



STO TECHNICAL REPORT

TR-HFM-ET-184

# C2 Capability Lifecycle Management

(Gestion du cycle de vie d'une capacité de C2)

This report documents the findings of Exploratory Team HFM-184 (2019 – 2020), which explored the challenging area of improving the governance of C2 capability.



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## **Authors**

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

These Panels and Group are the power-house of the collaborative model and are made up of national representatives as well as recognised world-class scientists, engineers and information specialists. In addition to providing critical technical oversight, they also provide a communication link to military users and other NATO bodies.

The scientific and technological work is carried out by Technical Teams, created under one or more of these eight bodies, for specific research activities which have a defined duration. These research activities can take a variety of forms, including Task Groups, Workshops, Symposia, Specialists' Meetings, Lecture Series and Technical Courses.

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# C2 Capability Lifecycle Management

## (STO-TR-HFM-ET-184)

### Executive Summary

#### Aims and Objectives

The aim of this document is to summarise the research undertaken by NATO STO HFM Exploratory Team (ET) 184, which was focused on the significant challenges observed across many NATO nations of improving defence Command and Control (C2) capability. It attempted to achieve this by taking a novel approach i.e., taking more of a whole of system, holistic and lifecycle perspective on the observed problems.

The objectives that were set for the ET were as follows:

- 1) Examine the underlying problem space and determine, within a potential future Research Task Group (RTG), which of a number of thematic areas could be usefully explored in an allied military C2 capability context to the benefit of NATO nations.
- 2) Explore the potential for developing military stakeholder guidance for a more holistic design approach and governance process for C2 capability development, and as part of this, consider whether it is possible to create a “NATO Code of Best Practice for C2 Capability Lifecycle Management”.

The secondary aims were to:

- 1) Explore the nature of the defence and research challenges.
- 2) Determine if they may be amenable to future research investigation.
- 3) Determine if there would be value and interest across NATO nations in addressing the identified challenges through further research.
- 4) If 3) proves positive, to propose how these challenges may be addressed via the formation of a new NATO RTG.

#### Key Findings/Conclusions

The research resulted in the identification of five major challenge themes, i.e.:

**Theme 1: Limited Ability to Evaluate C2 Capability.** To judge objectively the effects of change programs that have been initiated, and the level of C2 capability attained, calls for both appropriate knowledge and an ability to evaluate complex socio-technical systems like C2. However, this is arguably not the case for most militaries, and hence we remain very poor at evaluating the state of our C2 capability. This includes both the assessment of intended change and the actual outcomes, as well as evaluating the impacts of short and longer-term change.

**Theme 2: Limited Ability to Manage C2 Capability.** C2 is particularly challenging to govern and manage, as it is comprised of many diverse components that interact in complex ways to provide the overall holistic capability that we observe. However, this challenge provides little excuse for why the majority of defence organisations appear to be lacking effective C2 governance arrangements. Part of the reason may be that, until recently, C2 has not been considered or treated as a capability to be governed, unlike most other parts of the military enterprise.

**Theme 3: The Challenge of C2 Development.** Compared to development in many other domains, C2 development requires a relatively higher degree of alignment between human and technological components. In addition, the human fabric is complex, comprising of a plethora of rich interpersonal interactions between multiple decision makers, each of which may have competing interests and/or different views and beliefs on operations being conducted and C2 practice being employed. Taken together, the demands of aligning both organisational and technological development, the typicality of ambiguous and unclear objectives described using vague terminology, having to cope with stakeholders competing interests, having different views and beliefs on operations and C2 practice, and the fact that C2 enablers also need to serve other purposes, all pose huge challenges for the development and management of C2 capability.

**Theme 4: Resistance to Change.** Any intention to change and develop C2 must expect, and take into consideration, the likely resistance to the change. This resistance stems partly from individuals within an organisation perceiving the change as something that will affect them negatively. Resistance is also institutionalised – built into the system – by the means of traditions, training and education systems, accepted norms, etc. While personnel rotation is a way to inject new ideas into an organisation, and thus facilitate change, change is also highly dependent on the individuals driving the change, which is why changes may be short-lived in organisations experiencing high role rotation rates.

**Theme 5: Lack of Organisational Learning.** Observations of current C2 practice suggests that organisational learning is not being achieved. There is much that could be done to change development practices in the context of C2 to improve individual learning; e.g., through action learning and reflective practice. Informal knowledge sharing is also important and can, via social networks and systems, have a crucial role in obviating some of the organisation’s knowledge production and retention deficiencies. However, these do not necessarily lead to learning throughout the organisation. The lack of ability to enact organisational learning in C2 organisations is reflected in the fact that similar problems and errors are repeatedly seen.

It is beyond the scope of this work to devise solutions to all the challenges outlined above. Still, our review of the literature and documented experiences have yielded a number of recommendations and lessons learned. Consequently, we have put together an indicative list of mitigating solutions. However, the scope set for the ET at its outset was not to develop mitigating solutions, rather it was to determine that appropriate, relevant and feasible solutions may exist that could be further developed by a subsequent RTG.

The following is a summary of the primary conclusions from the research:

- 1) Whilst C2 concepts have changed quite considerably in response to significant developments in the security environment, C2 practice has remained very similar to that observed more than twenty years ago, especially compared to developments in other areas of warfare. C2 appears to remain stubbornly static despite our best efforts to transform it. Evidence for this claim comes in the form of many previous attempts at C2 transformation, the vast majority of which have fallen well short of delivering their promised outcomes.
- 2) There are a multitude of reasons why C2 transformation initiatives have failed and this report discusses a number of these with corresponding tentative solutions. However, a more fundamental solution also appears to be needed, specifically that defence organisations need to adopt something akin to a “lifecycle perspective” that attempts to understand, decide about, shape and cohere the multiple factors and components that contribute to C2 capability. The focus of such a perspective cannot be wholly on the development process, as there is also a need to embrace the feedback aspect of lifecycles, which in this context includes topics such as organisational learning and the adaptive management of current and emerging C2 capabilities.
- 3) A further striking observation of this research was the significant similarity of the issues and challenges faced by the individual nations taking part. This suggests that there are fundamental

forces at work that transcend national differences. We therefore propose that a NATO and partner nation-wide response to these challenges may be beneficial in helping to guide, stimulate, and drive national and coalition responses.

- 4) Any change in the way we approach transformation, however, will itself be a long-term process requiring both adaptability and long-term commitment by defence organisations. It is also essential to create a shared vision across the organisation and articulate a strategy for achieving the vision whilst also gaining buy-in from all relevant parts of the organisation. Without a sufficient degree of long-term commitment to change, then any significant transformation of C2 capability is unlikely to be realised. Ideally, what needs to happen in practice is that national and allied change programs are created, based on the principle of C2 being a capability that needs to be effectively governed. However, these programs need to be well advised.
- 5) Research conducted by ET-184 suggests that there is a considerably body of literature containing helpful and evidence-based advice on organisational change that would help in responding to many of the challenges identified. This initial exploration also suggests that the identified material could be sufficiently contextualised to make it relevant to military C2 organisations. It is therefore proposed that future C2 capability development programs could be considerably aided by the creation of a good practice guide for C2 capability transformation, which brings together, integrates and suitably contextualises the material. The focus of this guide should be on the practical ‘how to’ for improving the change/transformation, so that future C2 change activities will yield greater and longer-lasting beneficial effects. Note that this is not intended to imply that C2 should be transformed to a new fixed form, but rather that we need to change to a more sustainable adaptable form that is able to respond more quickly and ably to changing circumstances.
- 6) Essentially the primary challenges with C2 and C2 development are those concerned with human individuals and organisations. Thus, to a large extent, any future NATO STO research into this problem should ideally reside within a human-factors centred panel, i.e., HFM. However, as certain aspects of the problem set are also ‘systems’ related, aspects of future research could similarly also be relevant to the SAS Panel.

A shorter version of this report has already been published in a peer reviewed symposium, ICCRTS 2020 [1].

### **Recommendation**

We recommend beginning a new NATO RTG on C2 Capability Governance starting in either late 2020 or early 2021. As the results of the RTG can only be evaluated and exploited by our defence stakeholders it is also recommended that the RTG should strive for closer coupling with relevant stakeholder groups in some of the participating nations, and ideally within NATO too.

# Gestion du cycle de vie d'une capacité de C2

## (STO-TR-HFM-ET-184)

### Synthèse

#### Objectifs

Le but du présent document est de résumer les recherches entreprises par l'équipe exploratoire (ET) 184 de la Commission HFM de la STO de l'OTAN, qui se concentraient sur les difficultés considérables observées dans bien des pays de l'OTAN pour améliorer la capacité de commandement et contrôle (C2) de la défense. Ce document tente d'y parvenir en adoptant une démarche innovante, à savoir un point de vue holistique, qui envisage l'ensemble du système et tout le cycle de vie.

Les objectifs établis pour l'ET étaient les suivants :

- 1) Examiner tous les aspects du problème sous-jacent et déterminer, au sein d'un potentiel RTG futur, les thématiques pouvant être utiles dans le contexte d'une capacité de C2 militaire alliée au bénéfice des pays de l'OTAN ;
- 2) Explorer la possibilité d'élaborer des conseils aux acteurs militaires pour orienter la conception et la gouvernance du développement de la capacité de C2 vers une démarche plus holistique et, dans ce cadre, étudier s'il est possible de créer un « Code des meilleures pratiques OTAN pour la gestion du cycle de vie de la capacité de C2 ».

Les objectifs secondaires étaient de :

- 1) Explorer la nature des difficultés rencontrées dans la défense et la recherche ;
- 2) Déterminer si elles pouvaient faire l'objet de recherches futures ;
- 3) Déterminer si les pays de l'OTAN avaient intérêt à résoudre les difficultés identifiées en menant d'autres recherches ;
- 4) Si la réponse au point (3) était positive, proposer une solution pour résoudre ces difficultés par la formation d'un nouveau RTG de l'OTAN.

#### Conclusions essentielles

Les recherches ont abouti à l'identification de cinq grands thèmes articulant les difficultés, à savoir :

**Thème 1 : aptitude limitée à évaluer la capacité de C2.** Pour juger efficacement des effets des programmes de changement qui ont été lancés et du niveau atteint par la capacité de C2, il est nécessaire de posséder à la fois des connaissances appropriées et une aptitude à évaluer les systèmes socio-techniques complexes comme le C2. Cependant, on peut dire que tel n'est pas le cas de la plupart des militaires ; nous savons donc très mal évaluer l'état de notre capacité de C2. Cela recouvre à la fois l'évaluation du changement prévu et les résultats réels, ainsi que l'évaluation de l'impact du changement à court et long terme.

**Thème 2 : aptitude limitée à gérer la capacité de C2.** Le C2 est particulièrement difficile à gouverner et à gérer, car il comporte beaucoup d'éléments divers, qui interagissent de manière complexe pour produire la capacité globale que nous observons. Cette difficulté constitue néanmoins une bien piètre excuse pour le manque de dispositions efficaces de gouvernance du C2 dans la majorité des

organisations de défense. Cela s'explique peut-être partiellement par le fait que jusqu'à récemment, le C2 n'était ni considéré ni traité comme une capacité à gouverner, à la différence d'autres composantes de l'entreprise militaire.

**Thème 3 : défi du développement du C2.** Par comparaison avec beaucoup d'autres domaines, le développement du C2 nécessite une adéquation relativement plus élevée entre les éléments humains et les éléments technologiques. De plus, le tissu humain est complexe, composé d'une pléthore d'interactions sociales entre de multiples décideurs, chacun ayant des intérêts concurrents et/ou différents points de vue et convictions sur les opérations menées et sur la pratique de C2 appliquée. Dans l'ensemble, le développement et la gestion de la capacité de C2 se heurtent à d'énormes difficultés dues à la nécessité de faire coïncider l'évolution organisationnelle et technologique, la typicité des objectifs ambigus et flous décrits selon une terminologie vague, la coexistence d'intérêts concurrents parmi les acteurs, les différences d'opinions et de convictions sur les opérations et la pratique du C2 et le fait que les outils de C2 ont également d'autres finalités.

**Thème 4 : résistance au changement.** Toute intention de modifier et développer le C2 doit s'attendre à rencontrer, et prendre en compte, une probable résistance au changement. Cette résistance émane en partie d'individus au sein d'une organisation qui perçoivent le changement comme une source de désagréments. La résistance est également institutionnalisée – intégrée au système – du fait des traditions, des systèmes de formation théorique et pratique, des normes admises, etc. Bien que la rotation du personnel soit un moyen d'introduire de nouvelles idées dans une organisation, et facilite par conséquent le changement, ce changement dépend aussi fortement des individus qui le mènent, raison pour laquelle beaucoup de changements sont voués à une mort rapide dans les organisations dont le taux de rotation des rôles est élevé.

**Thème 5 : manque d'apprentissage dans l'organisation.** L'observation de la pratique actuelle du C2 suggère l'absence d'apprentissage au sein des organisations. Beaucoup pourrait être fait pour changer les pratiques de développement des compétences dans le contexte du C2 et améliorer l'apprentissage individuel, par exemple, avec l'apprentissage par l'action et la pratique réflexive. Le partage informel de connaissances est également important et peut, par le biais des réseaux sociaux et des systèmes, endosser un rôle capital pour éviter certaines défaillances de production et de conservation des connaissances d'une organisation. Toutefois, ces aspects n'entraînent pas nécessairement un apprentissage dans toute l'organisation. Le manque de capacité à mettre en place un apprentissage au sein des organisations de C2 transparaît dans le fait que des problèmes et erreurs similaires se répètent.

Les présents travaux n'ont pas pour objet de concevoir des solutions à tous les problèmes décrits ci-dessus. Cependant, notre revue de la littérature et des expériences documentées a produit un certain nombre de recommandations et fait émerger des enseignements. Nous avons par conséquent constitué une liste indicative de solutions d'atténuation. Néanmoins, l'objet de l'ET au départ n'était pas d'établir des solutions d'atténuation, uniquement de déterminer s'il existait des solutions adéquates, pertinentes et réalisables pouvant être développées par un RTG ultérieur.

Ce qui suit est un résumé des conclusions principales des recherches :

- 1) Même si les concepts de C2 ont changé assez considérablement en réaction à l'évolution sensible de l'environnement de sûreté, la pratique du C2 est restée très semblable à celle observée il y a plus de vingt ans, en particulier par rapport à l'évolution d'autres domaines de la guerre. Le C2 semble résolument statique, en dépit de nos efforts pour le transformer. Cette affirmation s'appuie sur de nombreuses tentatives antérieures de transformation du C2, dont l'immense majorité n'a pas donné les fruits promis.
- 2) L'échec des initiatives de transformation du C2 découle d'une multitude de raisons. Le présent rapport en aborde plusieurs, en fournissant des solutions indicatives correspondantes. Toutefois, une solution plus fondamentale semble également nécessaire. Il apparaît en particulier que

les organisations de défense doivent adopter quelque chose se rapprochant d'une « perspective du cycle de vie » qui essaie de comprendre, déterminer, façonner et mettre en cohérence les multiples facteurs et composants qui contribuent à la capacité de C2. Une telle perspective ne peut se concentrer entièrement sur le processus de développement, puisqu'il faut également prendre en compte l'aspect de retour d'information des cycles de vie, ce qui inclut dans ce contexte des sujets tels que l'apprentissage au sein des organisations et la gestion évolutive des capacités actuelles et émergentes du C2.

- 3) Ces recherches ont donné lieu à une autre observation frappante : la grande similitude des problèmes et des défis rencontrés par les différents pays participants. Cette similitude suggère qu'il existe des forces fondamentales transcendant les différences nationales. Nous suggérons donc qu'une réponse à l'échelle de l'OTAN et des pays partenaires pourrait contribuer à guider, stimuler et conduire les réponses nationales et de coalition.
- 4) Tout changement d'approche de la transformation sera cependant en soi un processus à longue échéance, nécessitant à la fois une capacité d'adaptation et un engagement à long terme des organisations de défense. Il est également essentiel de créer une vision partagée au sein de l'organisation et d'organiser une stratégie pour atteindre cette vision tout en emportant l'adhésion de toutes les parties concernées dans l'organisation. Sans un niveau suffisant d'engagement à long terme envers le changement, aucune transformation de la capacité de C2 n'est susceptible de se produire. Dans l'idéal, il faudrait créer des programmes de changement nationaux et alliés, en partant du principe que le C2 est une capacité qui a besoin d'être efficacement gouvernée. Toutefois, ces programmes doivent être bien informés.
- 5) Les recherches menées par l'ET-184 suggèrent qu'il existe un corpus considérable de littérature contenant des conseils utiles, basés sur des éléments probants, en matière de changement organisationnel, qui aideraient à aplanir beaucoup des obstacles identifiés. Cette exploration initiale suggère également que les éléments identifiés pourraient être suffisamment contextualisés pour les organisations de C2 militaire. D'après nous, les futurs programmes de développement de la capacité de C2 pourraient être grandement facilités par la création d'un guide des bonnes pratiques de transformation de la capacité de C2, qui réunirait, intégrerait et contextualiserait convenablement les éléments. Ce guide devrait mettre l'accent sur les solutions pratiques améliorant le changement/la transformation, afin que les futures activités de changement du C2 aient des effets bénéfiques plus importants et plus durables. Notez que cela n'est pas censé impliquer que le C2 devrait prendre une nouvelle forme fixe, mais plutôt que nous devons adopter une forme plus durable et évolutive, capable de répondre plus rapidement et habilement à l'évolution des circonstances.
- 6) Les principales difficultés du C2 et du développement de celui-ci sont essentiellement liées aux personnes et aux organisations. Ainsi, dans une large mesure, toute recherche de la STO de l'OTAN sur ce problème devrait idéalement se dérouler au sein d'une commission centrée sur les facteurs humains, autrement dit, la Commission HFM. Cependant, certains aspects du problème posé ayant également un lien avec les « systèmes », ils pourraient également intéresser la Commission SAS.

Une version abrégée du présent rapport a déjà été publiée lors d'un colloque à comité de lecture, ICCRTS 2020 [1].

### **Recommandation**

Nous recommandons de lancer un nouveau RTG de l'OTAN sur la gouvernance de la capacité de C2, dès la fin de l'année 2020 ou le début de l'année 2021. Étant donné que les résultats du RTG ne peuvent être évalués et exploités que par nos acteurs de la défense, il est également recommandé que le RTG s'associe étroitement avec des groupes de parties prenantes dans quelques-uns des pays participants, ainsi qu'au sein de l'OTAN, dans l'idéal.



## C2 CAPABILITY LIFECYCLE MANAGEMENT

### 1.0 INTRODUCTION

This section gives a short overview of Command and Control (C2) capability and how it has evolved over the last 30 years.

#### 1.1 Background to the NATO Exploratory Team on Capability Lifecycle Management

Prior to the formation of the ET, potential members across all three contributing nations had made a number of observations resulting from their involvement in many national and international programs charged with developing C2 capability in the period of the 1990s to early 2000s. What was commonly observed was that many of these programs and initiatives had simply disappeared, leaving little visible trace remaining. It was also noted that present day difficulties were very similar to those from about twenty years ago and that, in comparison with other areas in defence, C2 practice had remained largely unchanged in that same period.

Therefore, based on these observations, it was judged that it would be worth exploring the following broad questions:

- a) What are the primary reasons for the observed problems?
- b) Is there any existing science and corresponding literature that can help explain them?
- c) Are there any indications that potential mitigating solutions exist that could be exploited?
- d) Was further research warranted and likely to be beneficial and if so, what should it focus on?

Please note that, in relation to c) above, the original intent was not to develop mitigating solutions, just determine that appropriate, relevant, and feasible solutions may exist that could be further developed by a subsequent RTG.

#### 1.2 What Is C2 Capability?

In its broadest sense, capability is the power or ability to do something [2]. Lindbom, Tehler, Eriksson, and Aven [3] identified trends based on 15 capability definitions found in publications related to crisis management, where capability may be viewed as:

- 1) Equivalent to, or at least strongly influenced by *resources*;
- 2) Equivalent to *capacity* (e.g., the ability to prepare, or the ability to carry out training); or
- 3) Capability as a *factor affecting an outcome or goal*.

It is hard to find a NATO definition that is contained in an obviously relevant NATO document. For example, the following definition was contained in a NATO standardization office publication: “the ability to create an effect through employment of an integrated set of aspects categorized as doctrine, organisation, training, materiel, leadership development, personnel, facilities, and interoperability”, referred to by the abbreviation DOTMLPFI [4]. Thus, this capability definition is mainly in line with the third type of capability definition suggested by Lindbom et al. [3], where resources and the capacities of these resources enable a certain capability.

In this context, C2 is defined as the “set of organizational and technical attributes and processes by which an enterprise marshals and employs human, physical, and information resources to solve problems and accomplish missions” [5].

Thus, C2 capability is in this report defined as “*the ability to marshal and employ human, physical, and information resources to solve problems and accomplish missions. C2 capability is accomplished through a set of organizational and technical attributes and processes.*”

### 1.3 Development of C2 Over the Last 30 Years

Recent changes in national military doctrine and concepts have been made in an attempt to revise or adjust C2 approaches to better fit the evolving defence environment. One defining moment for C2 in recent years was the so-called “revolution in military affairs” of the 90s, which anticipated many beneficial implications of new information technologies for C2. This sparked a range of development and investments in new C2 practices among NATO and other nations, including such efforts as Network Enabled Capability (NEC, UK), Network-Based Defence (NBF, Sweden), Joint-Capable Command (JCC, Canada), Network-Centric Warfare (NCW, US) and NATO Network-Enabled Capability (NNEC, NATO). These efforts envisioned a fully connected battlespace with operators of different services able to interact in a seamless fashion to achieve the concept of dominant battlefield awareness, with the ability to use the assumed information superiority gained to rapidly task forces and weapons systems.

The authors of this report have been involved in these national and international programs and endeavours in developing C2 capability from the 1990s to early 2000s. This was in our roles as defence researchers and, for some of us, also occasionally in military service in staff officer positions. Surveying the time between these earlier days and today we have observed that many of these bold programs and initiatives, with their arrays of elegant terms and acronyms, have simply disappeared into obscurity. It is relatively easy to find references from the early phases of these programs, but much more difficult to find publications from the later stages. Consequently, it is hard to assess whether these programs did or did not meet initial expectations. One example is the Advanced Concept Technology Demonstration (ACTD) initiated around year 2000 “Commander-in-Chief for the 21st Century – CINC 21” [6]. CINC 21 consisted of a framework, a set of software applications and hardware applications aiming to improve command and control of forces by exploiting advanced visualization techniques and decision support systems, collaboration capabilities, and knowledge and enterprise management. The original CINC 21 was a US initiative, expanding to the four-nation-initiative Coalition CINC 21 (C-CINC 21), which included the United States, Australia, Canada, and United Kingdom [7]. A Google Scholar search for CINC 21 (Commander-in Chief 21, C-CINC, etc.) reveals a very limited number of hits between 2001 – 2006 [6], [7], [8]. The documentation that can be found describes the CINC/C-CINC 21 initiatives and visions, and the success of the technology demonstration in terms of integrating heterogeneous technologies and enabling information sharing. However, no information can be found of a succeeding project, nor any implementation of the results obtained in the technology demonstrations.

The authors also note the existence of observed similarities of operational difficulties with C2, and those within supporting research. Both sets of difficulties seem to be uncannily similar to those from twenty years ago; although they may be described using different words; for example, twenty years ago, network-centric approaches were dominating. It is easy to claim that we have learned from our previous mistakes, moved away from unachievable visions, and are now focused on developing concepts that will actually work. However, looking at the visions and formulations of yesterday, we find remarkably similar ones embedded in future concepts written today. For example, one of the US military operational goals, written more than twenty years ago (2001), stated



“leveraging information technology and innovative concepts to develop an interoperable, joint C4ISR architecture and capability that includes a tailorable joint operational picture” [9]. Seven years ago, information superiority was a hot topic [10], and more recently a very similar concept appeared as Information Advantage [11]. We experience frequent déjà vu!

Reflecting on the above points in relation to the national initiatives mentioned from the early 2000s, we judge that many of the C2 development projects contained within these did not fully realize the visions put forward at their inception. Although some changes have been implemented, many things have remained relatively constant, and outcomes have perhaps been less than ‘revolutionary’. Compared to developments in other areas of warfare, such as weapons technology, C2 practice, including current training and education, forms of organisation, and employment of enabling technology, has remained largely unchanged from twenty years ago [12] (pp. 14-15). Annex A provides some examples of the identified issues with C2 capability development taken from Canada, Sweden, and the UK.

There has not been a lack of efforts to address the challenge of transforming C2 with many systematic approaches, such as, e.g., The Army Command and Control Evaluation System – ACCES [13] and US Navy Headquarters Effectiveness Analysis Tool, HEAT [14]. In addition, different Codes of Best Practice such as GUIDEx [15], NATO Code of Best Practice of C2 Assessment [16], Experimentation [16], Campaigns of Experimentation, [17] and reviews lay down the basic principles of assessments conducted by teams of qualified scientists and their staff. Existing approaches and codes provide adequate guidance and sources of information, but at the same time they often demand or assume a high level of scientific control, which is difficult to obtain in military practice. Still, driven by operational needs and perceived problems of effectiveness, operational practice constantly performs exploration of and experimentation with, amongst others, new technologies, support systems, new ways of working, new organisational structures for current or changed conditions. Doing this light-heartedly might lead to missed opportunities or just false conclusions and hindsight costs [18].

#### **1.4 National Perspectives on Future C2 Development**

To a large degree, our current approach to C2 is still designed around the concepts for, and needs of, industrial style warfare. Whilst some of these in-built features are likely still required, the diversity and complexity of recent, current, and future situations arguably requires a substantial change in the way that C2 is designed, operated, and enabled. However, this need for change has not suddenly emerged; it has been with us for at least the last few decades.

Despite the difficulties of transformation discussed above, C2 remains an important capability for NATO to continue developing and sustaining. Emerging technologies have already changed our world in a way that challenge traditional military approaches thus calling for more innovative approaches to C2. Given that it is our primary means of responding to emerging conflict and crisis, C2 must be able to react effectively to the rapidly changing context in which future allied operations will be conducted. With emergent adversaries already using powerful, cheap and freely available technology with greater ease, flexibility and imagination than any conventional state, future C2 systems must be agile, potentially partly autonomous, and able to adapt to the context in which they are operated [19], [20].

The need for C2 transformation is illustrated by the examples of defence policy set by Canada, Sweden, and the UK. Canada’s latest statement of defence policy [21] anticipates an increasingly complex security environment and proposes an agile and adaptive approach to C2. Canada has pledged greater resources to the Canadian Armed Forces (CAF) to invest in new C2 systems with integrated information and communications technologies. In Sweden, the aim is to strengthen the defence capability in the forthcoming period. Besides restructuring and

reinforcing the Armed Forces organisation, it also includes the reestablishment of the total defence concept originally established during the Cold War but in recent decades largely decommissioned. The total defence concept encompasses both military and civilian defence in a whole-of-society approach to security. For C2, this requires the development of common concepts for collaboration and joint planning between the different military and civilian components. The UK has also determined that a more agile approach to C2 is needed to respond to the more varied, novel, complex and ambiguous threats of the future [22]. In light of this need, JCN 2/17 on the Future of Command and Control argues for a change in culture to create greater agility and coherence of C2, both within the military and across government. This calls for the adoption of new ways of thinking and organising C2, assisted by appropriate new technology. In summary, all three contributing nations, and likewise many others too, agree that continued development of C2 is an urgent necessity to respond to the ever-shifting external environment.

**Canada.** Canada's latest statement of defence policy, Strong, Secure, Engaged [21], is predicated on expectations of an increasingly complex security environment in the future, featuring asymmetric threats, failed, and failing states, and non-traditional adversaries. In response, the policy sets the objective that Canada's military will employ a modern approach to C2, an approach that is agile and adaptive. The new defence policy reaffirms the CAF's goal of developing C2 systems that enable joint functioning as well as the integration of intelligence and information-gathering capabilities. Canada has pledged greater resources to the CAF to invest in new C2 systems with integrated information technology and communications.

**Sweden.** For the near future, the Swedish Defence Commission states that a comprehensive review of command and control should be carried out, setting realistic priorities regarding technology, methodology, manning, education, organisation, and financing [23]<sup>1</sup>. Further, Sweden needs to take proper precautions in the information and cyber security fields and develop the capability to act defensively and offensively against qualified opponents in the cyber environment across the entire range of computer and network operations. For national defence, the total defence concept was reestablished and common concepts for collaboration and joint planning between the different military and civilian components have been developed. The desired end-state for the Swedish Armed Forces' (SwAF) central and regional C2 functions for 2025 is that the Armed Forces should strive for simplicity, clarity and flexibility in methods and organisation, enabling mission command and a responsibility-based culture [24]. There are several initiatives aimed at enhancing the ability to operate in collaboration with other nations and coalitions, explaining why joint operational planning with Finland is now conducted. Improved alignment is to be pursued with Norway, Denmark, the UK, the US, and NATO. A new joint operational doctrine has recently been released, which is aligned with NATO in introducing cyber as a domain along with Air, Land and Sea, and stressing the multi-domain perspective [25].

In support of the SwAF long-term-planning a future C2 concept has been developed [26], [27]. The concept is characterized by agility and resilience and includes methods and staff capabilities as well as organisational and mandate issues. It includes the ability to learn and adjust to new circumstances both in the short and longer-term perspectives. The future C2 concept notes that C2 needs will vary depending on the situation, and that there is no one C2 solution that will work in all situations. The ability to share information and align plans between all involved actors is imperative. The concept assumes that the SwAF has the ability to take advantage of innovations in technology. Finally, fallback solutions need to be in place, and practiced, to maintain C2 capability in the increasingly contested information environment.

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<sup>1</sup> The Defence Commission is a forum for consultation between the Government and representatives of the political parties in Riksdag. The objective is to achieve the broadest possible unity with respect to how Sweden's defence and security policy is to be designed. The Government forms its proposals for Riksdag based on reports from the Defence Commission.

**United Kingdom.** The UK's publication on the Future Operating Environment 2035 noted that threats in the future will be much more varied, novel, complex and ambiguous. To respond to this it suggests that a more agile and radical approach may be required to suitably enable future commanders. Based on that context, the DCDC Joint Concept Note (JCN) 1/17 on Future Force Concepts asks how it might be possible to enable this more agile command and control, with the intent to develop and sustain advantage in the face of increasing operational complexity. As part of the answer to that question, JCN 2/17 on the Future of Command and Control argues for a change in military culture to create greater agility and coherence of C2, both within the military and across government. It also suggests that this will require the adoption of new ways of thinking and organising C2, assisted by appropriate new technology. Finally, it identifies a primary development challenge, i.e., for C2 to be addressed effectively, it needs to be considered as a capability in its own right, implying both improved governance across all appropriate lines of development and a much better understanding of the C2 risks that Defence may be carrying.

## **1.5 Purpose and Scope of the Report**

Given the context set out above, the purpose of this report is to explore, in some detail, the nature of the challenges of managing, developing, and transforming C2 capabilities. It also aims to identify some of the reasons for the observed lack of progress in changing C2 practice compared to other areas in defence. Initially, we provide an overview of challenges related to C2 capability development that have been identified via a literature survey. Subsequently, a number of tentative solutions are identified, followed by a discussion where we argue that nations need to adopt a 'life cycle perspective' to successfully modify all the factors that contribute to a C2 capability. In Annex A, some examples of C2 programs that did not meet expectations are presented.

## **2.0 CHALLENGES TO THE DEVELOPMENT OF C2 CAPABILITY**

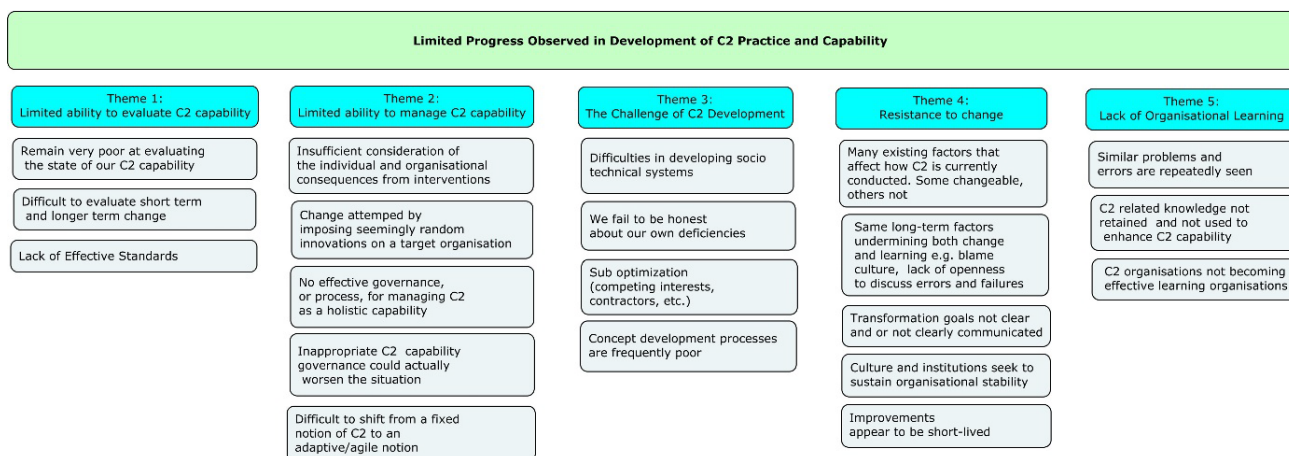
### **2.1 Methodological Approach**

In the previous section, we put forward the argument of there being a limited degree of change observed in C2 practice. This is despite the many accepted drivers for substantial change to C2, and the numerous initiatives undertaken. In principle therefore, there should have been a corresponding and sizeable degree of readily observable success, especially given the significant financial investments made and the existence of strong support from the highest levels of national defence organisations.

Given that we did not appear to have a clear understanding of the range of possible causes for a lack of effective change in C2, we took a systematic and systems-orientated approach to identify and investigate them. This started with an initial brainstorming session to understand why causes may persist. This session identified 20 potential 'challenges' for successful C2 transformation, and these were subsequently clustered into five broad themes. Each theme encompasses multiple specific challenges that may be faced by military organisations in trying to change their C2 capability. The themes identified are as follows:

- 1) Challenges related to evaluation of C2 capabilities.
- 2) Challenges related to managing C2 capabilities.
- 3) Challenges related to C2 development.
- 4) Challenges related to resistance to change.
- 5) Challenges related to organisational learning.

Figure 1 below gives a visual summary of how the different challenges were clustered into the five themes.



**Figure 1: C2 Challenge Themes and Related Challenges.**

The derivation of these five themes and challenges provided a focus for the subsequent literature review, which examined each of these in greater detail. It should be noted that the identification exercise we conducted was necessarily constrained due to both time and the degree of initial understanding that was available. Largely, what has been captured is bounded by the authors' collective military-centred experience, supplemented by the particular range of literature that has been studied. Given these constraints, it is likely that subsequent work will add to the identified set of challenges, and perhaps suggest new challenge themes.

The remainder of this section comprises of a review of each challenge theme together with its associated individual challenges.

## 2.2 Theme 1: Limited Ability to Evaluate C2 Capability

To judge objectively the effects of change programs that have been initiated, and the level of C2 capability attained, calls for both appropriate knowledge and an ability to evaluate complex socio-technical systems like C2. However, this is arguably not the case for most militaries, and hence we remain very poor at evaluating the state of our C2 capability. This includes both the assessment of intended change and the actual outcomes, as well as addressing short and longer-term change. In addition, the actual outcomes from command practice, especially in crises and disasters, are very seldom analysed in research [28] (p. 29). In part, this reflects our present weaknesses in assessing short and long-term C2 performance. The traditional means used to assess C2, such as Measures Of Performance (MOPs) and Measures Of Effectiveness (MOEs), all have drawbacks. MOPs assess actual outcomes, which are ultimately most important, but are usually affected by many external factors, causing them to be unreliable (e.g., Ref. [29]). MOEs may provide increased validity of measures (e.g., Ref. [30]) but they do not necessarily capture the full range of systems that contribute to C2 performance [31], [32]. Added to this, the uncertain and dynamic nature of military operations makes it difficult to define performance standards and it remains problematic to link performance outcomes to specific causal factors. Consequently, whatever contribution C2 may make is generally masked by the contribution made by other component systems ([32], p. 154). When comparing C2 performance across conditions, the innate difficulty in replicating operational and tactical environments across assessments means researchers never truly achieve comparable evaluations.

Assessing long-term C2 change is often hampered by our inability to create comparable assessment conditions over time [33]. Alberts [34] suggests that an alternative assessment approach would be to assess the match between C2 structure and security environmental demands in a “problem space” that reflects some of the dimensions in which conflict occurs. Thus, the suitability of any given C2 structure will be a matter of its fit to the environment as defined by these characteristics. Alberts and Hayes’ three-dimensional problem space, however, probably fails to account for all the factors that can affect C2 performance, including those that are informal and human-oriented, so that additional investigation of dimensions outside the traditional technological and information domains is needed [35]. Within the NATO STO, more recent work related to the problem space include attempts to define the dimensions of an endeavour space, representing all possible circumstances and characteristics an endeavour may exhibit. However, this still does not account for the specific factors affecting performance raised by Eisenberg [35]. Nonetheless, being able to represent some of the situational complexity may aid investigations into which C2 approaches better fit specific endeavour types [36], [37]. To guide future C2 development, more specific guidance is needed.

With a lack of a consistent system of metrics and established thresholds for their measurement, it is a challenge to design evaluations of C2 performance and C2 capability. The challenge is compounded by limited access to war fighters and test controls, environmental distractors, assessment tools that are not suitable for the measurement context, different interpretations of the requirements and specifications being tested, impacts of usability in operational testing that are impossible to quantify, limited sample sizes, system usability issues that are difficult to disentangle from other operational test factors, processes that are largely cognitive in nature and can only be measured indirectly, and the difficulty in performing over-the-shoulder in operational settings thereby introducing large variability in operational assessments [38]. Consequently, it is difficult to identify how best to mitigate performance identified capability decrements and deficiencies.

To address the challenges of evaluating C2, a number of systematic approaches have been advanced. For example, The Army Command and Control Evaluation System – ACCES [13] the US Navy Headquarters Effectiveness Analysis Tool, and HEAT [14]. Likewise, different codes of best practice, such as GUIDEx [15], NATO Code of Best Practice of C2 Assessment [16], Experimentation [16], and Campaigns of Experimentation, [17] have laid down basic principles of C2 assessment. However, these guides frequently demand or assume an unobtainable level of scientific control. Also, bad experiments, which cloak weak or false knowledge in an aura of legitimacy can lead to missed opportunities or false conclusions and an inevitable sense of ‘buyer’s remorse’ [16] (pp. 139-140); [18] (pp. 7-8).

One reason C2 evaluation remains difficult is that practitioners are frequently blind to the full spectrum of systems that make up C2. A C2 structure is comprised of distinct but interconnected systems that act to govern the actions of a military force. Most efforts to transform C2 structures focus on the formal systems of doctrine/SOPs, current practice, technology, and organisational structure that are well documented (e.g., Ref. [39]). Other systems – informal and not well-understood – tend to be neglected, such as accountability, career progression considerations, organisational culture, broader cultural values, leadership, morals, and trust. It is, however, crucial that all of these systems, formal and informal, be properly “aligned” in terms of the pressures, incentives, and constraints they impose on the C2 structure. When one or more system is unaligned to the dominant C2 concept, it is unlikely that the C2 structure can achieve its intended goals.

Various modelling techniques already exist for this purpose. Work Domain Analysis (WDA) [40], for example, is a technique for representing complex systems in a hierarchical network. The top-most level of a WDA model describes the purpose of the system at the most abstract level, while lower levels describe functions and physical components. The model created by the WDA technique can be used as a guide to understand the system at which ever level of abstraction is required and guide design of decision support, procedures, and interfaces. The WDA



technique has already been applied to C2 in a model of shipboard C2 on the CAF Halifax class frigate [41]. Creating this model illustrated the necessity of incorporating multiple interacting systems to capture C2, in this case the systems corresponding to the own ship, the opponent, and the physical environment. To create a comprehensive C2 model capable of representing C2 structures in all domains, it will be necessary to incorporate additional human, social, political, and cultural domains but a technique such as WDA provides a proven method applicable to C2. Consequently, C2 practitioners need to develop an understanding of the range of socio-technological systems that make up C2 [42] (p. 3). Only when the constraints and affordances of these systems are known, can C2 transformation be tailored to fully address the goals and needs of the organisation. Of course, to be successful any modelling technique should be based on direct observation of the system, so it is the system as it actually functions, rather than as it is described in formal documents, that is captured.

### **2.3 Theme 2: Limited Ability to Manage C2 Capability**

C2 is particularly challenging to govern and manage, as it is comprised of many diverse components that interact in complex ways, as observed in the final part of the last section, to provide the overall holistic capability that we observe. However, this challenge provides little excuse for why the majority of defence organisations appear to be lacking effective C2 governance arrangements. Part of the reason maybe that, until recently, C2 has not been considered or treated as a capability to be governed, unlike most other parts of the military enterprise [43]. As an example of how views may be gradually changing on this topic, the UK Army has created a formal body to assist with Land C2 governance; one that draws upon, and seeks to coordinate, C2 development work across multiple branches of the single service.

At this point, it is worth focusing first on the notion of what a defence capability is. In 2003, UK MoD defined capability from a focus on equipment. In this context capability was defined as “the capacity afforded by an equipment to a unit or force element to perform a task in a given environment or operational context” [44], [45] (p. 30). Also from this era was the concept of needing through-life capability management. This was highlighted at the time by the then Director of Strategy for the MoD’s Defence Logistics Organisation (DLO), Commodore Bob Mark. Mark noted that the MoD “has encouraged industry to focus on selling a product, not on sustaining a capability through its life” [46]. This through-life approach was described as a “*whole-system outlook taking an integrated approach to delivering all of the components of military capability not just the equipment*” [47].

Definitions that are more contemporary are difficult to find but a recent UK National Audit report [48] (p. 5) on defence capability describes it as such:

*The Ministry of Defence (the Department) develops and operates military capabilities in order to meet its strategic requirements and objectives. A military capability is not simply a piece of equipment such as a tank. Rather, it is a tank with a trained crew that: can communicate with others on the battlefield; can meet identified threats; and can be properly maintained and repaired during its lifetime.*

This long-standing problem with equipment focus was described in a 2006 ICCRTS paper [49] as “*the problem of ‘platform myopia’*” that stemmed from the lack of a holistic view and not putting platforms into context when considering what constitutes a ‘military capability’.

Partly because of the capability management deficit, changes are frequently made to C2 without sufficient consideration of the likely individual and organisational consequences [50]. The end-result is that the intended benefits of the change often fail to be realized, or are not as extensive as was hoped. Benefits are often not realized due to a lack of understanding of many other factors that are operating in the organisational context and how these might interact with the change [51]. In trying to understand the nature of these interactions, it may be worth considering parallels with the field of software engineering. In particular, this includes the work of Professor

Manny Lehman who developed a number of laws of software evolution, which may similarly apply with respect to change within complex organisations [52]. Lehman's Law 8 may provide some insight into why making interventions in complex systems like C2 can be difficult; i.e., "Feedback System: E-type evolution processes constitute multi-level, multi-loop, multi-agent feedback systems and must be treated as such to achieve significant improvement over any reasonable base." [53].<sup>2</sup>

Instead, there is a tendency to either: a) Assume simple, predictable feed-forward type changes are possible; or b) At the other extreme, assume it is possible to fire semi-random innovative change at a target organisation and obtain a decent outcome through 'survival of the fittest' [54]. Similar discussions about successful routes to organisational change have taken place in the context of complexity science. For example, as noted by Stacey [55]:

*The 'intention vs. emergence' issue raised by the questions: are new organizational states the outcome of prior shared intentions of the agents operating within them? Or do such states emerge from complex interactions between agents in the absence of prior shared intention? In other words: is it possible to determine the long-term future outcomes of a changeable system?*

On the latter point from Stacey, it is worth noting that whilst some of the changes we make may have more immediate consequences, if instead we manipulate some of the longer-term and lagging factors, the desired change could take years or even decades to be realized.

In addition to all the existing challenges of managing and developing C2 capability, a new and pressing one has recently emerged. That is, as explained in the introduction, most nations agree on the need to transition C2 capability to one that is much more adaptive and agile than before. This means that organisations need to be able to apply different C2 approaches and identify appropriate C2 approaches to fit a given situation [37]. Therefore, the challenge for C2 development becomes one of building in what might be referred to as 'adaptive capacity' into our C2 organisations and systems. Grisogono and Radenovic [56] refer to a similar concept of needing to take an adaptive stance. This raises further sub-questions of: a) What sort of adaptive capacity is required? b) How would we design this capacity? and c) How might we create this capacity in our organisations and sustain it? These questions are doubly difficult to answer given the challenges of engendering any form of change in C2, as discussed widely in this report. The particular challenge for those responsible for C2 capability management is one of how, given that we struggle to move from one fixed form of C2 organisation to another, do we move to one which is more adaptive?

Seeking to achieve and exploit a more adaptive form of C2 is also linked to resilience, in that this second property can sometimes be achieved by using a more adaptive response i.e., if circumstances are relatively predictable, and the organisation can use these predictions to adapt in ways that prevent its operations being significantly and detrimentally influenced by changes in the environment. Going one step further, organisations may proactively employ an adaptive approach if circumstances are highly unpredictable, where achieving objectives is more important to the organisation than the means of achieving them [57]. The challenge is therefore to evolve toward an adaptive organisational approach that can deal with unpredictability and change without overly compromising stability and strength. The challenging question that remains is one of finding a suitable compromise between these two extremes i.e., "Is it possible to operate both archetypes under the same organisational roof and develop the ability to have an adequate balance between them?" [58].

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<sup>2</sup> The idea here is that when we intervene in complex organisations like C2 we need to recognize that changes are likely to result in multiple feedback-like consequences, which are often difficult to predict. Therefore, considerable care and an iterative approach to change is required; one that actively seeks to identify and deal with multiple consequences.

In summary, we really do not sufficiently understand how to manage and coordinate change across multiple factors in both our C2 organisations, and in our C2 enabling organisations, to provide any level of assurance that we will create the integrated and coherent C2 outcomes that we seek. However, continuing without an active, purposeful, and coherent C2 capability management approach is also not a viable way ahead, to instigate the transformation in C2 that many nations seek. However, in trying to improve governance there is another risk to balance, which is that military and public service bureaucracies tend to develop overly conservative, mechanistic, ponderous, and over-bearing processes for governing things. As, noted by Parker and Bradley [59], despite changes made more generally to public sector organisations, many of the prior bureaucratic behaviours still exist. Due to this tendency, there is a significant risk that attempts to improve C2 capability governance could actually worsen the situation. As implied from Lehman’s characterization described above and in Stacey’s work on organisational complexity, a more adaptive, feedback-driven, responsive, agile, and organic collaborative approach may be preferable. This might require, for example, a change in capability development philosophy and associated processes, where adaptability is built in at the outset, in part by not-overly specifying, whilst simultaneously seeking to balance both coherence and increasing freedom to assemble and exploit variations of C2 capability ‘at the point of use’. The question is, is this achievable given the typical machine metaphor mindset [60] of much of the current military enterprise?

### 2.4 Theme 3: The Challenge of C2 Development

Compared to development in many other domains, C2 development requires a relatively higher degree of alignment between human and technological components. In addition, the human fabric is complex, comprising of a plethora of rich interpersonal interactions between multiple decision-makers, each of which may have competing interests and/or different views and beliefs on operations being conducted and C2 practice being employed. Just changing the culture in group settings like this is a huge endeavour for any organisation [61]. “Soft issues”, such as culture, policy, sense making, etc. must be carefully considered and correspond to different functionalities in multiple technical and organisational systems. For example, C2 agility includes both the ability to cope and/or exploit changes in circumstances [37]. C2 adaptability calls for the implementation of solutions that are both stable and flexible [57]. Yet to come is a new wave of adaptive and autonomous systems based on deep learning, AI, Big Data, and Enhanced Human Capabilities, etc. How will such new systems correspond to future C2 doctrine and practice?

As implied above, C2 is largely human centred including mental and social processes that are hard to define in concrete terms [62]. Consequently, objectives of C2 development are often described in abstract terms such as self-synchronization or agility. Such terms are in many ways open to interpretation, thus making it hard for people charged with implementing change to determine what specifically should be done [63]. If the statement from Wittgenstein; “In most cases, the meaning of a word is its use” [64] is true, what then if the use is unclear? The list of C2 transformation acronyms that have passed and mostly disappeared into the mists of time is particularly telling, e.g., Dynamic Engagement, Knowledge Management, Revolution in Military Affairs (RMA), Digitisation of the Battlespace – Land (DBL), Joint Battlespace Digitisation (JBD), Network Enabled Capability (NEC), Information Superiority, Warfare in the Information Age (WITIA), etc. As we have argued in the introduction, it is very difficult to determine whether these initiatives achieved their original aims and/or what their eventual consequences were.

In addition to the challenge of clearly specifying the nature and objectives of a C2 development, such changes are, as an organisational endeavour, usually subject to compromises being made between competing interests [65]. For example, development outcomes may be strongly influenced by alternative agendas held by different groups and individuals across the defence enterprise, such as competition between branches, careerism, and incentives for promotion. In addition, many of the enablers for C2 also provide (non-C2) capabilities and hence are only partly driven by desired C2 outcomes e.g., leadership and information systems serve many other purposes. This is likely to lead to competing requirements and priorities that have to be traded off.



C2 development can also be affected by doctrine, which tends to focus on describing which current practices are judged as good and effective, and as such tends to be based on experience gained from the recent past. This means that any capability development based on doctrine risks resulting in technologies, methods and organisations that are suitable for warfare of today or even of yesterday, rather than for the future. Thus, future force concepts are a critical driver for ongoing capability development [66]. However, the process of creating, exploring, and developing concepts is itself problematic. Concepts are generally developed according to Concept Development and Experimentation processes (CD&E). These processes describe how a concept becomes the foundation for driving capability development, and why experimentation is needed for the purposes of exploration, elaboration, and validation [66]. However, the process of implementing the driving concept is much less clear. For example, we presently do not understand how best to achieve a change from a fixed notion of C2 to an adaptive/agile notion. There are also uncertainties arising from the frequent unclear approval status of concepts, a lack of coherence between different but intersecting concepts and a wide variety of concept types ranging from those which are overly similar to those of the past, to those which are overly futuristic and impractical [67]. Although abstract concepts could in principle be realized, they will typically not be realized in practice because concept development processes are simply not good enough, i.e., they frequently cannot take an abstract idea and properly explore and develop it into a credible solution. Finally, operationalization of concepts may be risky due to uncertainties inherent in concept validation processes. It might be assumed therefore that a less risky approach would be to develop solutions based on recent and prior experience. However, as noted above, when these solutions are eventually implemented, a different risk emerges i.e., that the problems they were designed to address are no longer relevant.

Taken together, the demands of aligning both organisational and technological development, the typicality of ambiguous and unclear objectives described using vague terminology, having to cope with stakeholders competing interests, different views, and beliefs on operations and C2 practice, and the fact that C2 enablers also need to serve other purposes, all pose huge challenges for the development and management of C2 capability.

## **2.5 Theme 4: Resistance to Change**

There are many existing factors that affect how C2 is currently conducted, where some of them are clearly visible as explicit regulations (doctrines, handbooks, established processes) while others are to a greater extent implicit and tacit (organisational culture, professional identity). These factors are generally very hard to change. In addition, improvements, once implemented, often appear to be short-lived. The ability to maintain any transformation becomes highly dependent on the individuals driving the change. Sustainability of change is a multifaceted challenge, dependent on many factors such as whether the change is considered substantial or peripheral, whether it is credible, whether there is good leadership, and whether there are effective change management processes in place [68]. A system based on frequent rotation, such as the case of multinational peace-keeping operations, enables a constant inflow of new ideas which may facilitate change. However, the other side of this coin is that the constant rotation of personnel hampers the organisation's ability to learn and improve due to lack of institutional memory [69].

As a specific example, culture and professional identity are factors that are hard to change; nevertheless, they can significantly affect how C2 is conducted. Military traditions do serve a useful purpose, for example in creating a sense of unity within the Armed Forces' community. However, cultural norms and promotion criteria, when combined, can form a codex in which certain undesired behaviours are rewarded and desired ones suppressed. This can impair the ability to introduce change, as well as preventing effective realization of preferred command philosophy, as prescribed in many doctrines [70]. Blame culture also impairs the ability to change, especially when every trifling error is watched for, and the least step out of line is pounced upon [71] (p. 8). Such cultures tend to suppress change, innovation and risk taking, especially when attempting things that are out of step with currently accepted norms. Views on risk also have a part to play, as Military C2 implicitly includes the activity of managing

risk, whether this be in terms of misused resources in organisational development or fatal consequences in operations [72]. This can make it very challenging to convince people to admit to difficulties that have arisen and learn from them, as their very examination could open reporters up to retribution, be this informal or more formal in the case of health and security. There is thus an apparent paradox, which is that to learn we need to admit to our shortcomings, but in so doing, we simultaneously create opportunities for retribution to be served, which will prevent the very learning we seek [73].

Resistance to change can also be explained in terms of organisational institutionalism [74], which additionally may also explain why organisations struggle to learn. Organisational institutionalism describes how organisations are influenced by their institutional context i.e., by widespread social understandings (rationalized myths) that define what it means to be rational in the context of the particular organisation concerned [75]. Institutional practices are typically taken for granted, widely accepted and hence resistant to change [76] (p. 811).

One could argue that one key part of institutionalism within defence is the long-standing education policy, which has a tradition of learning through explanation of historical examples. In these historical exposes, role models are found whose words are frequently quoted in educational material – Napoleon, Clausewitz, Nelson, Patton, etc. There is thus a risk that such examples serve the purpose of sustaining a history-centred organisational self-image, i.e., one that is based on memorable battles fought in completely different operational environments than we face today. Arguably, the conceptual traditions these historical examples will create, will tend to suppress ideas from those who dare to think differently, and will also tend to promote stereotypical behaviour and degrade innovation [77].

When an organisation seeks to change its internal structure, there is general a degree of resistance that comes from the people within that organisation. This resistance among individuals is also multifaceted and includes perceptions and questions about the fundamental need for the change. This will include views on the motivations for the change and the degree of clarity in goals and strategy that are communicated about it [78]. An example of these phenomena is documented by Penrose [79] who describes the process and challenges faced by the Australian Federal Police (AFP) in transforming from a rigid paramilitary structure to a flattened hierarchical structure that employs self-empowered teams. The new structure was an unfamiliar network in which the operational core was re-organised into self-empowered teams under the authority of a middle management, with another management team set up to exercise strategic decision making. Within 12 months of adopting the new approach, the AFP experienced a significant drop in productivity and work quality.

Penrose [79] argued that this resistance was strong, in part, due to widespread confusion about responsibilities and roles in the new structure. Poor understanding of an organisational change breeds anxiety and feelings of powerlessness that undermine acceptance of change while, perhaps, increasing peoples' tendencies to revert to old, familiar ways of doing things [80]. Better communication of the new command structure and the rationale for change would arguably have mitigated the anxiety experienced by many in the AFP [79]. Other researchers have also pointed to honest and clear communication of transformation goals as a means to reduce personnel anxiety and resistance [81].

In summary, any intention to change and develop C2 must expect and take resistance to change into consideration. This resistance stems partly from individuals within an organisation perceiving the change as something that will affect them negatively. Resistance is also institutionalised – built into the system – by the means of traditions, training, and education systems, accepted norms, etc. While personnel rotation is a way to inject new ideas into an organisation, and thus facilitate change, change is highly dependent on the individuals driving the change, which is why changes may be short-lived in organisations experiencing high rotation rates.

## 2.6 Theme 5: Lack of Organisational Learning

Observations of current C2 practice suggests that organisational learning is not being achieved [82], [83]. There is much that could be done to change development practices in the context of C2 to improve individual learning, e.g., through action learning and reflective practice [84]. However, although individual learning is necessary, it is not sufficient for institutional learning [85]. Informal knowledge sharing through social networks and systems has a crucial role in obviating some of the organisation's knowledge production deficiencies, but these do not necessarily lead to learning throughout the organisation. One consequence is that deploying units can often repeat the same mistakes that previous deployed units have also made [83]. The usual response is a call for adoption of formal lessons learned processes, but some argue that these processes tend to simply reinforce organisational routines and discourage exploration of new ideas [86]. Others argue that lessons learned can only assist information gathering [87]. These problems have been recognized in many defence forces [88]. One example is Canada, which concluded that the Lessons Learned procedures often failed to adequately manage and preserve lessons learned [89]. In general, lessons learned activities have been uncoordinated and based on a wide variety of methodologies [90]. Attempts to address this problem have been made, for example by trying to develop a single, coherent, and effective lessons learned process to promote constant organisational learning and "enable best practices to be emphasised and programme weakness to be addressed in a routine manner." A key challenge that remains, however, is ensuring that effective action is taken based on lessons learned, as there is not, so far, a process dedicated to implementing changes [91].

There also seems to be a genuine lack of knowledge on how to help C2 organisations to become effective learning organisations. Management of the defence forces, including its development, is coordinated by commanders trained for wartime command rather than peacetime organisational management. Commanders have not received training in competencies needed to promote a learning organisation [92]. Yet they are, in many cases, the heads of such endeavours. As early as 1838, colonel John Mitchell of the British Army noted the army's inability to change: "Officers enter the Army at an age when they are more likely to take up existing options than form their own. They grow up carrying into effect orders and regulations founded on those received options; they become, in some measure identified with existing views, till, in the course of years, the ideas thus gradually imbibed get too firmly rooted to be either shaken or eradicated by the force of argument or reflection. In no profession is the dread of innovation so great as in the army" [93]. Almost 200 years later, it should be obvious that the current situation calls for commanders to be knowledgeable enough to be able to apply existing doctrine, innovative enough to create new solutions, and have enough cognitive competence to choose between the two. Still, the professional military education system is largely based on industrial age models that focus on a trade-school approach [94].

From a development perspective there is thus a need for greater competence in how to test and develop new concepts [18]. Alberts and Hayes [95] underline the importance of such expertise in the field of evaluation and experimentation in order to have an efficient development process by stressing: "Almost without exception, this will mean doctoral level (Ph.D.) training and a decade or more of experience in actually designing and conducting experiments." Efforts have been made to address this gap of competence, for example in Sweden by specific training programs at the Defence College [18]. However, these courses have now been cancelled due to budget considerations. This reflects a wider trend in which, institutions supporting lessons learned processes such as doctrine and research centres have often been subject to budget cuts [96].

In addition to the challenges of lessons and learning, there is also the constant loss of knowledge that occurs within C2 organisations, which is an inevitable consequence of the current military career system, i.e., one that is built on relatively short time assignments on different positions. Intended to give commanders a broad spectrum of knowledge and experiences, it comes with significant costs at the local level and in aggregate at the enterprise

level. Much of the organisational knowledge relating to C2 resides in peoples' memories and not in official records or lessons learned. Therefore, turnover in command personnel is contra productive regarding maintaining this important organisational knowledge [97]. Consequently, organisational knowledge on C2 relies on efficient training to transfer knowledge and experience between the teams staffing the C2 system. However, there are several barriers that tend to reduce the effectiveness of military team training. Freeman and Zachary [98] identifies three such major barriers:

- 1) Barriers related to Data Collection and Analysis. Assessing transfer of training of C2 teamwork calls for capturing and interpreting human-to-human interaction, a core process in C2, based on data which is highly elusive in nature. For example, social behaviours in terms of non-verbal cues such as facial expressions, gestures, and tones of voice. In a wider perspective, assessment of training also must consider human interactions with technologies and processes of sense making and inference concerning a wide variety of aspects. Specific C2 examples include the problem of determining the effectiveness of team interactions, particularly between commanders and staff, given that in many communications the intended message is implicit rather than explicit i.e., we have to concern ourselves with the topic of pragmatics [99].
- 2) Barriers related to Measurement and Measures. Assessment of transfer of training teamwork is frequently conducted as an informal process relying on expert judgment. As C2 is typically distributed in space and time, makes it hard to extract and correlate information about interacting processes. There is also a lack of replicable observational protocols, and multiple data sources are not normally available. It is therefore difficult to provide meaningful feedback; something which is essential for learning.
- 3) Barriers related to Theory and Models. Multiple models of teamwork in C2 are typically held in the minds of instructors and commanders. The subsequent assumption is that their experience allows them to apply their judgments about which models to apply in different circumstances. However, these mental models of teamwork are not consistent; they vary between instructors and are often biased.

In summary, the lack of ability to enact organisational learning in C2 organisations is reflected in the fact that similar problems and errors are repeatedly seen. Dyson [100] underlines the core argument of this report by concluding:

*Further research is required to establish greater precision in our understanding about the extent to which variables such as organisational culture (especially culturally-embedded understandings of military professionalism) and bureaucratic politics effect and are affected by the emergence of dynamic organisational capabilities.*

## **2.7 Summary of Insights on Challenges**

This report has included an identification and examination of a set of perceived challenges to successful C2 capability development. These observations highlight that C2 practitioners are frequently blind to the full spectrum of factors and systems that make up C2. When all these components, both formal and informal are not explicitly accounted for in transformation efforts, it is likely that the pressures, incentives, and constraints they impose on C2 will not be aligned toward a common transformation outcome. The move towards network-centric C2, for example, was thwarted, in part, because informal, human-oriented systems of authority and responsibility did not incentivize the broad sharing of decision rights despite the adoption of networked communications and data processing technologies. Those technologies led to broad sharing of information, which was one necessary component of network-centric C2 [29], but did not drive a concomitant move to broad sharing of authority. C2 practitioners need to develop an understanding of the range of socio-technological systems that make up C2 ([42], p. 3). Only when the constraints and affordances of these systems are better understood, can C2 transformation be tailored to fully address the goals and needs of the organisation.

Complicating matters even further is the fact that existing C2 components were often designed and developed some considerable time ago, frequently independent of each other and often without a guiding integration concept. Each of the capability components and the influencing factors also change over time, more-or-less independently. Hence, for example, if a state-of-the-art technology enabler was proposed initially, it might subsequently become unsuitable due to an emerging policy change.

To address these issues requires a “life cycle perspective” to be taken on all the factors that contribute to a C2 capability, i.e., governing C2 capability should not be restricted to just the life cycle of military units and/or their supporting technological systems. Finally, the challenges cannot be wholly responded to by just focusing on the development process itself; there is also a need to embrace the feedback aspects of lifecycles, which includes the topics of organisational learning and the adaptive management of current and emerging C2 capabilities.

### **3.0 POTENTIAL SOLUTIONS**

It was beyond the scope of the ET research to devise solutions to all of the challenges outlined in previous sections. However, our review of the literature, and documented experiences, yielded a number of recommendations and lessons learned. Such findings and recommendations have the potential to be a part of a future Code of Best Practice for C2 Lifecycle Capability governance. They also address what are often referred to as ‘soft’ issues in building consensus for change, where that change is ultimately more durable. Such approaches are essential to successful change strategies. Overall, we argue that it is obvious that, collectively across the NATO and partner nations, we need to change our approach to change. The remainder of this section therefore documents a number of potential solutions to the challenges of C2 transformation, but without significant elaboration of the detail.

In this section, we have used, as a key reference for solutions and recommendations, a project that was undertaken at the Swedish Defence Research Agency with the objective of identifying critical success factors for the acquisition of C2 support systems. These success factors were intended to contribute to more efficient acquisition and integration of such systems [101]. The report is written in Swedish, but we have extracted several of the success factors as potential recommendations and matched each of them to one of the five challenge themes discussed in the previous section. We have kept the original references to the recommendations in English in order to make the background to the recommendations more accessible for readers.

As a final note to explain some implicit assumptions, given that there are multiple problems that impair organisational transformation, for each of them there are multiple solutions that must be considered. Additionally, not all of these recommendations come specifically from the area of C2, reinforcing the point that the applicability and relative emphasis that should be placed on each solution will depend, of course, on the particular organisation, the intended transformation, and the environment in which the organisation operates. Consequently, in proposing a list of solutions relevant for a Code of Best Practice, each solution must be carefully considered and adapted for the specific context, and that includes how the solutions may overlap and interact.

#### **3.1 Potential Solutions to the Limited Ability to Evaluate C2 Capability**

There remains a limited ability to evaluate C2 capability both in the longer and shorter terms, in large part due to drawbacks with existing and standard measures of C2 performance and effectiveness. This is not a new discovery, but a recognition that problems of evaluating C2 effectiveness are long-standing and are unlikely to see much improvement without significant effort being applied. In aggregate, these measures fail to convey a sufficiently comprehensive picture of the current state of C2. We do not adequately understand what C2 is, or how we can assess its effectiveness. One major factor in previous ineffective C2 transformations has been that C2 practitioners have



tended to concentrate on too limited a set of formal components of C2 systems (doctrine and technology) at the expense of “softer” components (i.e., human-oriented systems such as authority, responsibility, career considerations). By not identifying and coordinating changes across all component types that affect and enable C2, practitioners have created cases in which changes to doctrine and technology have been unsupported, or even directly opposed, by changes occurring in the soft systems and vice versa. Without alignment of all the components of C2, efforts to change will often fail to gain traction or have the desired effects.

This calls for determining and studying the range of factors that influence the design and development of C2 capability as part of a socio-technological system. The intent should be to create a more comprehensive model of C2 and C2 capability development that can both guide the development activity and be used with evaluation methods. Currently, there is no universally agreed-upon model of C2 and it is beyond the scope of this report to offer a pre-determination of all the appropriate aspects of C2 that must be included. However, we would expect that the C2 model would include abstract/generic descriptions of both components and properties and the C2 capability development model would explain how these components and properties are intended to be shaped over time. Whatever the model, it must address the need for greater integration of social and human/cognitive systems and not focus on the traditionally dominant areas of doctrine and technology (e.g., Ref. [102]). It also calls for ensuring that, when C2 changes are made, they are guided by any developed model to verify that appropriate changes are i) Made in all C2-relevant systems; and ii) Are aligned toward achieving the same outcomes.

The remainder of this section lists some potential solutions to the challenges created by our limited ability to evaluate C2 capability. The solutions are presented as steps to be taken in a project of C2 transformation, assuming organisational will and support. Examples taken from Nordström et al. [101] include:

**Develop cooperation with stakeholders.** Develop close collaboration with SMEs, users and other stakeholders regarding the goals and planning of the project as well as the requirements and design of the products procured through the project [103], [104], [105].

**Solution-independent and clear requirements.** Requirements formulated for a system should be clear, but also formulated in such a way that different (technical) solutions can be used [106].

**Follow up results through direct observations.** Follow-up needs to be done by conducting a direct observation of work performed. The use of indirect monitoring methods such as reports, indicators and the like should be avoided [107], [108], [109].

In addition we have identified:

**Health/Maturity issues.** Regular organisational assessments should be made to judge the current state and future trends within organisations in regard of their overall fitness and maturity. These are intended to be broad-spectrum assessments covering a wide range of potential aspects and issues within an organisation, rather than being focused on individual interventions. A key benefit is that such assessments permit the identification of potential undesired and unexpected side effects emerging from change/interventions. The analogy with human health is a good one; i.e., in that broad-spectrum assessments attempt to provide a similar assessment of overall health and the detection of desired and undesired impacts as with medical interventions [110].

**Self-measurement and assessment.** Strongly linked to the types of assessments conducted to gauge organisation health and maturity is the idea of undertaking these on a self-assessment basis. One of the reasons for doing this is to avoid measurement biases creeping in as a result of data being purposefully

altered to meet a real or perceived target (i.e., Goodhart's law<sup>3</sup>). Organisations tend to be much more open and willing to admit to deficiencies if this is undertaken as part of an internal process of self-assessment and self-correction with positive benefits for the individual and the wider organisation [110].

### **3.2 Potential Solutions to the Limited Ability to Manage C2 Capability**

Defence organisations generally lack effective governance of C2. At the outset, this has been caused by defence organisations tending to not treat C2 as a capability to be governed, but rather as an implicit outcome that will emerge on demand when it is needed. The reality is that C2 is extremely difficult to manage or govern due to the many interacting components of C2 systems; hence taking a holistic approach is essential.

This calls for the development of an active, purposeful, and coherent change approach, but at the same time assurance that this approach gives sufficient freedom of manoeuvre for the people enacting it, such that it does not become overly centralised and bureaucratic and does not lose its necessary agility. Below are specific solutions intended to better support our ability to manage C2 and C2 transformation. Examples taken from Nordström et al. [101] include:

**Step-by-step development and procurement.** The principle of step-by-step development and procurement means that the work of procuring, developing, and delivering a new system should take place in a series of smaller steps, each of which is so small that it can be easily reviewed and managed. Instead of procurement work following long-term plans, work on development and procurement should be carried out in a series of smaller steps. Each step should be adapted to the circumstances and should help to achieve the overall goal of the work [105], [111], [112], [113], [114].

**Work towards clear goals with a focus on results.** Work carried out should be based on clear goals with a focus on results rather than strictly following processes, procedures, and routines. Focus should also be on delivering functioning (part) products rather than extensive documentation of the work done, as well as on ensuring that the project group is flexible and adapts the working method to achieve the goals of the project [108], [115].

**Decentralized organisation with wide allocation of decision rights.** Decisions must be made as close to the stakeholder activity as possible [107], [115]. This is similar to the next solution.

**Use mature technology and methodology.** Using mature technology and methodology reduces risk in the project by minimising technical uncertainties and uncertainties resulting from untested methodology. This requires analysis of how existing technology can be put together in new creative ways [116], [117], [118] [119].

**Simplicity.** Simplicity should be strived for regarding choice of technology, processes, procedures, project goals and delimitations for the project [105], [107], [118].

**Holistic perspective.** People involved in C2 transformation must realize that proposed changes to C2 will be included as subsystems within the framework of a larger C2 system which in turn is a subset of the military force system which ultimately is a sub-part of the societal security system [106].

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<sup>3</sup> Goodhart's law is named after British economist Charles Goodhart. One well-known simplification of his ideas is phrased as follows: "When a measure becomes a target, it ceases to be a good measure."

**Realistic schedule and budget.** The aim of the transformation project must be possible to realize within budget and timetable taking into account the technological and engineering challenges that the project will face [118], [120].

In addition we have identified:

**Federated approach to change.** In many cases it may be more effective to avoid the typical centrally controlled approach to change. Such approaches tend to generate hostility and ‘push-back,’ do not exploit the innovation available in the organisation and tend not to take account of the differences in the organisation which require any change to be adapted to those differences. A more distributed approach to change, based on broad intent setting and agreement and a more federated response is often preferable. This is based on a more distributed approach to leadership that emphasises collective collaboration rather than individual power and control [121].

**Maintain funding.** Related to the previous solution, maintaining adequate funding is critical for C2 transformation. This warrants repetition because funding faces numerous obstacles imposed by competing budget demands, both within the military and across the whole of government.

**Draft an explicit strategic plan.** A strategy and strategic plan are necessary elements for C2 transformation [122]. The strategy provides a concept of how the C2 structure will be changed, with the strategic plan laying out the detailed steps. The absence of a strategic plan can undermine peoples’ understanding of the vision for change and encourage groups within the organisation to work on their own competing plans, resulting in confusion and doubt regarding the feasibility of change [122].

### **3.3 Potential Solutions to the Challenge of C2 Development**

Just as we do not fully understand all the interacting systems making up C2, we also lack sufficient understanding of how to effectively change C2 in ways that produce desired outcomes. C2 development is difficult because many changes require consideration of a broad spectrum of different, technological, and non-technological factors. Softer human and organisational issues must be aligned with development of concepts and doctrine, technical solutions, and the reality of armed conflict. In addition, C2 is largely human-centred and dependent on mental and social processes which are hard to define, understand and influence. Because of the human-centric nature of C2, change initiatives can readily fall foul of multiple conflicting objectives and priorities. These objectives for C2 development are also often described in vague and abstract terms, leaving them open for multiple and potentially conflicting interpretations. In addition to precision in formulating concepts, concept development needs to be accompanied by a sufficiently comprehensive experimentation and validation process [66].

There is a need for a greater degree of alignment between organisational and technological development, and also a need to change the current techno-bias, such that concepts and organisational needs become the primary drivers. It also calls for ensuring, as part of a wider C2 transformation effort, that cultural and institutional change is aligned with any plans to exploit state-of-the-art technology. Technology-driven change is not excluded from this consideration, as many ideas of how to use and develop technological artefacts evolve when they are put into real operational practice. Finally, there is a need to change the concepts, language and terms used to talk about C2, moving away from the abstract and ambiguous and those that embody current traditional biases and hence constrain how we think about future C2. Ideally, a new ‘language of C2’ is needed in conjunction with a more comprehensive model of C2 (as discussed above). The following are some potential solutions to challenges related to the C2 development. Examples taken from Nordström et al. [101] include:



**Put user needs in focus.** The needs of the ultimate users of the C2 system should be the focus during procurement; i.e., users' experiences should be utilized in the procurement process [107], [108].

**Continuous management of risks and uncertainties.** Risk management includes identifying the risks that may affect project results and taking preventive measures to reduce those risks. Management of uncertainty means that strategies need to be available to raise awareness of the uncertainties that exist during the project and the critical assumptions that have been made (during the course of the project) to deal with these uncertainties [109], [112], [123].

In addition, we have identified:

**Change the language of C2.** Alberts [34] has argued that progress in transforming C2 has been hampered by the language customarily used to discuss it. Psychologists have long known that one's language plays an outsized role in structuring one's understanding by constraining the kinds of concepts and relationships that can be readily expressed (e.g., Ref. [124]). In C2, as all things, concepts become coded in traditional language and the users of the language are not necessarily aware of how the language imposes barriers to new ideas and ways of thinking. Possible C2 structures may be difficult to conceive, let alone implement, without new language that facilitates thinking outside the traditional space of C2. Pigeau and McCann [102], for example, re-introduced the concept of command intent by analysing the way the terms command and control have been traditionally described and putting forth new definitions that emphasised different aspects of the C2 space. In changing the way we talk about C2, Pigeau and McCann re-invigorated the concept of command as the sharing of intent, along with a broader distribution of decision authority. In particular, they highlighted the validity – in fact, the necessity – of implicit processes of information sharing as part of C2. Rather than control being a rigid exercise of authority, it is possible with the term command intent to see control as a more flexible process of influence. Alberts [34] has suggestions on what a new language of C2 should be but, unfortunately, fewer ideas on how one goes about promoting, and encouraging the adoption of, a new language.

**Integrated and co-evolutionary approaches to systems and organisational development.** Change should not be driven top-down from requirements but rather in more holistic and evolutionary manner where the impact of any aspect of change that is rippling through the numerous facets of organisations and enabling systems is continuously considered, assessed, and managed. Thus, systems development ideally needs to be more integrated, rather than stove-piped [125].

**Building adaptive capacity: decision making, organisations and enablers.** As set out in all the national statements on future requirements for C2, more adaptive approaches to C2 are required to deal with the more diverse and dynamic settings for military operations. This creates a further challenge for any approach to C2 capability governance. As set out in many of the arguments contained in this report, current military enterprises are finding it difficult to effectively design and develop more static instantiations of C2. It is far less clear how to build a more dynamic and adaptive C2 capability, or whether our current organisations are technically and institutionally capable in their current form [126].

### 3.4 Potential Solutions to the Resistance to Change

Even when objectives are clear and priorities are agreed upon, there can still be substantial resistance to change when transformation initiatives are started. Some of the factors relating to how C2 is conducted today are notoriously hard to change, such as culture and professional identity. There is a wide array of constraining factors that have the potential to undermine any change that is proposed, such as, for example, blame culture, lack of willingness to admit mistakes and lack of openness to discuss errors and failures.

This requires us to take into account, when considering any potential change, many relevant factors, such as organisational culture, institutionalism, military traditions, and so on to frame C2 changes in ways that minimise any likely resistance. The following solutions offer some ways to reduce resistance to change within an organisation.

Examples taken from Nordström et al. [101] include:

**Create and maintain a culture of trust.** Blame culture effectively impairs the ability to change. Organisational change requires a culture in which the organisation has a willingness to admit mistakes and an openness towards discussing errors and failures, which enables innovation. Creating and maintaining a culture of trust is about giving those who have been given the task of solving the best possible conditions for solving it, trusting that they are given the task done and providing the necessary support. Excessive control increases the likelihood of inefficiency and cheating [107], [115].

**Careful selection of project members.** Ensure that the project members have the right skills, are motivated to work in the project and can work effectively together [105], [118].

In addition, we have identified:

**Establish a consistent vision across the organisation:** According to Jeffery [122], a clear vision, which describes the desired end-state of change, is necessary for successful C2 transformation. Although the vision may evolve over time, a high degree of consistency is needed to help organisational personnel to understand and accept the vision. Creating a shared vision is critical to motivating people to work to achieve it. Even so, a well-communicated, consistent vision can still meet resistance, especially from those who could see the loss of resources and responsibilities under the new C2 structure [122]. We therefore need a clear and shared view of what C2 should be capable of doing in future settings, and there should also be a shared vision for how the enterprise might reasonably achieve this (i.e., “how to get there”). The principles of project management should be tailored to fulfil the requirements of one’s concept [66].

**Elect a change leader and plan for transitions:** A single individual can be a powerful catalyst for change, as was the case in Canada’s 2005 C2 transformation. Gen Hillier, the Chief of Defence Staff (CDS) who initiated the transformation, was charismatic and well-respected, which countered, to some extent, the natural resistance to the vision he promulgated. However, Gen Hillier, departed his post as CDS without securing a successor to continue to champion the transformation or formally standing up a team of champions for transformation that could move the vision forward after Hillier’s departure as CDS [122]. Without a champion, transformation efforts will tend to lose urgency and become fragmented among leadership posts that may pursue disparate approaches that undermine the original strategy for change. Drafting an explicit strategic plan can mitigate the absence of a change leader but only to the extent the organisation continues to believe in and accept that plan.

**Honest and clear communication.** In every phase of concept development, it needs to be ensured that the communication of the new concept to the target audience is clear, and encompasses the key issues that need to be addressed in order to make it useful as a baseline for capability development [66].

**Use systematic models of organisational change.** Use a systematic change model, for example Kotter’s eight steps [127], Luecke’s suggested Seven Steps [128], Lewin’s Unfreeze-Change-Refreeze model [129], ADKAR (Awareness, Desire, Knowledge, Ability, Reinforcement) [130], and Davis’ Technology Acceptance Model (TAM) [131].

### 3.5 Potential Solutions to the Lack of Organisational Learning

Successful change can be undermined by problems in organisational learning. In particular, defence organisations tend to make the same mistakes when attempting to improve and/or transform C2 because they lack an effective organisational learning function. Ideally, continuous development and organisational learning need to be comprehensive, pervasive, and acting in unison. Typically, in the military environment we are constrained to the use of more traditional methods such as lessons learned capture and reviews but these are frequently inadequate and biased toward traditional thinking and conservative-scale changes. As a consequence of a lack of effective learning, we continue to employ ineffective strategies and similar problems and errors are repeatedly seen in action within C2 organisations. This calls for:

- Training military personnel and leaders in organisational learning techniques.
- Developing ways to combat the constant loss of knowledge within C2 organisations from rapid personnel turn-over.
- Developing means for knowledge externalization and transfer.

The following are some potential solutions to challenges related to the lack of organisational learning. Examples taken from Nordström et al. [101] include:

**Develop the organisational culture so that the appropriate behaviour is rewarded.** Leaders running small, down-to-earth projects that deliver what users need should ideally be rewarded, instead of incentivizing the running of large projects (which run a greater risk of being delayed and going over the assigned budget). Furthermore, organisational culture needs to preference innovation rather than risk aversion [118], [132].

**Strategic competence development.** Long-term work on identifying and developing new technologies and finding applications for new technologies to enable the rapid development of new capabilities when needed [105], [106], [133].

**Create an ability to respond to changes.** An organisation requires an ability to respond to, and manage, changing needs that arise during the course of the project. This means that it is more important to be able to adapt the project than strictly following plans [103], [112], [133].

**Efficient communication.** Significant importance should be placed on communication, both internally within the project group and externally, to ensure projects succeed [105], [107].

**Regular follow-up focusing on the future.** The purpose of follow-up and evaluation is to utilize experiences that can be used to achieve increased efficiency in the future. The basic question for follow-up and evaluation should thus be “what can be done better?” rather than “what went wrong?” [107], [109].

In addition, we have identified:

**Maintain commitment.** A key requirement for successful transformation is commitment by the organisation and its people to see the transformation process through. Transformation can take a long time so it is understandable that – especially as people come and go through the organisation – belief in, and effort toward, transformation wanes. Experience, however, shows that when commitment weakens it is likely that transformation will stall [122]. In particular, an organisation should draft an explicit plan to maintain commitment through communications, successions of key personnel, and necessary funding for change.

**Translation of learning into change.** To institute change effectively there is a need to exploit learning effectively. This requires the recognition of patterns in experience, interpreting these

patterns to gain insights, integrating the change actions that emerging from the insights and institutionalising actions that have been learned and judged to provide benefit. One example is the 4i model which strives to instantiate these ideas [134].

### 3.6 Summary of Potential Solutions

The solutions put forward above represent lessons learned from scientific and operational studies of C2 change. What is needed is a unifying framework that can encompass all these solutions but provide a clear structure in which to plan and conduct C2 transformation. The ET did not have sufficient scope, time, or resources to provide such a framework. We therefore propose that these are investigated as part of the work of a future RTG.

## 4.0 CONCLUSIONS

Right now, NATO nations face a time of increasing risk. Events of broad scope, including climate change, increasingly prevalent authoritarian movements around the world (even in some NATO nations), and the rising influence of China, are creating a security environment that presents numerous challenges.

The emerging security environment presents the risk that traditional C2 structures are not well-suited to address the challenges imposed. We will likely encounter less large-scale physical conflict but more small-scale asymmetric conflicts, as well as increasing information, cyber, and influence actions against NATO members. This provides a motivation to investigate ways to improve NATO C2 transformation capabilities and agility.

In this report, we have discussed the observation that, whilst C2 concepts have changed quite considerably in response to significant developments in the security environment, C2 practice has remained very similar to that observed more than twenty years ago, especially compared to developments in other areas of warfare. This observation raises an important question of whether there is a good reason for this lack of change. It could be the case that C2 capability is already judged to be 'good enough', but it is also possible that C2 remains stubbornly static despite our best efforts to transform it. The answer would appear to be the latter, and this is particularly problematic, given that C2 remains a critical capability for NATO, with the clear requirement for change emerging from the need to respond effectively to the rapidly evolving context of future allied operations. Evidence for this claim comes in the form of many previous attempts at C2 transformation, the vast majority of which have fallen well short of delivering their promised outcomes. Although each transformation has generally led to some improvements, the fundamental form of C2 has remained very much as it was during the Cold War period.

This report has explored some of the potential reasons that C2 transformation initiatives have failed and discussed a number of tentative solutions. In addition to these individual solution ideas, however, it is argued that a more fundamental solution will also be needed, specifically that defence organisations need to adopt something akin to a 'life cycle perspective' that attempts to understand, decide about, shape and cohere the multiple factors and components that contribute to C2 capability. The focus of such a perspective cannot be wholly on the development process as there is also a need to embrace the feedback aspect of lifecycles, which in this context includes topics such as organisational learning and the adaptive management of current and emerging C2 capabilities.

A further striking observation of this research was the significant similarity of the issues and challenges faced by the individual nations taking part. This suggests that there are fundamental forces at work that transcend national differences. We therefore propose that a NATO and partner nation-wide response to these challenges may be beneficial in helping to guide, stimulate, and drive national and coalition responses. Change in the way we

approach transformation, however, will itself be a long-term process requiring adaptability and long-term commitment by an organisation. It is necessary to create a shared vision (goals) across the organisation and articulate a strategy for achieving the vision and gaining buy-in from all parts of the organisation. Without a sufficient degree of long-term commitment to change then any significant transformation of C2 capability is unlikely to be realized.

In practice that means a program focused on making C2 a capability to be governed. To assist this, it is proposed that an RTG could aim to create a standard of practice for C2 transformation that ensures our military organisations critically assess success and failure, learn from these, and use the feedback to make improvements. The emphasis would be on sustaining healthy organisational cultures and identifying mitigations to the barriers for change. NATO nations need to agree on much of the above and to share lessons learned about both success and failure. The work of the proposed RTG could create a framework in which NATO militaries can improve the change/transformation approach itself so that future efforts at C2 change will yield greater and longer-lasting effects.

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## **Annex A – NATIONAL PERSPECTIVES ON THE NEED FOR C2 TRANSFORMATION**

In this annex, we present some examples of C2 capability development endeavours that did not fully realise the visions put forward at their inception. The examples, taken from each of the three participating nations (CAN, SWE, UK) and NATO, illustrate some of the problems introduced in the report and provide contexts for thinking about the reasons that C2 transformations have not been fully successful.

### **A.1 CANADA**

In 2005, Canada initiated an ambitious C2 transformation plan that aimed to replace the nation's traditional service-centric model with an agile, joint-capable C2 structure [1], [2]. It was expected that an agile C2 capability would be needed to meet the anticipated future security environment, where Canada would face increasing asymmetric threats and conflict among small and non-state actors. CDS General Rick Hillier created an organisational capability for joint operations through the creation of Operational Commands and Special Operational Forces Command (Joint Commands) in which all service elements were grouped. Moreover, he was also successful in changing the CAF culture by convincing the existing leadership of the value of a new joint force structure and tailoring the education of new leaders to that structure. The transformation effort, however, was undermined by C2 doctrine being drafted without a concrete plan for change among the services and hence providing insufficient direction, and by a lack of coordination with the services, all of which produced their own C2 guidance that did not conform entirely to the CAF vision [3]. Although progress was made on the transformation [4], Canada's latest strategic defence plan [5] continues to identify joint C2 as a need for Canada and lays out substantial new investments required to achieve meet that need. In particular, Canada's joint C2 system remains incomplete, with a need to develop systems to integrate intelligence and joint targeting capabilities, as well as providing a more robust ability to deploy joint C2 systems in the field [5].

### **A.2 SWEDEN**

At the beginning of the 21st century, the Swedish Defence Commission (Försvarsberedningen), came to the conclusion that the threat of an invasion could no longer serve as the major rationale for the military defence [6]. Subsequently, Sweden launched an ambitious program to transform its relatively large defence organization to a significantly smaller organisation that could defend the country against more limited attacks and participate in international security cooperation.

Network-Based Defence (NBF) was an important basis for this reform. In NBF, shared information and situation awareness were key concepts. Staffs, units, commanders, and soldiers would all have access to C2 systems that would ease communication and information sharing to allow faster, more efficient decision making [7]. A Concept Development and Experimentation Center (JCD&EC) was established as the Swedish experimental platform for C2 development and several experimental exercises were executed in the forthcoming years. The Center was the heart of the development of Swedish versions of new concepts such as Effects Based Operations (EBO); Knowledge Support (KS), the Effects Based Approach to Operations (EBAO); the Comprehensive Approach (CA); expeditionary operations, and Integrated and Distributed C2 (ICD2) [8], [9].

Efforts to transform Swedish C2 capabilities, however, did not proceed without some difficulties. In the reports from the Defence Commission, made in advance of the 2009 parliamentary defence decision for the period

2009 – 2014, NBF was hardly mentioned. However, in 2007, Statskontoret, the Swedish Agency for Public Management, had expressed sharp criticism of NBF and its implementation [10]. According to the State Office, the work had not produced any tangible results. In addition, a core recommendation from the Defence Commission was that the proposed development towards a more useful and accessible defence force would take place at the pace the economy could afford [11]. Consequently, resources would need to be released in response to specific change recommendations accompanied by clear arguments. As a part of the reorganisation and downsizing of the Armed Forces, JCD&EC was decommissioned on 31 December 2012 [12].

In hindsight, the Defence Commission noted in 2019 that NBF was an essential element of the transformation of the defence force but also concluded that the development was characterised by technological optimism and that the investments made within the framework of the NBF failed to produce the anticipated improvement to operational capability. The Defence Committee therefore emphasised the importance of the work on technology development, and development of future capabilities, but argued that the experience gained through NBF must guide future transformation efforts [6].

### **A.3 UNITED KINGDOM**

In the early 2000s, the UK MOD started the development of a new concept called Network Enabled Capability. This was viewed at the time as being at the ‘at the heart of our transformation’ for UK defence capability. NEC was in fact the UK’s attempt to implement the US concept of Network Centric Warfare [13]. NEC was defined in Joint Service Publication (JSP 777), which stated that it “...will improve the integration of weapon systems, Command and Control (C2) nodes, and Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) systems to enable commanders to achieve appropriate, timely and precise effects.”

Even at the outset, concerns were raised about the potential to deliver on the promises of NEC, and its associated concept of the Effects Based Approach (EBA). These were most notably expressed in a 2003 House of Commons Defence Review Committee report [14]. For example, the report noted of the NEC concept:

*“It requires decision-enabling information systems that the UK does not yet possess.”* (para 55)

*“It may also raise challenges to the British concept of mission-command.”* (para 55)

*“The doctrinal basis for embracing these technologies needs to be rigorous and clearly understood if the benefits of the network are to be realized.”* (para 55)

*“This will require as much development, or even transformation, of the human dimension, as of high profile technological advances.”* (para 64)

*“The current preoccupation with speed, agility, parallel operations, decisiveness and tempo misses a vital human aspect of effects-based thinking, which has significant ramifications for the way we train our Armed Forces. We are not convinced that these have been adequately addressed by the White Paper.”* (para 88)

The defence committee was arguably correct to express these concerns, for example as evidenced by a conclusion that emerged some seven years later from the Deputy Chief of the Defence Staff (Equipment Capability) DCDS(EC). In the 2010 report, he noted that “a lack of training and a shortage of dedicated staff with appropriate skills to exploit the NEC effect are hampering the development of Joint Battlespace Management” [15].

A few years later UK military concepts were advanced yet further, building on NEC and EBA to create the “Comprehensive Approach”. In 2006, the UK Joint Doctrine and Concepts Centre (JDCC) made the case for this approach, which aimed to integrate ‘all lines of operation’ – diplomatic, information, military and economic [16]. However, as with NEC, this concept also ran into difficulty, with the British military’s campaigns in Iraq and Afghanistan judged to have employed “ad hoc civil-military cooperation rather than a comprehensive approach.” Reflecting on operations in Iraq it was noted that “differences between FCO and MOD were often felt even at the tactical level,” and that the lesson learned was that “the disconnect between the various arms of government has undermined faith in the Comprehensive Approach and whether it can be delivered” [15] (p. 796).

More recently, General Barrons expressed similar ideas to those expressed in NEC within an initiative called “Warfare In The Information Age” (WITIA). In this initiative, he explained that military transformation would be “largely about the rapid adoption and adaptation of civil-sector-derived technology and methods in disruptive military applications” [17]. General Barrons also noted that adoption would require transformative change in how defence conducts its business, and one part of that change was with respect to the need for more Agile Command and Control. Specifically, it was declared that “*Operations in the information age will require a more flexible approach to Command and Control. A highly hierarchical structure with centralised decision making will not provide the necessary agility that the wide variety of operations will increasingly demand.*” It was believed that new doctrine, training and technology, for example to enable concepts such as more dispersed and virtual headquarters, would be some of the enablers of a more agile approach. A harsh analysis of the desired outcomes from WITIA suggests that few if any may have been attained [18].

Summarising, during the last 20 – 25 years we have seen multiple initiatives designed to transform UK C2 capability, and these have resulted in improvements. However, despite this, observations continue to emerge, particularly from command post exercises, suggesting that the extent of transformation has fallen short of what was desired and intended. It is therefore interesting to contrast the observed degree of change in C2 with the substantial and rapid advances made in other areas of defence, such as military weapons and platforms, opening up the interesting question as to why this should be so.

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<b>14. Abstract</b> <p>Doctrine and concepts for C2 have changed over the past three decades. We now find ourselves in an era of constant competition, hybrid warfare and rapid technological development. Nonetheless, compared to developments in other areas of warfare, such as weapon technology, platforms, etc., C2 practice, including current training and education, organisation, and employment of enabling technology, is largely the same as twenty years ago. This report explores reasons why C2 transformation may have failed or stalled and explores potential solutions. A meta-solution may be needed; i.e., adopting a “life cycle perspective” that shapes all factors that contribute to C2 capability. The feedback aspect of lifecycles will also need to be embraced, including organisational learning and the adaptive management of current and emerging C2 capabilities. The research concludes that there is significant similarity in the issues faced by the individual nations taking part, suggesting that there are forces at work that transcend national differences. We propose that a NATO and partner nation-wide response to these challenges would be beneficial in helping to guide, stimulate, and drive national and coalition responses. In practice, this entails the creation of programs focused on making C2 a capability to be governed. To assist in this endeavor, it is proposed that an RTG create a standard of practice for C2 transformation that ensures our military organisations assess success and failure, learn from these, and use the feedback to make improvements. The emphasis would be on sustaining healthy organisational cultures and identifying mitigations to the barriers for change. NATO nations need to agree on much of the above and to share lessons learned about success and failure. The proposed RTG could create a framework through which NATO militaries can improve the change/transformation approach so that future efforts at C2 change will yield greater and longer-lasting effects.</p>			







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