryckewaert@herstalgroup.com
Ostara	Darius Puidokas	Darius.Puidokas@kam.lt
Glock	Christina Novak	Travel-Management@glock.at
Tubitak	Yamak Burcu	burcu.yamak@mke.gov.tr
IHC Defence	Wouter Blaas	WAC.Blaas@royalihc.com
CMCA Integrated Systems	Mike Forsyth	MF@cmca.ltd.uk
Pratt and Whitney, Raytheon	Michael Winter	michael.winter@prattwhitney.com
Pratt and Whitney, Raytheon	Joshua Fredrickson	joshua.frederickson@prattwhitney.com
DNV Maritime	Derek Riezebos	Derek.Riezebos@dnv.com
DNV Maritime	Christian Von Oldershausen	christian.von-oldershausen@dnv.com
Hensoldt	Olivier Chierotti	olivier.chierotti@hensoldt.net
Raytheon/Collins Aerospace	Bernhard Ewers	Bernd.Ewers@collins.com
Jacobs	Will Masters	will.masters@jacobs.com
GE Aviation	Giorgio Abrate	Florian.Gleissner@ge.com
SAAB	Fhleming Christensen	Fhleming.Christensen@saabgroup.com
Airbus	Philippe Chemoul	philippe.chemoul@airbus.com
ThyssenKrupp	Ulf Jensen	ulf.jensen@thyssenkrupp.com
Intracomm Defence	Theodoros Dionisopolous	tdio@intracomdefense.com
Vincorion	Henning Radtke	Henning.Radtke@vincorion.com
Vincorion	Daniel Zeitler	Daniel.Zeitler@vincorion.com
Northrop Grumman	Richard Woolgar-James	Richard.Woolgar-James@euro.ngc.com

NATO UNCLASSIFIED

7. **NATO Priority:** Major Political Priority (Summit Topic), Major CNAD Priority
8. **Intended Follow on to the Study:** TBD – depending on study outcomes.
9. **Other NATO Bodies Involved in the Related Area of Work:**

IS-ESC
STO
IS-DPP
Etc. (Enterprise-wide)

10. **Current Industrial Involvement with the Sponsor Group:**

N/A – via normal Main Group.

11. **Proposed Start Date:** 1 January 2023
12. **Desired Completion Date:** NLT 31 March 2024.
13. **Study Classification:** NATO UNCLASSIFIED, releasable to IP
14. **Study Open to Partner industries:** IP
15. **Final report releasable to:** Allies (INV) + IP
16. **Sponsoring Group Point and IS Point of Contact:**

NATO Defence Investment (DI) Points of Contact for the NIAG study will be Justin Mohn (mohn.justin@hq.nato.int) and Simon Baumann (baumann.simon@hq.nato.int).

Reserve 1 NAFAG/JCGVL

- 1. Title of the Proposed Study:** Modularity in the Design of Multinational Rotorcraft.

- 2. Brief Description of Proposed Study:** The study will identify, assess, and recommend modularity design features for current national and future multinational rotorcraft with the objective of increased platform capability, adaptability, interoperability, and supportability. The increase in rotorcraft utility to be achieved will leverage technology that is at least at Technology Readiness Level (TRL) 4 or can be matured to TRL 7 by 2030.

- 3. Background:** In 2016 JCG Vertical Lift (JCG VL) proposed a NIAG study to address modularity in the design of the next generation rotorcraft. The study final report was published in May 2018. The SG-219 final report highlighted the advantages that could be obtained through the application of modularity at the system level. Follow-on JCG VL sponsored studies built on this foundation in SG-227 on Rotorcraft Manned and Unmanned Teaming, SG-239 on Integrated Sustainability for Next Generation Rotorcraft, SG-246 on Innovative Military Aviation Acquisition, and SG-266 on Joint-Domain Rotorcraft Interoperability and Survivability. Each of these studies highlighted the benefits of modularity and the potential adaptability of the NATO rotorcraft fleet to meet a mix of mission requirements as well as the advantages of Conditioned Based Operations (CBO). However, the term “rotorcraft modularity” needs to be clearly defined at the hardware and software level to assist nations in the modernization of their current rotorcraft fleets and potential acquisition of a future next generation capability. In 2021 NATO held a Workshop dedicated to Modularity.

- 4. Objectives of the Study:**
 - a. The objective of the study is to address rotorcraft modularity at the hardware and software interface level and to identify advantages and increased capability resulting from common interfaces. The application of common interfaces and qualification standards will enable the adaption of mission specific modules and enhance the fleet capabilities to address specific missions. Common interfaces will also enhance platform supportability and system availability.

 - b. The study is not expected to require the development or use of operational scenarios. Should a scenario be required the study will utilize the detailed Concept of Employment (CONEMP) developed in the SG-266 study.

 - c. The study will address rotorcraft hardware and software functions and identify common interfaces and qualification standards that would enhance platform modularity and capabilities. The SG-219 NIAG study recommended CBO for the Next Generation Rotorcraft, leveraging robust situational awareness of status and conditions of all on-board systems for improved capability, safety, survivability, affordability, and supportability. There is significant overlap in

modularity and CBO. Issues and opportunities associated with CBO should be considered with modularity.

d. The study will address the following:

- i. The study will identify a set of rotorcraft modules, e.g., structures, propulsion, electronics, and evolve a common set of hardware and software interface requirements and qualification standards that will facilitate the exchange of mission components between nations.
 - ii. Design and identify a family of electrical connectors (power and signal) for different types of components and subsystems. Identify the technical requirements for the development of a STANAG for a common family of rotorcraft connectors.
 - iii. Propose common software communication protocols and data models. As well as the impacts of module/black box condition monitoring.
 - iv. Propose rotorcraft mechanical, vibration, thermal, and electromechanical environment standards.
 - v. Review current NATO rotorcraft standards and identify those standards that need to be updated/revised or eliminated. Propose new standards as applicable.
- e. The study will fully address the questions above and document the analysis and rationale for the conclusions reached and the recommendations contained in the final report. It is anticipated the study will recommend the development of new STANAGs.

5. Alternative Solution Options: Yes. Modularity is not a single approach or answer. Alternative methods to obtain the end objective of mission adaptivity, integration and interoperability are expected. The alternatives will not reduce the scope of the study but may in fact expand the level of activity required.

6. Active Companies with Proper Experience: There are extensive major aerospace companies and small and medium size enterprises (component and system suppliers in the first, second and third tier of the supply chain), located in the NATO and Partner nations having the technology and capability to make a positive contribution to this study. The listing of individual companies identified by the Sponsor would not be known or all inclusive. The NIAG national heads of delegation have the list of companies in their nation they have authorized to participate in NIAG studies. This list may or may not include the company point(s) of contact.

- 7. NATO Priority:** Alliance rotorcraft interoperability is an area of increased importance to ensure maximum use and capability of existing assets is to be realized. The study results will provide important information to the NATO Multinational High Visibility Program pertaining to the Next Generation Rotorcraft Capability (NGRC).
- 8. Intended Follow on to the Study:** The results of the study support select nations in the acquisition of their Next Generation Rotorcraft Capability (NGRC). This program is in the Pre-Concept Phase and should enter the Concept Phase shortly before the initiation of this study. The study results will provide nations with important information when they are maintaining and modernizing their current rotorcraft capabilities. The study results may also support anticipated Emerging Disruptive Technology activities evolving within NATO Headquarters. The study and final report will articulate NATO's vision on modularity documented in the NIAG SG-219 Final Report and the 2021 NATO Workshop on Modularity.
- 9. Other NATO Bodies Involved in the Related Area of Work:** There are several NATO organizations and agencies involved or interested in this topic, to include ACO, ACT, IMS, AIRCOM, DI (Multinational Programs), and NSPA (Project Management/Contracting). The study results will inform nations and national industrial supplier to assist in focusing their research, development, and products to support modular NATO systems.
- 10. Current Industrial Involvement with the Sponsor Group:** Sponsor's past NIAG studies over several years have consistently attracted 12 to 25 companies from 10 to 15 nations. This study is expected to see the same level of interest and participation.
- 11. Proposed Start Date:** April/May 2023.
- 12. Desired Completion Date:** June 2025.
- 13. Study Classification:** up to NATO Restricted.
- 14. Study Open to Partner industries:** IP
- 15. Final report releasable to:** Allies (INV) + IP
- 16. Sponsoring Group Point and IS Point of Contact:**
Sponsor: Mr. Lars Ericsson, Chairman, JCG VL
Staff Advisor: Mr. Alexander DeFazio, DI.

Reserve 2 NNAG/AWWCG

1. Title of the Proposed Study: Specialised Unmanned Surface Vessel for ASuW/AAW Force Protection.

2. Brief Description of Proposed Study:

Study the feasibility of developing a surface UxV as a point defence toolbox with sensors, Hard Kill and Soft kill capability in coordination with other specialized HVU UxV's for surface applications to protect the HVU's during its operations in Littoral waters against relevant targets like low RCS fast flyers.

3. Background: The potential of Unmanned Surface Vessels (USVs), large and small, in all maritime operations has not yet been considered to its fullest extent within Allied forces. The potential to develop USVs as part of a point defence system is significant, coupled with the advances in autonomy, especially regarding COLREG/collision avoidance, mean that ultimately successful development of systems such as PD USVs could yield manpower and thus capability cost savings into the future.

4. Objectives of the Study:

The study may address:

- Issues with leaving a heavily armed autonomous unmanned surface vehicle on its own. What new standards would be required?
 - Safety standards
 - Man in the loop
 - Cyber security
 - Communication - interoperability
- It cannot be a frigate, but how small could you build it and still have sensor and firepower enough to make it a real self defence tool
 - Realistic engagement range. Since this tool is protecting unmanned systems one could put all efforts at killing the targets at close range. With close in range weapons the “safety area” could be limited
 - Type of weapons – existing or new development
 - Hard kill or Soft kill or both – link to “reusable off board decoy” SD initiative
 - Portability – as part of “mother ship” you deploy this tool when the threat demands
 - Seaworthiness
- Several scenarios could be envisioned, but the initial need stems from the challenge of protecting other specialized USV toolboxes i.e. that are keeping important shipping lanes in the littorals free from mines.
- Targets:
 - Flying bombs
 - Long range surface missiles
 - Smaller ground launched missiles

- Aircraft
- Helicopter

5. **Alternative Solution Options:** Yes, open to alternative suggestions.
6. **NATO Priority:** Would form part of Maritime Engagement, a key shortfall in the MC SRA.
7. **Intended Follow on to the Study:** Potential to develop a STANAG for the C2 of small USVs.
8. **Other NATO Bodies Involved in the Related Area of Work:** STANAG 4817, C2 of Multi-domain UxVs. ESC Autonomy Strategy. CNAD EDT work stream. NCIA AI Development. ACT NWCC. C3S – C2 of Autonomous Systems. NATO MUSI (REPMUS 21, DYMS 22).
9. **Current Industrial Involvement with the Sponsor Group:** None as of yet.
10. **Proposed Start Date:** 1 March 2023
11. **Desired Completion Date:** 1 June 24
12. **Study Classification:** NATO Unclassified, releasable to IP
13. **Study Open to Partner industries:** IP
14. **Final report releasable to:** Allies (INV) + IP
15. **Sponsoring Group Point and IS Point of Contact:**

NNAG Level 2 Capability Group – Above Water Warfare.
IS POC Mr Sean Trevethan. Trevethan.Sean@hq.nato.int

Reserve 3 NNAG/SDCG

1. Title of the Proposed Study: AI Support to Internal Battle Damage in Warships

2. Brief Description of Proposed Study:

This study will investigate the feasibility of using AI/ML to support ships teams when a warship sustains battle damage. It will specifically look at the following:

Exploitation of ships internal platform management systems to automatically re-configure auxiliary power and systems to maintain operation of key capabilities such as propulsion

systems, weapon systems and sensors in maintain a warships ability to fight the external battle.

Exploit a ships internal fixed fire fighting and damage control systems to automatically deal with damage, containing fires and floods as appropriate.

Provide decision support to Ship's teams when determining internal battle damage priorities and damage repair.

Provide decision support to operators as to optimum capability based on damage sustained. i.e. max speed available, weapons available etc.

3. Background:

This NIAG study will be focused on providing decision support and automatic system configuration when a warship is sustaining battle damage. The practice of training with battle damage is common place for most warships generating for an operational deployment. The challenge to ship's teams fighting the internal battle is immense and one that puts a significant load on ship's teams. Exploiting the advances in AI/ML in this area could significantly aid ship's teams and free up and focus personnel on the damage that really matters, enabling allied forces to fight and win. It would have to draw on data from the ships combat system and a ships platform management system to provide holistic recommendations.

4. The objectives of the study are to:

1. Understand in what scenarios AI/ML would be useful in the internal battle.
2. Determine which warship systems would need to be accessed to glean the most benefit.
3. Identify which systems could be automatically reconfigured and which would still require human intervention with decision support.
4. Identify the security classification challenges of access Combat System data and Platform Management Data.

5. NATO Priority: Combat Survivability

6. Intended Follow-on to the Study: Development of a concept paper for Nations to consider development with their own systems.

7. Are any other NATO Bodies involved in the related area of work? Not directly, but ESC AI Strategy and NCIA AI development are related.

8. Is there any current Industrial involvement with the Sponsor Group? Not yet.

9. Proposed start date: May 2023.

10 Desired completion date: 24 months after commencement of the study

11. Study Classification level: NATO Unclassified, releasable to IP

12. Study Open to Partners? IP

13. Final report releasable to: Allies (INV) + IP

14. Sponsoring Group Point of Contact and IS/DI Point of Contact:, ST-SCS: Chair Mr. Mattias Osback

IS/DI - Mr Sean Trevethan. Trevethan.Sean@hq.nato.int

Reserve 4 NAFAG/JCGISR

1. Title of the Proposed Study: Examination of implementation of 5G networks on NATO Command & Control (C2) systems: Risks and Opportunities

2. Brief Description of Proposed Study: Proposed study is intended as a specific follow-on to the NATO Industrial Advisory Group (NIAG) 2020 study entitled, *5th Generation International Mobile Telecommunications (IMT) for NATO Operations*. The study should leverage the assessments made in the 2020 proposal to inform policy & requirements and identify tangible opportunity to incorporate 5G technology into emerging National and NATO all-domain C2 efforts. The study should also provide a critical look at the risks associated with incorporating 5G technology into the C2 mission area. It is envisioned this study will inform efforts associated with Alliance Future Surveillance System and other fledgling traditional and multi-domain C2 capabilities.

3. Background: Nations and NATO Staff, Agencies, and Military Authorities are all working to modernize legacy C2 systems to enable multi-domain C2. In general, these efforts endeavour to connect disparate sensors and enable decision-making at the tactical edge. 5G technology may afford an opportunity for an evolutionary leap in C2 capability throughput enabling the application and exploitation of data in C2 systems via Machine Learning (ML), Artificial Intelligence (AI), Big Data analytics, and automation/decision aids. Implementation of 5G technology also poses inherent risks and vulnerabilities that are not clearly understood when used in a military operating environment.

4. Objectives of the Study: The objectives are to expand on the 2020 study to:

- a. Identify detailed set of opportunities to incorporate connectivity for data processing at the edge into current or emerging C2 systems.

- b. Identify detailed set of opportunities to incorporate high-bandwidth, low-latency networking to link disparate ground, naval, and air and space platforms (e.g. Internet of Things-like concept). Taking additional care to identify range concerns.
- c. Explore efforts to exploit ML, AI, automation, and data analytics to enable speed and efficiency in C2 systems. Specific areas of interest include:
 - Data fusion/correlation from disparate national C2 systems
 - Intelligent routing/self-regulating networks
 - Full spectrum informed mission planning
 - Increased speed of decision making through technology
- d. Identify risks and policy gaps associated with implementing 5G technology on NATO C2 systems. Additional areas of interest include data integrity, data availability, non-repudiation, and mission assurance.
- e. Identify impact or areas of concern to military operations of spectrum sell-off for 5G markets, to include NAEW&C.

5. Alternative Solution Options: Yes

6. Active Companies with Proper Experience: No active companies identified.

7. NATO Priority: High

8. Intended Follow on to the Study: The output will inform efforts associated with Alliance Future Surveillance System and other fledgling National and NATO traditional and all-domain C2 capabilities and programs.

9. Other NATO Bodies Involved in the Related Area of Work: NIAG 2020 Study Group, *5th Generation International Mobile Telecommunications (IMT) for NATO Operations*

10. Current Industrial Involvement with the Sponsor Group: None to date.

11. Proposed Start Date: Spring/Summer 2023

12. Desired Completion Date: Spring/Summer 2024

13. Study Classification: Up to NATO Secret

14. Study Open to Partner industries: Invitees only

15. Final report releasable to: Allies (INV)

16. Sponsoring Group Point and IS Point of Contact: NAFAG/Joint C2 Community of Interest. IS POC: Mr. Alexander DeFazio, defazio.alexander@hq.nato.int , Tel: +32 (0)2 707 3848

Reserve 5 NAFAG/JCGVL

1. Title of the Proposed Study: Improving Mission Planning and Cycle Time to Increase Mission Effectiveness and Survivability

2. Brief Description of the Proposed Study: The study will investigate means to improve the Mission Planning process while in parallel reducing the cycle time. Based on assessments conducted under previous NIAG Study Groups this is predicted to lead to a significant increase in Mission Effectiveness and Survivability of deployed assets. The principal outcomes from the study will be:

- To inform NATO of the operational and capability shortfalls in Joint All Domain Operating (JADO) environments imposed by established Mission Planning, Operating Picture, Decision Support Tools, and ISR Collect and Dissemination capabilities.
- To identify the main challenges and common themes associated with developing and implementing the improvements to these capabilities required to reduce the planning cycle to a) less than 48 hours, b) less than 24 hours, and c) less than 12 hours through a combination of operational and industrial practical experience, analysis, and engineering judgement.
- To outline the key near-term activities required to overcome these challenges, along with the longer-term roadmap to establish and implement next generation mission planning, COP, decision support tools including synthetic environments, and ISAR Collect capabilities for Intelligence functions, to reduce planning times to a) less than 48 hours, b) less than 24 hours and c) less than 12 hours.
- To develop a set of common lessons to inform future NATO activities.

3. Background: The Joint Capability Group on Vertical Lift (JCG VL) has sponsored several NIAG studies addressing various topics including Next Generation Rotorcraft Technologies, Manned Unmanned Teaming (MUM-T), Rotorcraft Sustainment, Novel Procurement and most recently Rotorcraft Interoperability and Survivability. The last of these NIAG SG.266¹⁰ recently held its year 2 kick-off meeting and is due to report in summer 2023. The SG.266 Interim Report covering the first year of (Work Package #1) identified that future NATO air operations in a near-peer threat environment, including vertical lift missions, can improve survivability and mission success by:

¹⁰ NIAG SG.266 Joint-Domain NATO Rotorcraft Interoperability and Survivability in a Peer Nation Threat Environment.

- significantly reducing the Air Tasking Order (ATO) planning cycle time from the current 72-hour baseline to enable forces to respond earlier and faster to changing events in the battlespace;
- improving pre-flight Mission Planning and “in-mission” replanning outcomes by providing Force, Mission and Flight Commanders, and Planning Teams, with near real-time situational awareness by creating an accessible and high fidelity Common Operating Picture (COP);
- enabling Force Commanders and Planners to rapidly assess alternative mission options and undertake multiple “what-if” analyses during both the ATO generation and unit level planning cycles by using simulation, 'fly-throughs' and war-gaming technologies; and
- developing air, ground, and ship based ISR systems to capture, process, exploit and disseminate relevant information on the battlespace, as required by NATO and allied forces Intelligence functions to support Next Generation Mission Planning (NGMP) activities.

The established ATO Cycle of 72 hours, that may be reduced in time critical circumstances, has been determined by processes, procedures and information exchange between all stakeholders, the need to optimise the use of limited numbers of High Value Air Assets (HVAA) and force multipliers (such as SEAD/DEAD, Electronic Attack and AAR platforms), to achieve a synergistic effect on the enemy by employing Composite Air Operation (COMAO) techniques and avoid Blue on Blue fratricide. Synchronisation of actors necessary for Joint All Domain Operations (JADO) including but not limited to Air (ISTAR, Combat Air, and Close Air Support), Land (Long Range Precision Fires, Ground Manoeuvre Forces and Missile Defence Systems), Maritime (Long Range Precision Naval Fires and Amphibious Units) is now the predominant “pacing” activity of the Mission Planning cycle. Planners familiar with the issues expect that, unless there are changes, the Operations Desks (that works the 24 hours prior to a mission) will have to take on additional responsibilities and will need additional appropriately experienced and trained people.

The Common Operating Picture (COP) is expected to be a key asset in any future conflict, but there are many unanswered questions including where does it reside, how is it sustained and updated, is it accessible to all actors across NATO and its allies, how is information prioritised for the various users (planners, pilots, mission commanders etc.), what information goes to the COP and what is sent from the COP, and how will latency, accessibility, security, and standards be addressed?

Rapid assessment of mission planning options and conducting “what if” analyses will help Force and Mission Commanders develop the optimal plan and understand increased risks if the required force package and appropriate crews cannot be readied in time¹¹. Decision Support tools using Artificial Intelligence / Machine Learning

¹¹ This information for rotary-wing assets is expected to be held in a Modern Aviation Sustainment Architecture (MASA) developed to support Condition Based Operations (CBO) enabled platforms based on the

(AI/ML), wargaming and digital twin technologies have the potential to provide such assessment, while the addition of synthetic environments should enable “whole force” mission rehearsal / exercises to be completed and lessons identified.

All rotary-wing platforms, fixed and rotary-wing UAS and ALE have a range of “ISR Collect” capabilities including EW, EO/IR and sometimes radar. These onboard systems have the potential to automatically capture, process and store relevant information on the battlespace throughout the mission for subsequent assessment by the intelligence community using “big data” analytics to identify all-important changes to the operating environment including strong and weak intelligence “signals”. To quote extant USMC philosophy, 'every platform is a sensor'.

Improvements in Mission Planning (MP) and reduced MP cycle times, at both CAOC (ATO) and unit level, are considered essential to deliver the required improvements in mission effectiveness and survivability that will be necessary to operate in a peer nation threat environment in the 2030s and beyond.

Development and implementation of a continually updated Common Operating Picture (COP) accessed by NATO and allied partners to inform their mission planning teams and Tactical Operating Pictures of individual force elements (e.g. combat air, helicopters, long range ground fires, missile defence units etc.) will be a pre-requisite to improving the effectiveness of mission planning prior to the mission, and enable rapid re-planning during the mission to respond to rapidly changing threats.

Development and implementation of Decision Support tools enabling rapid assessment of mission options and conducting “what-if” analyses prior to the mission will improve MP outcomes including risk assessments. They also have the potential to support re-planning during the mission. Synthetic environments should enable mission commanders and crews to conduct “fly-throughs” to review / rehearse the mission to test AI/ML assumptions and allow “whole force” mission rehearsal / exercises to be completed and lessons identified.

Development of platform ISR collect capabilities, high-capacity databases and “big data” analytics will enable Intelligence functions to provide Force and Mission Commanders and planners with up-to-date assessments of the battlespace including Red Force posture and the evolving threat environment, both critical inputs to mission planning and re-planning.

4. Objectives of the Study

recommendations of NIAG Study Group 239 Integrated Sustainability for the Next Generation Rotorcraft, dated May 13th 2020.

- a. The study will identify and prioritise the capability shortfalls in established Mission Planning, Operating Picture, Decision Support Tools, and ISR Collect capabilities and identify and prioritise the principal challenges to the development and implementation of NGMP systems, Common Operating Picture, Decision Support Tools (including Synthetic Environments) and ISR Collect capabilities to improve mission effectiveness, success, and survivability.
- b. The study will investigate the practicality of reducing the MP cycle time to less than 2 cycles of darkness (within 48 hours) and less than one cycle of darkness (within 24 hrs) and assess the viability for high tempo operations within 12 hours¹². The study will also identify and recommend material (e.g. technology and equipment based solutions) and non-material (e.g. process and procedure re-engineering and organisational change) activities that have the potential to overcome the capability shortfalls partially or completely in the short term (2025), medium term (2030) and long term (2035) and their impact of them on Doctrine, Organisation, Training, Material, Leadership, Personnel, Facilities, and Infrastructure (DOTMLPF-I).
- c. The study will identify the main challenges associated with the development of MP Systems, COP, Decision Support Tools and ISR Collect capabilities through the Study Team members operational and industrial practical experience, analysis, and judgment. This will be supplemented by members of the Quick Reaction Team and reach-out to relevant NATO Centres of Excellence, Competency Centres, HQ and Staff functions.

The study will utilise the output from SG.266 (Work Package #2 that will analyse current Mission Planning processes, procedures, and information exchange requirements between all stakeholders with the objective to establish a framework where potential planning deficiencies can be identified, and potential improvements can be assessed. In doing so, it will identify pacing activities, bottlenecks, and where improvements might be made. This work should be completed before this study commences

- d. The study will consider integration with established NATO Command & Control (C2) and Mission Planning Systems; systems requirements and appropriate architectures; common information database requirements¹³; information exchange requirements; accessibility to NATO and allied forces; information integrity and security; analytical tools including Artificial Intelligence / Machine Learning (AI/ML); User Interface (UI) including Input/Output Portals, and use of

¹² There will be a limit to how much the planning cycle can be accelerated. At some stage Force Commanders will have to resort to using 'on call' aircraft held at very high readiness to hit Time Sensitive Targets and support Troops In Contact etc.

¹³ These include Red Force Order of Battle, Force Posture and Recent Actions; and Blue Force Post Mission Reports, Battle Damage Assessment, and Rotary Wing Force capability, serviceability, and availability status.

Virtual & Augmented Reality; cyber security; training needs; computing and facilities requirements including environments for software development and sustainment, and modelling and simulation; support and maintenance; standards and protocols; test and evaluation; qualification and certification.

- e. The specific issues addressed by the study will be documented in a final report that will enable NATO and member nations to understand and evaluate their future Mission Planning, Common Operating Picture, Mission Rehearsal, and ISR Collect options. The report will make recommendations relating to potential future capabilities and will identify where investment in development of key technologies to achieve them may be necessary. The study group will also be required to provide a detailed briefing to the primary sponsor; JCGVL, along with summary briefings to the two Primary Sponsor Groups (NAAG and NAFAG)¹⁴.

5. Alternative Solution Options: The sponsor is open to the study team identifying alternative solutions to the problem, however this should not be considered a key objective and should not significantly reduce the depth of the study addressing the point raised in section 4 of this document.

6. Active Companies with Proper Experience: Companies listed in the table below have contributed to related studies in the past and should be invited to consider participation in this one if approved.

FR	Airbus Helicopters	David ALFANO	david.alfano@airbus.com
UK	BAE Systems	David BETTLE	david.bettle@baesystems.com
US	Bell Helicopters	Doug ENGLIN	denglen@bellflight.com
US	Boeing	Daniel NEWMAN	daniel.i.newman@boeing.com
US	Collins Aerospace	Guillaume ZINI	Guillaume ZINI
US	Elbit Systems US	Layne MERRITT	layne.merritt@elbitsystems-us.com
US	WL Gore	Jeffrey WOODS	jefwoods@wlgore.com
DE	Hensoldt	Geert MANSVELT	geert.mansvelt@hensoldt.net
US	Honeywell	Howard WIEBOLD	howard.wiebold@honeywell.com
DE	IABG	Matthias MUELLER	matthias.mueller@iabg.de; MuellerMa@iabg.de
UK	Leonardo MW	Andrew MERRICK	andy.merrick@leonardocompany.com
IT	Leonardo SPa	Paoloandrea CASTELLETTI	paoloandrea.castelletti@leonardocompany.com

¹⁴ The sponsor will investigate options for the MAG briefs to be in a combined briefing session or at the Tri-MAG as appropriate.

UK	Northrop Grumman	John HUGALL	John.Hugall@euro.ngc.com
UK	Nova Systems	John LING	john.ling@novasystems.com
UK	QinetiQ	Andrew HUMPHRIES	amhumphries@qinetiq.com
FR	Rockwell Collins	Pierre DUBOIS	Pierre.Dubois@collins.com;
US	Sikorsky/LM	Simon GHARIBIAN	simon.j.gharibian@lmco.com
DK	Terma	Mikael KALLESØE	mkn@terma.com
UK	Thales	George BUTLER	George.butler@thalesgroup.com
IT	ADC-2	Mario DE LUCIA	mario.delucia@libero.it; mario.delucia@virgilio.it
UK	Adept	Antony DUTHIE	tony.duthie@adeptaviationsolutions.co.uk
BE	AOS	Giorgio SCAPPATICCI	gscappaticci@aofs.org
UK	Ascalon	Paul KENNARD	ascalondefence@btopenworld.com

7. NATO Priority: High

8. Intended Follow on to the Study: Sharing this information across NATO will benefit the alliance by enabling lessons learned to be captured, shared and reviewed thereby identifying best practice or common areas of concern. This information will help to inform future procurement requirements and direct research to address the priority challenges in national programmes and informing the NATO STO community of collaboration opportunities. In the longer term it is believed that a STANAG for Mission Planning Systems leading to increased commonality between NATO nations could be an outcome from the proposed NIAG Study Group.

9. Other NATO Bodies Involved in the Related Area of Work: There are a broad range of NATO bodies involved in the development, evaluation and exploitation of Mission Planning Systems. This includes NAFAG, The MC Air Standardization Board, Allied Command Operations, Allied Command Transformation, the Joint Air Power Competence Centre (JAPCC), and the NATO Science and Technology Organization.

10. Current Industrial Involvement with the Sponsor Group: The JCG VL has a strong relationship with rotorcraft manufacturers and principal systems providers of NATO Partner nations. This relationship has been developed over the past 10 years through a series of NIAG study groups and associated activities.

11. Proposed Start Date: March 2023

12. Desired Completion Date: No later than June 2024

- 13. **Study Classification:** NATO UNCLASSIFIED, releasable to IP
- 14. **Open to Partners:** IP
- 15. **Final report releasable to:** Allies (INV) + IP
- 16. **Sponsoring Group Point of Contact and IS Point of Contact:** NAFAG/JCGVL. IS POC: Mr. Alexander DeFazio, defazio.alexander@hq.nato.int , Tel: +32 (0)2 707 3848

Reserve 6 C3B

- 1. **Title of the Proposed Study:** Development of a Service Catalog to identify possible commercial Satellite-as-a-Service capabilities and standards in a hybrid architecture.
- 2. **Brief Description of Proposed Study:** The study will provide NATO with a Service Catalog to describe the technical specifications, possible interfaces, standards, architectures of space data, products, and services in the Satellite-as-a-Service model to be used in a (hybrid) cloud environment. This will not only improve NATO’s Command & Control (C2) resilience (increasing the variety of services through different service providers considering crisis-time scenarios) but also introduce more availability in an on-demand commercial services model in areas where the existing infrastructure cannot meet current demand.
- 3. **Background:** Space Systems are heavy to deploy, require significant initial infrastructure investments, and are costly to operate. In addition, considering the lengthy timelines required for planning, building, and deploying capabilities, obsolescence poses a great challenge for owning capabilities. Further, on-board automation is required for satellite constellations with hundreds of satellites to provide the desired common task in applications such as IoT. However, mission planning on-ground is still essential for high-resolution imaging or SAR (Synthetic Aperture Radar) satellite systems because of the task complexity and reliability requirements¹⁵.

To mitigate these challenges, a shift toward a commercial Satellite-as-a-Service model is becoming more prominent, and the industry is looking into automating mission planning for utilizing space systems of satellite constellations. This offers increased flexibility to meet a variety of demands, control of bandwidth and coverage, minimal ownership risk, and the latest technologies with no further investment.

The C3B is tasked to establish a list of existing standards (NATO/open) and potential new standards needed to ensure Space Domain Awareness technical interoperability. As stated

¹⁵ STO-AVT-336 Enabling Platform Technologies for Resilient Small Satellite Constellations for NATO Missions: “Enabling Platform Technologies For Resilient Small Satellite Constellations For NATO Missions (AVT-336)”.

in the Bi-SC Space Domain Action Plan,¹⁶ with a fully implemented Space Domain Awareness Capability, NATO will have the capacity to receive, analyze, synchronize, and fuse National and Partner inputs/data to build and share a Recognized Space Picture. In this context, a (hybrid) cloud operating model will meet the criteria mentioned above, increasing C2 resilience for crisis-time scenarios.

A holistic approach must be taken to analyze the risks, opportunities, and challenges of using commercial on-demand services. The NIAG study NIAG-SG-203 “Current and planned space data, services and products that may benefit NATO JISR” already produced a final report similar to this proposal, but the study was done in 2016, had a 6-year horizon, and was constrained to JISR applications of space-based services. Further, the NIAG study recommended a follow-on study to cover medium-to-long term (2030) commercially available solutions and technologies addressing the evolving NATO JISR requirements. In this context, below are some examples of technical and non-technical aspects of what the industry is expected to provide insights on.

Technical service areas include:

- a. Hybrid Cloud hosted Space-based data: Combining Cloud capabilities (e.g., storage, data exchange, process and compute, etc.) with the acquisition of space-based data enables faster data processing on the cloud and extended availability across a hybrid cloud environment.
- b. Enhance JISR capabilities: NIAG-SG-235 already has offered industry input on enhanced JISR. As per the recommendation from the study’s final report, a follow-up study covering medium-to-long term (2030) commercially available solutions and technologies addressing NATO JISR evolving requirements must be considered. This would especially be relevant for combating climate change to support NATO 2030 Agenda.
- c. Increased resilience in Advanced Early Warning systems: Timely detection of hypersonic threats (e.g., through Low-Earth-Orbit satellite constellations) can be done but needs to work in coordination with existing NATO early warning systems.
- d. High-bandwidth low-latency communication capabilities: This will increase resilience by improving the availability of Military SatCom capabilities, a scarce resource. Further, LEO satellite constellations can pave the way for high-availability communication networks and support Next Generation Networks’ deployment in the future.
- e. Resilience against Kinetic Attacks in Space: In a crisis, adversaries can disrupt satellite operations by spoofing, destroying sensors, on-board computation, data links, or satellite electric power systems. Hence having back-up services increase capacity for crisis-time without any initial investments using an on-demand model.

Non-technical aspects include:

- a. Governance: Defining existing and potential accessibility, data formats, and information exchange requirements in a hybrid cloud environment. Discuss the potential availability and delivery methods of the different space products or data in a

¹⁶ MCM-0039-2021 “Space Domain Action Plan” 20 September 2021.

hybrid cloud, Multi-Domain Operations context. Further, assess the Satellite-as-a-Service model from a procurement perspective and funding models considering peace-time and crisis-time scenarios.

- b. Risk Assessment: The existing Risk Register of NATO Core Communications Capability Program (CCCP) does not reflect the future expansion and regeneration of NATO Core Communication Capabilities. As part of the holistic approach, the associated risks should be identified. The industry can provide details on what level of transparency they are willing to give NATO considering information security, supply chain security, other partnerships they have, technical specifications etc.

4. Objectives of the Study:

- a. Provide alternatives and recommendations improving NATO's resilience in Command and Control capabilities through a commercial Satellite-as-a-Service model.
- b. Identify critical C2 services for peace-time that should remain on military infrastructure and the non-critical C2 services that can run over commercial on-demand services. Further, explore which (and how) of those critical C2 capabilities can be transitioned into commercial services in case of denial of service of military systems at crisis-time.
- c. An assessment of NATO's accessibility to the data, services, and products identified, along with suitable exchange mechanisms. Identify what the industry can offer to improve NATO's C2 capabilities from a technical, governance, and procedural/procurement perspective.
- d. Enable C3B to consider the governance aspects of the Satellite-as-a-Service operating model considering technical and non-technical aspects. This will also support the development of the Risk Register for utilizing X-as-a-Service architecture.
 - a. Produce a Service Catalog, which includes detailed product descriptions, Data format, service interfaces, timelines, cost, architecture, and business models for space-based data acquisition and communication services, integration into a (hybrid) cloud environment.
 - b. Selected use cases can have a follow-on demonstration and testing in NATO exercises and training (e.g., War gaming, CMX, and CWIX).

5. Alternative Solution Options: TBD

6. Active Companies with Proper Experience: TBD

7. NATO Priority: TBD

8. Intended Follow on to the Study:

SET-SCI-297 "Specialists' Meeting on Space Sensors and Space Situational Awareness"

STO-AVT-336 "Enabling Platform Technologies for Resilient Small Satellite Constellations for NATO Missions"

9. **Other NATO Bodies Involved in the Related Area of Work:** ACO, ACT, NATO Space Command and Space CoE.
10. **Current Industrial Involvement with the Sponsor Group:** TBD
11. **Proposed Start Date:** 01/01/2023
12. **Desired Completion Date:** 01/01/2024
13. **Study Classification:** TBD
14. **Study Open to Partner industries:** IP
15. **Final report releasable to:** TBD
16. **Sponsoring Group Point and IS Point of Contact:**

LCdr Paul Bridgers (Bridgers.Paul@HQ.NATO.INT)
Mr Gerard Elzinga (elzinga.gerard@hq.nato.int)