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Introduction

Today's military operations are becoming more complicated with the increasing number and variety of options available to commanders at all levels. The expansion of military activity beyond the Air, Maritime, and Land domains to Space and Cyberspace has broadened the community of warfighters that modern militaries require to operate successfully and efficiently in the battlespace. As the changing character of war becomes entangled in the digital world, future conflicts will be decided by those who are the fastest at collecting, correlating, fusing, analysing, and securely transporting the required quality data across multiple domains to the appropriate decision-maker.[1] This inevitable transition into a new technological era directly affects all critical air operation concepts, including Close Air Support (CAS).

In military tactics, CAS is defined as air action, such as air strikes, by fixed- or rotary-wing aircraft against hostile targets in proximity to friendly forces and has

Close Air Support Command and Control

Digitally Enhanced CAS Operations

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played a critical role in recent military operations. Providing CAS to joint forces remains a crucial mission in the context of joint operations. In addition, CAS has to meet operational requirements to maintain its undeniable place in future wars. One of the basic criteria to achieve this is to act seamlessly with other forces while effectively and efficiently conducting all CAS missions.

Since CAS requires detailed coordination between forces to maintain high-situational awareness on the battlefield, having the ability to operate in all domains with improved and digitized communication systems, which complement traditional CAS procedures, is vital for conducting effective CAS. One way to attain this goal is the enhanced Digitally Aided Close Air Support (DACAS) capability.

DACAS is defined as a machine-to-machine exchange of the required CAS mission data between the Joint Terminal Attack Controller (JTAC), or the Forward Air Controller (FAC), and a CAS platform or a Command and Control (C2) node.[2, 3] The primary purposes of the

DACAS capability are to identify friendly forces, locate enemy positions, reduce human input error, share real-time targeting information between CAS participants, and supplement voice communication. A few nations are currently using datalink standards with multiple network options and message formats to provide evolving DACAS capabilities. However, there are critical interoperability problems with this methodology, due to the diversity of the national communications capabilities and systems as they are often unable to communicate seamlessly with each other. Recent DACAS activities, notably in the Bold Quest events,[4] have focused on developing and improving the interconnectivity or the machine-to-machine interface. Collaborative efforts are developing gradually, with some technical aspects concentrated on incorporating emerging and cutting-edge digital technologies as we move towards a more effective CAS.

Digitally Capable Communications in CAS Operations

C2 tasks traditionally include establishing the command hierarchy, authority allocation and delegation, planning, allocating resources, and assigning and managing functions accordingly to the mission's objectives. Much of the available data is often irrelevant to most users, and there must be guidelines on who gets what information. In the future, information technology must enable decision-makers access to high-quality relevant information, at the right moment, corresponding to their position within the C2 organization. C2 is not just about situational awareness; it is also about how and who makes decisions. Dynamic, real-time information sharing and networking are critical for establishing full operational capabilities and facilitating these exchanges.[5] Most NATO member nations' services operate dedicated, yet independent C2 systems. Often, these systems do not communicate seamlessly with each other. Sometimes, even the different branches of a nation's military use C2 systems tailored to their specific needs and special conditions. However, many NATO nations have identified this issue and are in the process of developing modern, overarching networks, aimed at bringing the different services under a unified C2 architecture.[6] Effecting new C2 among allies will require commanders and subordinate commands to operationally and technically digest the cross-cutting nature of Multi-Domain Operations (MDO). NATO is already acting on this challenge, thus preparing for future interoperability problems.[7]

Effective C2 is also one of the critical factors in leading successful CAS missions and minimizing the likelihood of fratricide. CAS C2 requires a secure, dependable, and interoperable communications system between aircrews, air control agencies, JTACs/FACs, ground forces, and fire support agencies. From a CAS standpoint, sensor and communications suites represent the system's heart and soul. Generally, communication capabilities should be reliable and interoperable enough to move the CAS asset to the target area safely and execute the mission effectively.

Aircraft and ground units have a variety of communications equipment, which operate across a range of frequencies, enabling voice or digital communications during a CAS mission. For instance, JTACs are equipped with various radios to communicate with aircrews via voice and with specific devices to enable digital data communications for DACAS. However, aircraft capabilities vary, affecting the contact with the JTACs, and not all aircraft are capable of digitally communicating across most common digital systems and message formats.[8] Conveying the wrong message, due to miscommunication, especially during the targeting phase, can cause unexpected collateral damage. Therefore, identifying friendly forces' locations and accurately marking targets' positions directly enhance the situational awareness of a CAS team. All CAS participants rely on accurate battlefield information provided by all available assets during every part of a CAS mission.

The transition to digital control of CAS operations began in earnest over the past decade. With little guidance to ensure interoperability, nations often fielded non-standard, non-interoperable, service-specific digital data exchange capabilities. These non-interoperable systems degraded mission performance in joint and coalition environments and increased the potential for human errors. Some NATO and national capability events and exercises assessed the Alliance's

digital CAS interoperability issues. While the development of tablet digital communications has been underway for some time, the current focus is to develop an improved data load file that provides optimized digital, machine-to-machine communication between JTAC and striker. Overcoming these interoperability issues will improve the speed of the CAS information exchange and data accuracy, enabling CAS forces to be more effective and resilient.

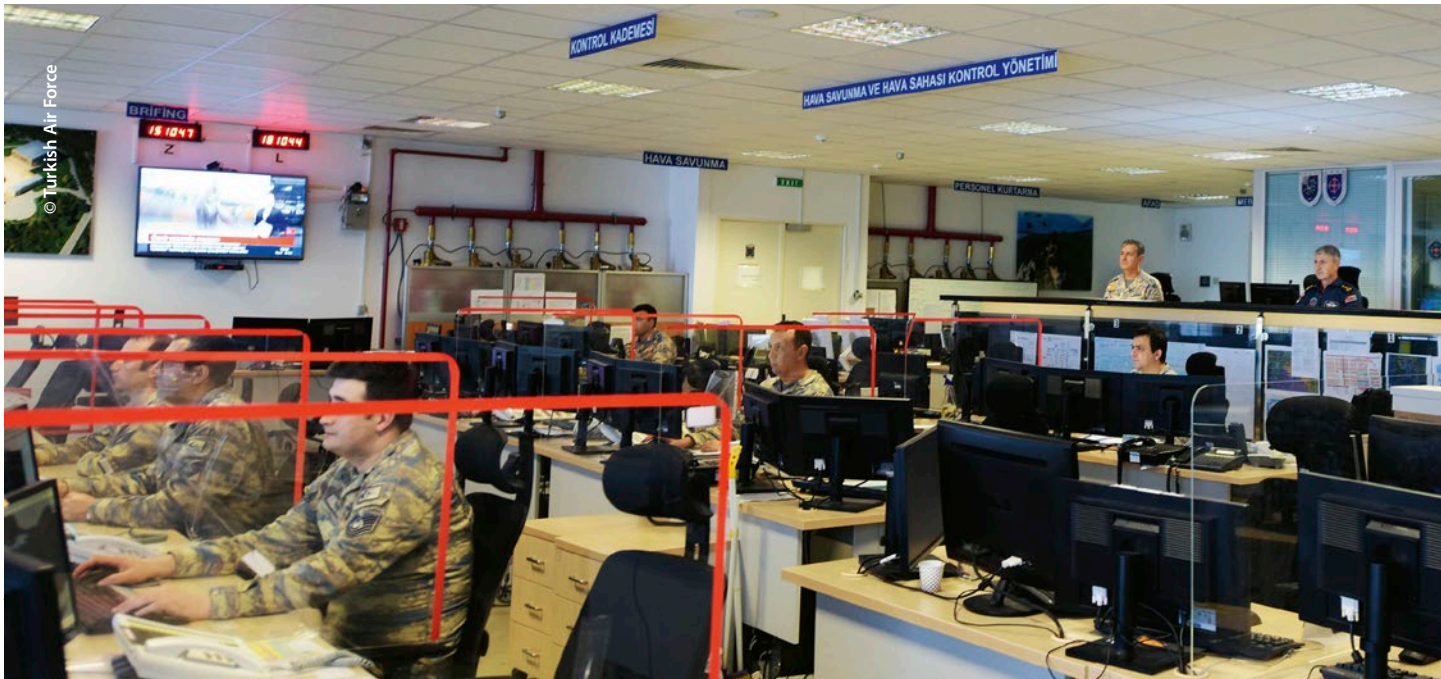
NATO Communication and Information Agency has worked to develop an understanding of the standards required for DACAS equipment and identify interoperability challenges. The Bold Quest exercise series aims to develop CAS C2 and DACAS capabilities at all levels, offer new solutions to address interoperability problems, and use them synchronously between the participating countries.

However, there has been much delay in accepting digital technologies, which has led DACAS development efforts to be coordinated across services and nations. Standardization has not occurred across all Alliance's JTAC schools, partly due to the large number of disparate national and service-specific communications networks used for CAS.[9]

A Battle-Proven Approach

A system's survivability is defined as 'the capability of a system to avoid or withstand hostile environments'.[10] From the commander's point of view, taking all necessary steps, starting from the research and development stages of new equipment, is essential for providing safety for the troops on the battlefield. Generally, the technological advances implemented into extant or new weapons and sensor systems, besides influencing C2 structures, drive the amendment of concepts, doctrine, and tactics, techniques, and procedures. There must be a balance between combat survivability, mission performance, and systems' reliability. The responsiveness of Air Power is crucial for ground forces' survivability, with a direct impact on their schemes of manoeuvre.

The Turkish Air Force (TURAF) has made one noticeable combat survivability approach for CAS operations. Turkey has conducted successful air and ground operations against terrorist organizations for a long time, especially in high-threat and contested environments such as Syria. Syrian urban environments create complex challenges when conducting CAS. Apart from the risks posed by the defensive strategic weapon systems at high- and mid-altitudes, the lower echelons of the Syrian airspace were also dangerous. Peer-adversary jamming activities also challenged the friendly communications networks during these air operations. To overcome the significant environmental challenges, minimize the threat exposure, and respond immediately to time-sensitive and fleeting targets, TURAF established a digital backbone to



expedite the application of CAS. During the CAS execution phase, digital aids to verbal communications such as machine-to-machine tasking and information exchange among CAS participants provided advantages of speed and accuracy.

The main goal was to provide appropriate means to maximize mission effectiveness and combat survivability of both CAS assets and friendly ground forces in this high-threat operational environment.

The Turkish Joint Force Air Component (JFAC) is the central and final control node for tactical air command, control, and communications and remains the focal point for coordinating aerial firepower in CAS missions. The JFAC embedded CAS team provided air expertise and has integrated the liaison and coordination functions together with other supported ground forces. Having a resilient digital and secure communications network interconnecting all services plays a crucial role in air operations. JFAC digital solutions supported missions across all communications infrastructures (wireless access, telephone access, intercom, telephone conference loops, and Link-16 voice loops). With the help of those capabilities, the JFAC carried out efficient air mission control with traditional elements (coordination of artillery fire, airspace control measures, safe routing of CAS aircraft, and distribution of C2 messages among all participants), expedited communications, and enhanced cognitive awareness on the battlefield. Decision-makers executed collective actions while being responsive to the changing environment. Timely target acquisition was fundamental to effective and responsive CAS. Therefore, all available Unmanned Aircraft Systems (UAS) sensor capabilities, used for target acquisition to pinpoint enemy locations and discriminate them from friendly troops and civilians, were fused into the joint operation centre to feed the JFAC's dynamic targeting processes in real time. With this support, the CAS team and planners could obtain timely and accurate intelligence data on the enemy's capabilities and locations, in order to make informed decisions.

TURAF deployed agile software capabilities to cover all necessary data, such as Air Tasking Orders (ATO), Airspace Control Orders (ACO), Airspace Control Plans (ACP), and Notice to Air Missions (NOTAM) etc., in a digitized information network pool. All C2 elements reached out to the Single Integrated Air Picture (SIAP) over the network, which was a crucial decision-making element for airspace management. It produced synergy, efficient information transfer, and accurate data exchange among services. The necessary warfighting data was fed into all other services or shared on request. Creating more C2 nodes on a case-by-case basis and handing over more responsibilities to subordinate units via mission-type orders helped achieve the commander's intent.

Through this overarching CAS C2 construct, the joint force's capabilities were enhanced beyond the limits

of individual sensors leading to better coordination of engagements, superior management of scarce battlefield resources, and greater situational awareness over larger areas.

Going Forward

Effective CAS requires detailed coordination between aircrews and ground forces, coupled with two-way seamless communications capabilities. Technology is rapidly maturing and becoming a vital factor in future combat operations. By leveraging the capability of digital data communications systems and voice communications, coordination is enhanced to achieve accurate, timely, and responsive CAS operations. However, there are always interoperability challenges hindering these efforts. To improve the interoperability in NATO regarding DACAS, a thorough understanding of the specific digital communications capabilities is required.

Likewise, by constantly addressing the interoperability issues and emphasizing the need to share relevant information, future situational awareness will be set, especially in the light of technological developments and lessons learned. The ability to speak the same digital language with each other in joint operations will contribute to the effectiveness of NATO forces in contested operational environments. The standard one-size-fits-all solution is not always available, and decision-makers should explicitly balance and leverage emerging technologies according to military requirements to maintain the edge in future high-threat battle arenas. Other than the technological mitigations for challenging C2, the next best option might be to digest the lessons learned from past air campaigns in geopolitically sensitive and risky areas. Creating cognitive awareness among the Alliance's member nations will be crucial to enhancing the situational awareness of DACAS and CAS capabilities in future conflicts. To win future battles, the side with an information advantage across multiple domains will undoubtedly be more successful. It is essential to ensure that the right information is available to the right decision-maker at the right place and time. More than ever before, Air Power practitioners must have a clear and common understanding of simultaneous manoeuvres in multiple domains. Through NATO's Defence Planning Process, the Alliance should harmonize new concepts with new thinking to adapt MDO to interoperability and preparedness for C2 resilience. ●

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