NORTH ATLANTIC TREATY ORGANIZATION

RESEARCH AND TECHNOLOGY ORGANIZATION

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STO TECHNICAL REPORT

STO-TR-SAS-085

Executive Overview

Task Group SAS-085 Final Report

on

C2 Agility

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EXECUTIVE OVERVIEW

The NATO Research Task Group, SAS-085, accomplished its objectives by articulating the principles of Command and Control (C2) Agility and substantially validating them with empirical evidence. Further, the group identified next steps toward practical implementation in NATO operations and priorities for increasing the rigor and practicality of methods for measuring and improving C2 Agility.

BACKGROUND

The success of an approach to C2 is determined by its appropriateness, given the nature of the mission and the circumstances, as well as the collection of entities needed to accomplish it. The 21st century military mission space is large and complex, characterized by extreme uncertainty, and exposed to increased public and media scrutiny. In addition to the high intensity combat operations traditionally associated with the military, potential missions include a wide spectrum of challenges such as counter-insurgency, counter-terrorism, stabilization, reconstruction, and support to multi-agency disaster relief. In many of these endeavors, the effects that need to be created involve more than traditional military effects and include inter-related economic, social and political effects. These missions are referred to as *Complex Endeavors* and require the participation and contributions of a large variety of both military and non-military actors, a collective that SAS-085 refers to as a *Complex Enterprise*. Given the differences between and among these mission challenges and the collections of entities needed to meet them, different approaches to C2 are required.

The ongoing transformation of 21st century institutions and actors from the Industrial Age to the Information Age and beyond to an age some call the “Age of Interactions” continues to have a profound effect on how institutions manage themselves, and how they work with others. This can be attributed to increasingly accessible and affordable mobile networking and related trends that are inexorable, creating both vulnerabilities and opportunities that are shaping the information-related capabilities of the various actors and the environment in which these missions take place.

This *‘networked’* reality requires that NATO and its member Nations rethink C2, interpreted in its broadest sense to include acquiring, managing, sharing and exploiting information, and supporting individual and collective decision-making. As our understanding of Complex Endeavors and Complex Enterprises matures, we will be better able to recognize the changes in missions and circumstances that require corresponding changes in the way C2 is approached. The ability to dynamically adopt an appropriate C2 Approach is integral to C2 Agility.

SAS-085

Previous research and experience indicate that the logical response to high degrees of uncertainty and complexity is to improve Agility. Agility, like any other *‘good’,* is not an end unto itself and exhibiting maximum Agility is often not the answer. SAS-085 was formed to improve the understanding of C2 Agility, the variables that it influences, and the variables that, in turn, influence it. SAS-085 has developed a conceptual model of C2 Agility that captures the relevant variables and relationships. A number of agility-related hypotheses are suggested by this model. SAS-085 has conducted both retrospective case studies and simulation-based experiments to validate this model and to test these hypotheses.

THE CONCEPTUAL MODEL OF C2 AGILITY

C2 Agility is the capability of C2 to successfully effect, cope with, and/or exploit changes in circumstances. While other factors will also influence outcomes, C2 Agility enables entities to effectively and efficiently employ the resources they have in a timely manner.

The functions associated with C2 can be accomplished in a wide variety of ways. NATO research group, SAS-050, concluded that C2 Approaches can be categorized by how decision rights are allocated, how entities interact, and how information is distributed.

These form the key dimensions of an entity's[1] C2 Approach Space, as depicted in Figure EO-1: C2 Approach Space.

- Allocation of Decision Rights (ADR)
- Patterns of Interaction (PoI)
- Distribution of Information (DoI)

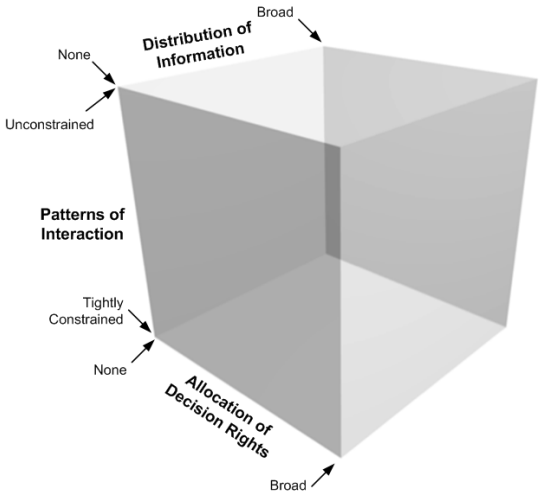

Figure EO- 1: C2 Approach Space

In practice, these dimensions are inter-dependent as, for example, the way decision rights are allocated will have a considerable influence on the patterns of interactions and information flows. Each C2 Approach occupies its own region in the C2 Approach Space.[2] These regions vary from highly centralized, stove-piped hierarchies to loosely-coupled networks.

[1] SAS-085 uses the term "entity" to refer to organizations, teams, individuals, systems, and processes, each of which can manifest agility.

[2] Large organizations and Collectives usually do not employ a uniform C2 Approach. In fact, commanders will give certain subordinates more degrees of freedom than others even if they have similar responsibilities; they will use different C2 Approaches for specific sub missions and tasks. We refer to this phenomenon as C2 Approach heterogeneity. We discuss this later in this report and in more detail in Annex A.

SAS-065 developed a NATO Network Enabled Capability (NEC) C2 Maturity Model (N2C2M2) that defined five increasingly network-enabled approaches to Collective C2: Conflicted C2, De-Conflicted C2, Coordinated C2, Collaborative C2 and Edge C2 and graphically located them along a diagonal in a Collective's[3] C2 Approach Space as depicted in Figure EO-2: NATO NEC C2 Approaches.

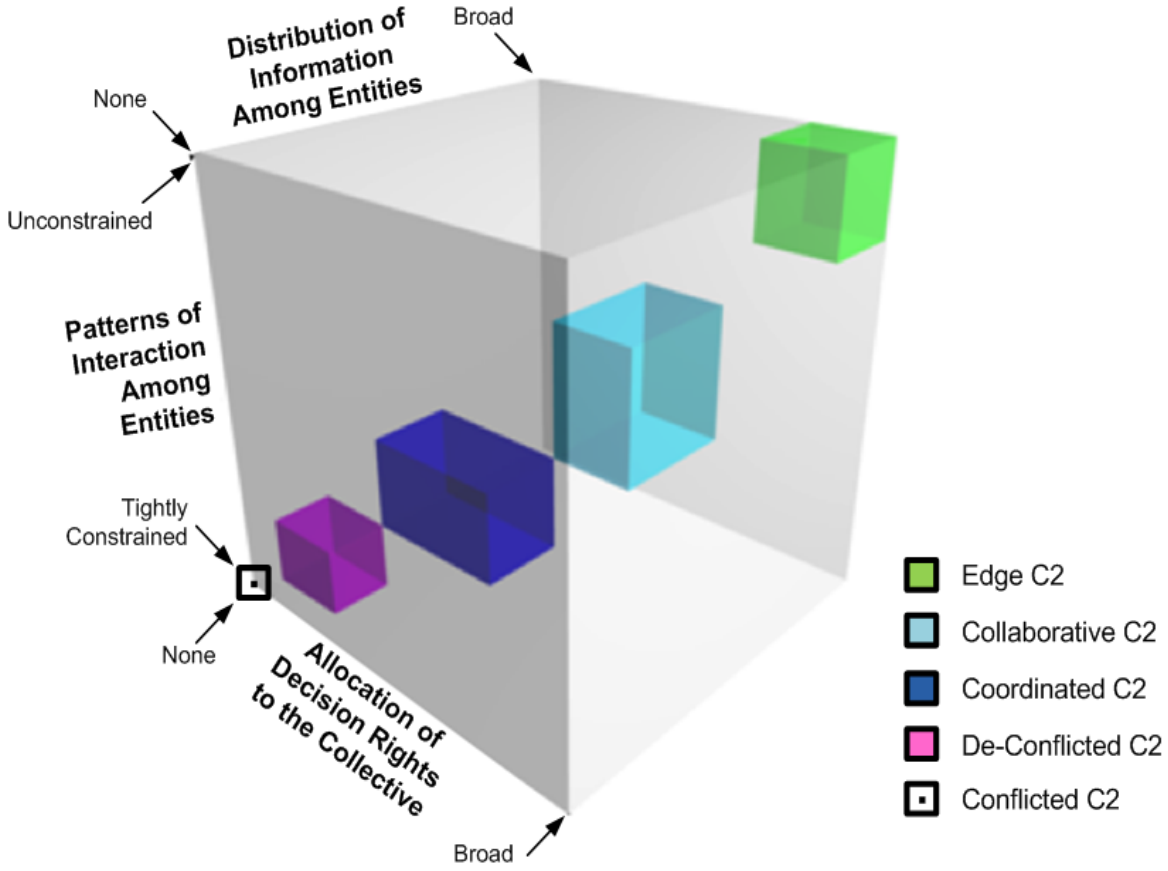

Figure EO- 2: NATO NEC C2 Approaches

A Collective's mission, objectives, and strategy will vary with circumstances and therefore, no single C2 Approach works well for all missions and circumstances. We can visualize an Endeavor Space where different regions correspond to different mission changes.

[3] EO-1 depicts an Entity's C2 Approach Space while EO-2 depicts a Collective's C2 Approach Space. The dimensions differ. For example, the allocation of decision rights are allocated within an entity in the Entity C2 Approach Space and from entities to the Collective in an Collective's C2 Approach Space.

For each region in this Endeavor Space, there is presumably an appropriate C2 Approach, as depicted in Figure EO-3: Appropriate C2 Approach.

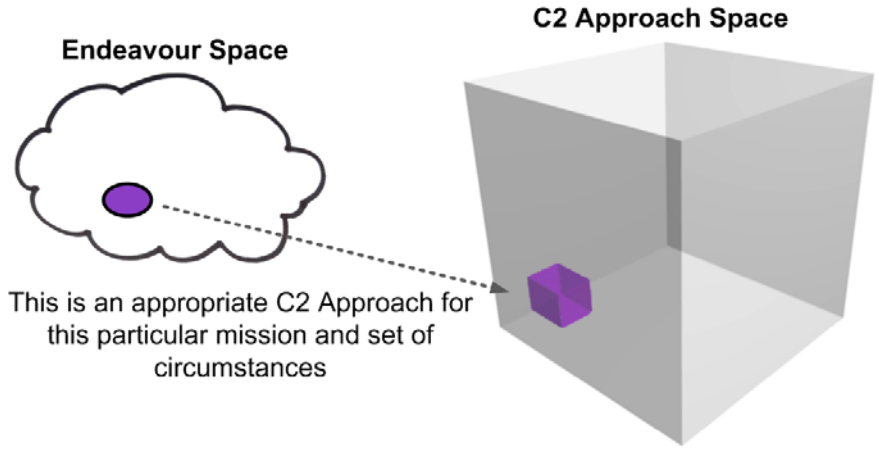

Figure EO-3: Appropriate C2 Approach

As case studies and experiments have shown, entities that carefully consider the nature of the mission and circumstances they face and initially adopt an appropriate C2 Approach increase their likelihood of success. Over time, entities and Collectives may need to be able to successfully operate in many regions in the Endeavour Space. There will also be times when an entity is engaged in a highly dynamic situation where the mission, and/or the circumstances will change and one's current C2 Approach will no longer be appropriate. For both of these reasons then, there is a need to be able to employ more than one approach to C2 to be effective and to remain effective. Thus, entities and Collectives will need to develop the ability to navigate through the C2 Approach Space in response to changing missions and circumstances. This ability to manoeuvre in the C2 Approach Space is necessary for an entity to have if they are to manifest C2 Agility. This ability to maneuver in the C2 Approach Space is depicted in Figure EO-4: C2 Maneuver.

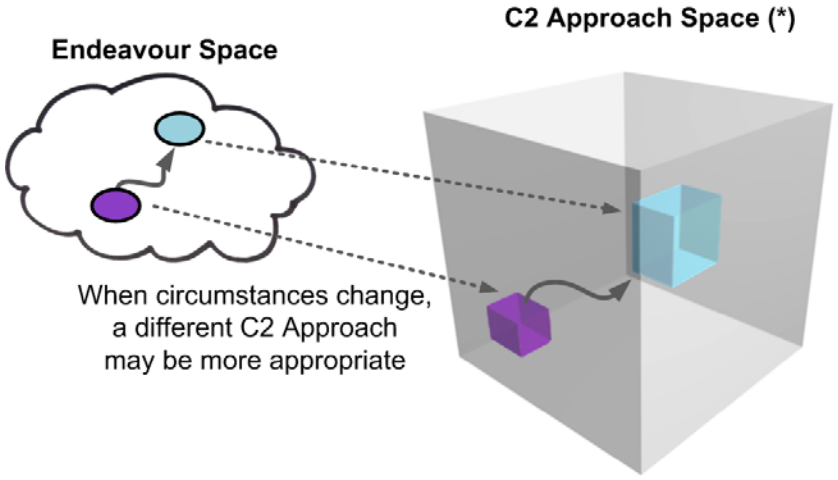

Figure EO-4: C2 Maneuver

C2 Maneuver involves:

1. Recognizing the significance of changes in circumstances that affect the appropriateness of one's C2 Approach,

2. Understanding which C2 Approach(es), given the new mission and/or evolving circumstances, are now more appropriate, and,

3. Being able to transition, as necessary, to a more appropriate C2 Approach.

Therefore, organizations that wish to improve their C2 Agility must monitor not only the external situation but also themselves[4] so that they understand what adjustments in their C2 Approach may be needed to effectively and efficiently maneuver in the C2 Approach Space.

C2 AGILITY HYPOTHESES

The SAS-085 C2 Agility Conceptual Model (C2ACM) suggested a number of testable hypotheses. SAS-085 considered twelve hypotheses that involved the relationship between 1) the actual location[5] of an approach in the C2 Approach Space and its C2 Agility, and 2) C2 Agility and C2 Maneuver. SAS-085 sought to empirically test the clarity and meaningfulness of the C2ACM's basic concepts as well as the validity of these twelve hypotheses using both retrospective case studies and simulation-based experiments.

SAS-085 FINDINGS AND CONCLUSIONS

Based on its retrospective case studies and simulation-based experiments, SAS-085 concluded that:

- C2 Agility is both desirable and feasible

  It is desirable to increase C2 Agility because doing so improves the likelihood of mission success. Increased C2 Agility contributes to mission success by enabling entities to adopt more appropriate approaches to C2 in more situations and to adjust their approaches as the mission and circumstances change. Conversely, a lack of C2 Agility can contribute to a lack of mission success. Improving C2 Agility is feasible because 1) the concepts have proven to be readily understandable, observable and measurable, and 2) key C2 Approach dimensions and other variables that impact C2 Agility can be influenced or controlled by entities.

- C2 Agility Theory has matured to the point where it merits serious consideration by the operational community.

  C2 Agility concepts and practices are ready to be incorporated into education, doctrine, exercises, and, as commanders and staffs learn how to apply these concepts, to be employed. While these concepts

[4] Later in this report we refer to monitoring the state of 'self' and how one is actually operating as *"Self-Monitoring."*

[5] The actual location is determined by observations / calculations of the values of the metrics employed for each of the three dimensions of the C2 Approach Space as opposed to a desired (intended) location

can be applied now, there is much more to understand about alternative approaches to C2, Collective C2, matching missions and circumstances to C2 Approaches, and the benefits and risks associated with both improving C2 Agility and not improving C2 Agility.

- There is no "one-size-fits-all" approach to C2

  Given the variety of missions, circumstances, and the collections of entities needed to meet these varied challenges, there is no single approach to C2 that is appropriate for all of these situations. Therefore, NATO, member Nations, and partners will need to be able to employ more than one approach to C2, understand when different C2 Approaches are appropriate, and have the ability to efficiently transition between and among C2 Approaches in a timely manner.

Taken together these findings and conclusions indicate that the desire expressed by military leaders to improve the Agility of their forces is both well-founded and actionable. SAS-085 members therefore conclude that, given the nature of 21st century mission challenges, C2 Agility is a critical capability that should be pursued with some urgency by NATO and its member Nations.

WAY AHEAD

Having concluded that improving C2 Agility is both desirable and practical, the members of SAS-085 recommend that NATO, member Nations, and partners take the following steps to improve their C2 Agility.

In the short run,

- increase awareness of the need for C2 Agility and the feasibility of improving it
- incorporate C2 Agility concepts into military education and training
- assess the levels of potential C2 Agility in military organizations and their partners
- observe and document C2 Agility when manifested in operations
- organize a community of interest focused on making improvements in C2 Agility

In the mid-term,

- identify specific ways that C2 Agility can be improved
- develop and deploy tools to help organizations improve their C2 Agility
- capture and disseminate lessons learned

As a result of these efforts, it is expected that the longer term will bring substantially greater understanding through an iterative process that involves lessons learned from operations, research, and analysis.

As an integral part of the way ahead, SAS-085 envisions extending the Campaign of Experimentation to address critical path issues, with the following priorities:

- develop *concrete* and practical instantiations of Endeavor Spaces for representative scenarios; test the ability to teach and apply the concepts in specific cases
- develop the characterization of heterogeneous C2 approaches so that related issues can be addressed comprehensibly from the start and effectively reflected in education and training
- improve the definition of agility-related metrics (at different levels of detail) and visualizations, with an eye toward making measurement increasingly down to earth, but solidly rooted
- enrich the mechanisms for analytic experimentation so that they can deal with more stressful aspects of C2 Agility, such as heterogeneity within the Collective and more substantial network problems.