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CENTRALIZED CONTROL OR DISTRIBUTED CONTROL – DO WE NEED A PARADIGM SHIFT?

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Abstract: *The centralized control and decentralized execution is one of the basic tenets of air power command and control, a tenet that has proven its importance and usefulness throughout history. The development of electronic and cyber warfare capabilities, space, surface-to-air missile systems and A2/AD (anti-access/area interdiction) strategies create contested operational environments that limit traditional concepts of command and control (C2) in the effective employment of air forces. The new US Air Force Doctrine, "Air Force Doctrine Publication 1 – The Air Force", formally establishes mission command as the philosophy for command and control (C2) airpower and centralized command, distributed control, and decentralized execution the way to be implemented. Conducting air operations in a contested operational environment requires an approach to command-and-control principles that responds to threats to communications and attacks on air operations centres. Distributed control exploits the flexibility and versatility of air power to ensure that it remains responsive, survivable, and sustainable, especially in a contested environment. The benefits associated with distributed control (as well as decentralized execution) are maximized when the commander's intent is clearly communicated and guides subordinate actions, in order to allow continuity of operations. Commanders will continue to face the challenge of harmonising centralization, distribution and decentralization, a struggle that will be situation dependent and that requires an approach within the guidance of the higher echelon.*

Keywords: *command; control; centralized; distributed; air operations; contested.*

Introduction

The c*entralized control and decentralized execution* is one of the basic tenets of air power command and control, a tenet that has proven its usefulness and importance during history. Air Force Operations Doctrine establishes this principle as being of particular importance and contributing to the effective and efficient use of air power alongside the other "basic principles of air operations employment." (Doctrina pentru Operații a Forțelor Aeriene 2016, 15)

World War II is the starting point for the first part of this basic tenet, *centralized control* which grew out of worries that dividing air power into multiple elements with distinct commands would reduce its effectiveness. As the operating environment changed the principles of air power evolved, *decentralized execution* appeared in order to allow flexibility and response to dynamic situations. (Mulgund 2021)

Pham (2019) argues that the lessons of history on the application of air power have been apparently misinterpreted, in that there has been a "dogmatic adherence to the simplistic phrase *centralized control and decentralized execution*". The security challenges of the international environment and the emergence of contested operational environments due to new weapons systems and technological progress demonstrate the need to adapt concepts of air power application.

The development of electronic and cyber warfare capabilities, space, surface-to-air missile systems and A2/AD (*anti-access/area denial*) strategies create contested operational

environments that limit traditional concepts of *command and control* (C2) in the effective employment of air forces.

The new US Air Force Doctrine, "Air Force Doctrine Publication 1 – The Air Force (2021), formally establishes *mission command* as the philosophy for *command and control* (C2) airpower" and *centralized command, distributed control, and decentralized execution* the way to be implemented.

Given the coverage and strategic effects of air power, the employment of *mission command* necessitates addressing some key elements and reaching a balance between flexibility at the tactical level, risk management, precise timing of effects to obtain synergy and the challenges and logistical realities of operations. To be able to achieve all this, the Air Force needs to:

- "concentrate responsibility and authority" to decide, direct and approve "military operations through centralized command;"
- enable the "delegation of planning, coordination" and evaluation actions to "dispersed locations or subordinate echelons as possible through distributed control;"
- promote "disciplined initiative and effective tactical control" through decentralized execution. (Mulgund 2021)

Given the realities of the operational environment and the fact that the Air Force cannot risk becoming incapable of effectively executing its assigned missions, exploring the merits of the *distributed control* tenet becomes mandatory.

A contested and changing operational environment

In contrast to recent conflicts, where Air Force operations have taken place in a permissive environment without major threats to command-and-control systems, future operations will take place in a contested environment. (Priebe 2019, 47) The conditions imposed by an adversary, who intends to contest the operating environment, require consideration of how the Air Force will analyse, "plan, decide, and coordinate actions to achieve mission success." (Mulgund 2021) Operations conducted in a contested environment are defined, "contested operations" and are described as "operations constrained by adversary capability and/or actions". (Tompkins 2018)

Currently, every operational domain is contested, air, land, maritime, space, information environment (including cyber) and electromagnetic spectrum (EMS), limiting the Air Force's ability to act. The term "contested environment attempts to encompass all adversary attempts to disrupt military operations across the depths of battlespace, including kinetic and non-kinetic attacks." (Priebe 2019, 1) For example, the adversary could "use cyber-attacks, electronic warfare (EW), offensive space weapons and ballistic and cruise missiles in order to attack critical components of military force, involving command and control systems, air bases, and communications systems." (Priebe 2019, 1) At the same time, we see that the presence of anti-access/area denial (A2/AD) environments is increasing and besides the challenge to survive in such an environment we can be positive that the communications and datalinks will be contested. This approaches to disrupting the operational environment understanding and intelligence sharing represents a "deadly Clausewitzian fog." (Pham 2019)

A study on NATO's future challenges finds that after more than a decade of Alliance operations in Afghanistan, we have become accustomed to operating without air threats against an inferior adversary. In the future, however, we must be prepared to encounter even a peer adversary. In this situation, a degraded environment can become evident through degraded or absent satellite navigation, execution of ISR missions with an adversary jamming sensors, and of course, degraded communications. It can also significantly hinder the efficient

and effective use of the electromagnetic spectrum through advanced electronic warfare (EW) operations (Ernst 2016) The development of A2/AD (*anti-access/area denial*) strategies diminishes freedom of manoeuvre and limits the Air Force's ability to operate.

The development of space and cyber capabilities can negate many of the Air Force's capabilities, including satellite communications and navigation systems and the use of Global Positioning System (GPS)-based precision weapons. Some countries have already demonstrated capabilities to attack space targets and anti-satellite weapons have been tested, validated and proven to be effective. These concepts extend into the electromagnetic spectrum domain, a key extension of the space and cyber domains which is also an intensely contested environment. Electromagnetic spectrum can be exploited by jamming systems to degrade or deny communications, the use of surveillance and radar research systems, the use of some weapons systems, network-centric operations and ISR collection. (Yalinalp 2016)

While kinetic threats such as fifth-generation fighter aircraft, advanced air-to-air missiles and long-range surface-to-air missiles are obvious threats, non-kinetic threats, commonly overlooked, are those that compromise access to information, networks, databases, and communications systems that enable command and control (C2). The development of advanced electronic warfare (EW), cyber, space and ISR capabilities, which are force multipliers, enable multi-domain operations and the creation of a contested environment. Estimating that command and control (C2) networks in future conflicts will be degraded is quickly becoming the "operational reality" for the operations planning process (Tompkins 2018).

A RAND study for the United States Air Force (USAF) identified two types of threats from a contested environment that could have a significant impact on the air operations. These threats are air attacks and long range ballistic and cruise missile strikes on air operations centres (AOC) and air bases, and disruptions of communications links between the operating points of the Air Force. The major vulnerability to the command-and-control system is from attacks on the air operations centres and substantial communications disruptions, which could render the Air Force unable to plan and coordinate the air operations. (Priebe 2019, 47-48)

To operate in a contested environment with degraded or destroyed command and control systems, Air Force processes and methods of operating must evolve. Modernizing command and control systems requires not only a hardware upgrade, but also a change in the conceptual component and *modus operandi*.

Centralized control

The Romanian Air Force's Doctrine for Operations establishes *centralised control and decentralised execution* as one of the "basic principles of air operations" that contributes to the effective and efficient use of air power. (Doctrina pentru Operații a Forțelor Aeriene 2016, 15) *Centralized control* establishes priorities for the use of air power if demands exceed the available air capabilities. Furthermore, in joint operations, the principles that contribute to the effective use of "air power are *centralized control, decentralized execution*, and *strategy to task*." (Doctrina pentru Operații a Forțelor Aeriene 2016, 21) "It can be concluded that the planning of an air operation is carried out only at the level of a single structure, whose mission is to plan and direct it, in this case the *Air Operational Component*. According to this approach, the other participating structures, in particular the Air Force structures, have only the role of participating in the operation and preparing the specific missions." (Chiriac 2018, 6)

The principle of *centralized control and decentralized execution* was adopted within the Air Force because of the uniqueness of air power, including range, speed, concentration of effort, and simultaneity of multi-level war effects. (Theriault 2015, 100) Within the United States Air Force, beginning with Second World War, "doctrine promulgated a command and

control (C2) philosophy known as *centralized control and decentralized execution*." (Priebe 2019, 48) In order to respond to a changing operational environment and with a limited number of aircraft it was considered that only under a single control authority the aircraft could be efficiently reallocated and massed. Through *decentralised execution* commanders have flexibility and can change the way a mission is executed according to the actual operational environment. (Priebe 2019, 48)

The experiences of the air operations in North Africa instilled the concept that appointing a single air commander to plan, coordinate and control air power actions in the theatre of operations leads to holistic planning. Specifically, the theatre-level commander's perspective allows him to exploit speed, flexibility and air power focus in exploiting unplanned opportunities and vulnerabilities within resource constraints. (Docauer 2014, 25)

Through centralized planning detailed guidance is communicated to lower echelons using an air mission order (ATO). Employing decentralized execution, the second element of the traditional tenet of air power, from the moment the mission has been communicated through the air mission order, the air operations centre (AOC) personnel should not typically interfere in the execution of the mission. Although the air operations centre (AOC) may have planned many of the empowering details and set operational constraints, the thorough mission planning and tactics selection necessary to successfully accomplish the mission is being accomplished at the unit executing the mission. Intermediate structures have a reduced responsibility regarding the functioning of the operational command structure. One developer of "US Air Force doctrine stated that operational experience in Central Command for approximately twenty years has conducted to a misconception that *centralized control and decentralized execution* of air power represents control at the combatant commander (CCDR) and *decentralized execution* at the mission commander level. The intermediate structures involved function mainly as force contributors and not as possible nodes of execution." (Priebe 2019, 48)

According to Hallen (2012, 12), during the Second Lebanon War, the Israeli Air Force established Forward Air Operations Centres (AOCs) directly under the main Air Operations Centre, thus adopting a flexible approach to the principle of *centralized control and decentralized execution*. In this situation, the focus of the Lead Air Operations Centre (AOC) was to conduct strategic campaign planning, the local battle space control and coordination being transferred to the Forward Air Operations Centre (AOC). The command and control architecture used by the Israeli Air Force for the application of air power was considered a success, indicating that the principle of "*centralized control* may be the product of historical misinterpretation rather than a proven tenet in its own right." (Pham 2019) Historical events highlight the fact that commanders face a wide range of operational challenges and it is unrealistic for them to follow to one or two " master principles." (Creveld 1985, 261)

Traditional command and control (C2) architecture consists of single lines of communication to a decision node, the Air Operations Centre (AOC), which processes information and then directs capabilities to produce binding effects. (Grumman 2015, 8) In a contested environment the traditional approach, *centralized control and decentralized execution*, would have substantial vulnerabilities. Physical attacks on the Air Operations Centre (AOC) or communications disruption would have significant consequences regarding "the ability to plan, execute, and evaluate air operations". (Priebe 2019, 49) To be able to execute successful operations in a contested environment it will be necessary to change the way command relationships are established, plans are prepared, "prioritizes and allocates resources, and orders are communicated." (Priebe 2019, 49)

Air power requires a thorough understanding of the command principles and flexible employment to ensure that supports the higher intent, "not dogmatic adherence to a single doctrinal tenet." (Pham 2019)

Distributed control

Conducting air operations in a contested operational environment requires an approach to command and control principles that responds to the new challenges, such as threats to communications and attacks on Air Operations Centres (AOC).

US Air Force (2021) formally established *mission command* as the new thinking for the employment of air power and "*centralized command, distributed control and decentralized execution* the principal tenet of command and control (C2)" application. (U. S. Air Force 2021) This represents a development of the air power principle, *centralized control and decentralized execution*, in order to deliver "a unifying framework for the development of new concepts of operation, organizational approaches, and material solutions to address the challenges" generated by the emerging operating environment. (Mulgund 2021)

Peck (2019, iv-v) conducted quantitative research to evaluate the effects "of decentralizing the command and control (C2) of airpower under varying operational conditions. In the research was used the experimental method pointed to test hypotheses concerning decentralization of control." "The necessary data was provided using JAEX, a stochastic, attrition-based Blue-versus-Red wargaming model." (Peck 2019, v) The dependent variable was the "mean difference between JAEX outcomes under *centralized control* and outcomes under *decentralized control*" and "independent variables were the operational conditions and the complexity of the scenario." (Peck 2019, v) The results of the experiment outlined "the relationships between operational conditions of interest and the mean difference between outcomes under *centralized control and decentralized control*." (Peck 2019, v)

According to Peck's experiment, when the Blue centralized C2 node was increasingly degraded, thus decreasing its capability to employ in logical manner the centralized control, the initial benefit of the centralized command and control, varying from 40% to 80%, declined to -20% (demonstrating and advantage for Red). Therefore, the three decentralized command and control nodes created more effective air power than the centralized Blue's nodes that were seriously degraded. (Peck 2019, v)

Distributed control exploits the flexibility and versatility of air power to guarantee that it stays "responsive, survivable, and sustainable, especially in a contested environment" (Mulgund 2021) where execution forces might lose touch with the Air Operations Centre (AOC). "*Decentralized execution* is the delegation of authority to achieve effective control, encourage disciplined initiative, and empower subordinates to exploit fleeting opportunities especially in physically or electronically contested environments.

The main effort of the *distributed control* is on:

- Disseminating and executing commander's vision, intent, and orders;
- Assuring apportionment and allocation in harmony with commander's intent;
- Local integration of kinetic and non-kinetic capabilities to synchronize effects;
- Achieving refinement of situation-based operational and tactical planning." (Mulgund 2021)

"Distributed control represents the process (how) of transitioning control authority from one entity to another" (Hostage and Broadwell 2014, 39) and does not imply, definitely, "that command authorities or command responsibilities are delegated from the Combined Forces Air Component Commander (CFACC) or a subordinated commander to another." (Hostage and Broadwell 2014, 39) The benefits associated with *distributed control* are maximized when the commander's intent is clearly communicated and guides the actions of subordinates. Undesirable outcomes may arise when distributed control is employed in the absence of precise guidance and when the overall situation, mission and operational limitations are nor clearly stated.

Under a different approach, "*distributed control* can be defined as the conditional, adaptive delegation or assumption of control activities through orders or protocols to synchronize operations, maintain initiative, and achieve commander's intent." (Hostage and Broadwell 2014, 39) According to Theriault (2015, 107), responsibility for execution of operational design, not command, is delegated to the forward commander in operations, who has a clearer picture of the immediate combat environment than the Air Operations Centre (AOC) commander. *Distributed control* drives the forward commander to some extent "to look beyond his sphere of influence and coordinate across other Air Force, joint and coalition nodes to achieve theatre-wide effects." (Theriault 2015, 109)

In order to be resilient and effective in a contested environment the Air Force must adapt and move beyond the traditional philosophy of *centralized control*. If the lines of communication and datalinks were to be disrupted, "the concept of *distributed control* empowers subordinate commanders, organizations, operations centres and battle management command and control platforms to amalgamate otherwise disconnected units into teams of synchronized combat airpower" (Hostage and Broadwell 2014, 38-39) and to increase the air power's resilience.

US Air Force Chief of Staff General David Goldfein said the Air Force is "shifting doctrinal reliance on large, vulnerable centralized command and control centres to more agile, networked solutions …treating *distributed control and decentralized execution* of multi-domain operations." (DeCook 2018) To execute the full spectrum of operations across the "competition continuum" (U. S. Air Force 2021, 2), in a contested operational environment, the Air Force needs to shift the philosophy of *command and control*, from *centralized control* to a concept of *distributed control.*

The employment of *distributed control* represents adapting the command and control (C2) system from a single node to an array of C2 nodes, increasing the resilience of the system. For example, the Joint Force Commander can choose to assign separate geographic sectors assuming that local communications would probably be more resilient. The commander can reallocate capabilities between sectors and, in the event of serious disruptions, would continue to operate following the previously stated intent of the higher echelon.

Besides creating more command-and-control nodes and realizing a more resilient command and control system, *distributed control* requires a change in how orders are communicated to subordinate units. In a contested environment, characterized by dynamic changes and disrupted communications, orders should be transmitted through "mission type orders". To achieve unity of effort, subordinates need to understand higher echelon orders and the commander's intent rather than to receive detailed orders. (Priebe 2019, 54-55)

Mission type orders (MTOs) are an order writing "technique" that gives subordinates "maximum freedom of action within the commander's intent. By focusing on objectives and effects rather than targets, they emphasise the results to be achieved based on the priorities and intent of the higher echelon, not how to achieve them. By expressing intent and direction, the commander seeks to provide clear objectives and goals to enable subordinates to execute the mission. The commander's intent should specify the goals, priorities, acceptable risks, and limitations of the operation" in order to enable the subordinates to function autonomously for the stated period of time. (Mulgund 2021)

Mission type orders (MTOs) should contain clearly and concisely the "mission, organization, commander's intent and overall concept of the operation, tasks to subordinate units, and minimum essential coordination instructions." (Mulgund 2021) Mission type orders (MTOs) follow the normal five paragraph order (situation, mission, execution, force sustainment and command, signal and communications) "can be adapted an applied to peer and lower echelons and are issued based on the direction given in the planning orders

(PLANORDs), operations orders (OPORDs), joint air operation plan (JAOP) and the air operations directive (AOD)." (U. S. Air Force 2021, 12-13)

Commanders will have a difficult task on the degree of authority to delegate to subordinates in a contested operational environment. The 7440th Fighter Wing, that was deployed in Turkey for the Operation Desert Storm, had the authority to plan the packages for the missions, allocate aircraft, and design the operation after receiving only the objectives and a list of targets from the Air Force commander. (Priebe 2019, 55-56)

For example, in an extreme situation, the commander might assign a subordinate unit a very important and demanding mission, (suppression of enemy air defences in a specific geographical area for a specific period of time) and allow the unit to determine resource allocation, establish mission packages and execute the necessary tasks to accomplish the assign objective. "In this model, the air tasking order (ATO) would be created in a distributed rather than central manner in the Air Operations centre (AOC), centralized control and detailed orders allowed the commander to allocate limited resources, reallocate as priorities changed, and retain the sensitivity of policy decisions at higher echelons. However, detailed control has made the Air Force dependent on a small number of vulnerable nodes. Latency and disruptions in communications between AOCs and the force can also make a centralized process too slow." (Priebe 2019, 56)

According to Hostage and Broadwell (2014, 43) "the mantra of centralized command, distributed control and decentralized execution is not a change from our past, but a healthy adaptation to the realities of contemporary warfare." The realities of the operational environment have changed dramatically, the Air Force needs to adapt and change the way he trains, plans, prepares and conducts operations to be resilient and successfully accomplish the missions.

Commanders will continue to face the challenge of harmonising centralization, distribution and decentralization, a struggle that will be situation dependent and that requires an approach within the guidance of the higher echelon.

Conclusions

The rapid changing operational environment has demonstrated the need to adapt the concepts of air power use. In a contested environment, threats to communications and the risk of attacks on air operations centres (AOC) will challenge the traditional approach to command and control (C2) of air power, *centralized control and decentralized execution*. The new philosophy of the US Air Force, *centralized command, distributed control and decentralized execution*, is the response to a contested and fluid operational environment.

Distributed control and the use of mission orders (MTOs) are the answer to changes in the operating environment and would allow the Air Force to continue to carry out its missions effectively. Distributed control leverages the flexibility and versatility of air power to ensure that it remains relevant, especially in challenged environments where the loss of connections between execution structures and the Air Operations Centre (AOC) will be a reality.

The doctrinal revision is not a singular approach, the adaptation to the new operating environment and the implementation of the new concepts of command and control will be a long and at the same time transformational process for the Air Force.

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