REPORT DOCUMENTATION PAGE

Form Approved
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1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
20-04-2018	Master's Thesis	Aug 2017 - Apr 2018

4. TITLE AND SUBTITLE

The Air Force C2 System:
An Essential Element of Multi-Domain Battle

5a. CONTRACT NUMBER
N/A

5b. GRANT NUMBER
N/A

5c. PROGRAM ELEMENT NUMBER
N/A

6. AUTHOR(S)
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5d. PROJECT NUMBER
N/A

5e. TASK NUMBER
N/A

5f. WORK UNIT NUMBER
N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Joint Advanced Warfighting School
Joint Forces Staff College
7800 Hampton Blvd
Norfolk, VA 23511

8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Joint Forces Staff College
7800 Hampton Blvd
Norfolk, VA 23511

10. SPONSOR/MONITOR'S ACRONYM(S)
JFSC

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
N/A

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release, distribution is unlimited.

13. SUPPLEMENTARY NOTES

N/A

14. ABSTRACT

The character and conduct of warfare continue to change the modern battlefield. For the last two decades the United States military has evolved from its Air-land battle construct, designed to defeat a massive conventional attack, to an organization that is capable of coordinating distributed effects to find, fix, and defeat terrorists. The modern battlefield, however, is and will continue to be, different. It is more fully integrated across the entire globe and in each operational domain. This evolutionary development presents a new level of complexity requiring extensive cross-domain integration to achieve operational success versus high-level coordination as in the past. To achieve success in this new environment, the U.S. military is developing a new operating concept - multi-domain battle (MDB). In MDB, the different services will operate in an integrated manner across multiple domains simultaneously and sequentially in mass scale to achieve operational effects. If successful, MDB as a concept will allow forces to present overwhelming tactical and operational challenges to adversary's, thus ensuring we maintain a decisive operational advantage. The operational effectiveness of MDB relies almost completely upon command and control (C2). C2 is essential to

15. SUBJECT TERMS

Multi-Domain Battle, Multi-Domain Battle Command & Control, Command & Control, Air Battle Manager, Operational Art, Air and Space Operations Center

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Brandon C. Durant
Unclassified	Unclassified	Unclassified	SAR	51	19b. TELEPHONE NUMBER *(Include area code)* 757-443-6051

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NATIONAL DEFENSE UNIVERSITY

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The Air Force C2 System:

An Essential Element of Multi-Domain Battle

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THE AIR FORCE C2 SYSTEM:

An Essential Element of Multi-Domain Battle

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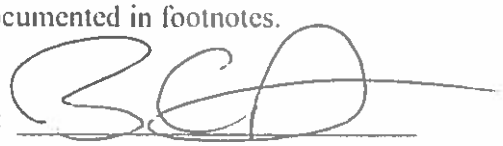
A paper submitted to the Faculty of the Joint Advanced Warfighting School in partial satisfaction of the requirements of a Master of Science Degree in Joint Campaign Planning and Strategy. The contents of this paper reflect my own personal views and are not necessarily endorsed by the Joint Forces Staff College or the Department of Defense.

This paper is entirely my own work except as documented in footnotes.

Signature: 

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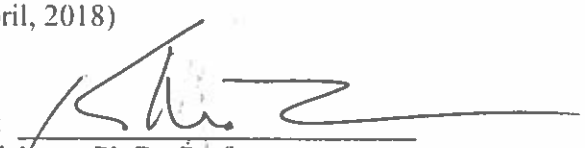
Thesis Adviser: Signature: 
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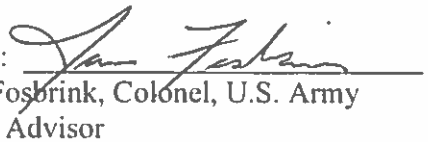
Approved by: Signature: 
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ABSTRACT

The character and conduct of warfare continue to change the modern battlefield. For the last two decades the United States military has evolved from its Air-land battle construct, designed to defeat a massive conventional attack, to an organization that is capable of coordinating distributed effects to find, fix, and defeat terrorists. The modern battlefield, however, is and will continue to be, different. It is more fully integrated across the entire globe and in each operational domain. This evolutionary development presents a new level of complexity requiring extensive cross-domain integration to achieve operational success versus high-level coordination as in the past. To achieve success in this new environment, the U.S. military is developing a new operating concept - multi-domain battle (MDB). In MDB, the different services will operate in an integrated manner across multiple domains simultaneously and sequentially in mass scale to achieve operational effects. If successful, MDB as a concept will allow forces to present overwhelming tactical and operational challenges to adversary's, thus ensuring we maintain a decisive operational advantage. The operational effectiveness of MDB relies almost completely upon command and control (C2). C2 is essential to synchronizing multiple effects in time and space at a level never before attempted by operational commanders. As a key provider of joint C2, the Air force has recognized that its current C2 system is not capable of supporting MDB, yet it has not identified what must be done to improve it. This paper identifies these requirements and then uses them to assess the current Air Force C2 system in order to determine where shortfalls exist preventing it from being able to provide C2 required to support DB operations. It then concludes by

providing recommendations for how to improve both the Air Force and Join force C2 systems to ensure they are prepared to deliver C2 capable of supporting MDB operations.

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CHAPTER 1: INTRODUCTION – THE FUTURE BATTLEFIELD

"War is more than a mere chameleon that slightly adapts its characteristics to the given case." Carl Von Clausewitz[1]

"It is a good thing to build-up and master the employment of new technology in battle, to set up new and more effective forms of co-operation, to restructure the organs of command and control and establish more complex procedures[.]" M.V. Tukhachevskii[2]

As the character and conduct of warfare continue to change military planners have begun to change how they adapt to the condition of the modern battlefield. For the last two decades the nation's warfighting concept have evolved from an Air-land battle approach to defeat a massive conventional attack to a distributed battlespace of assets capable of finding, fixing, and defeating irregular actions across the globe. As the capabilities required to conduct these operations continue to evolve, they are being considered for employment in major combat operations on the emerging battlefield is both physically and conceptually more complex - a battlefield that is now fully global and multi-dimensional. Actions in this battlefield are expected to span across operational domains simultaneously and transcend geographic boundaries. Based upon this, in future warfare, the control of multiple domains will be the key to achieving decisive action.

To overcome this emerging operational challenge, the Army, Air Force, and Marine Corps have developed two interrelated concepts: the Army-Marine Corp's Multi-Domain Battle (MDB) concept and the Air Force's Multi-Domain Command and Control

[1] Carl Von Clausewitz, *On War*, translated and edited by Michael Howard and Peter Paret, (Princeton:, NJ: Princeton University Press, 1976), 89.
[2] Richard Simpkin, *Deep Battle: The Brain Child of Marshal Tukhachevskii*, (London: Brassey's Defence Publishers, 1987), 154.

(MDC2) concept.[3] MDB is derived from the Air-land and Air-Sea battle concepts that sought to coordinate operations within two domains and within one geographic battlespace[4]. MDB aims to integrate operations simultaneously within multiple domains and battlespaces. MDB recognizes and attempts to adapt advancements in technology, specifically cyber and information that have changed the operational environment. In applying advanced technologies MDB will allow for multiple operations to be conducted by multiple services and specialties into and out of multiple domains. In doing this an unprecedented level of centralized command will be required, which will support an equally unprecedented level of force integration and effect synchronization. Specifically, MDB will allow friendly forces to operate in all domains simultaneously and sequentially regardless of their actual location allowing joint force commanders to achieve overwhelming capability simultaneously to create tactical and operational challenges beyond which an adversary can overcome.[5] In other words, in MDB, the enemy will be paralyzed – constantly pressured in all domains and fixed in time and space, suspect to being observed, attacked, destroyed, or neutralized at will. To appreciate the complexity associated with MDB discussed to this point a more detailed explanation of its operational framework must be understood..

As noted in Figure 1, MDB has renamed the three operating zones developed in Air-land battle (rear, close, and deep) to tactical support area, close area, and deep maneuver area, and added three supporting zones; the strategic support, operations

[3] David G. Perkins, "Multi-Domain battle: Driving Change to win in the Future," *Military Review*, (July-August 2017), 8-9.
[4] Ibid, 11.
[5] David L. Goldfein, *Strategic Studies Quarterly*, (Maxwell AB Alabama, Spring 2017), 8.

support, and deep fires.[6] The strategic support zone is where cross-combatant command coordination occurs, as well as where, joint logistics, nuclear, and strategic level space and cyber effects are coordinated and controlled.[7] The operational support zone is where the operational level command and control (C2) is located. This zone is comprised of conventional joint located within range of enemy kinetic fires.[8] The deep fire zone is beyond the range conventional forces can be employed, where joint fires, special operations, and tactical level cyber and information warfare specialists will operate.[9]

[6] U.S. Army, *Multi-Domain Battle: Evolution of Combined Arms for the 21st Century*, (Dec 2017), 9-11.
[7] Ibid, 10.
[8] Ibid, 11.
[9] Ibid, 9.

MDB Operational Framework

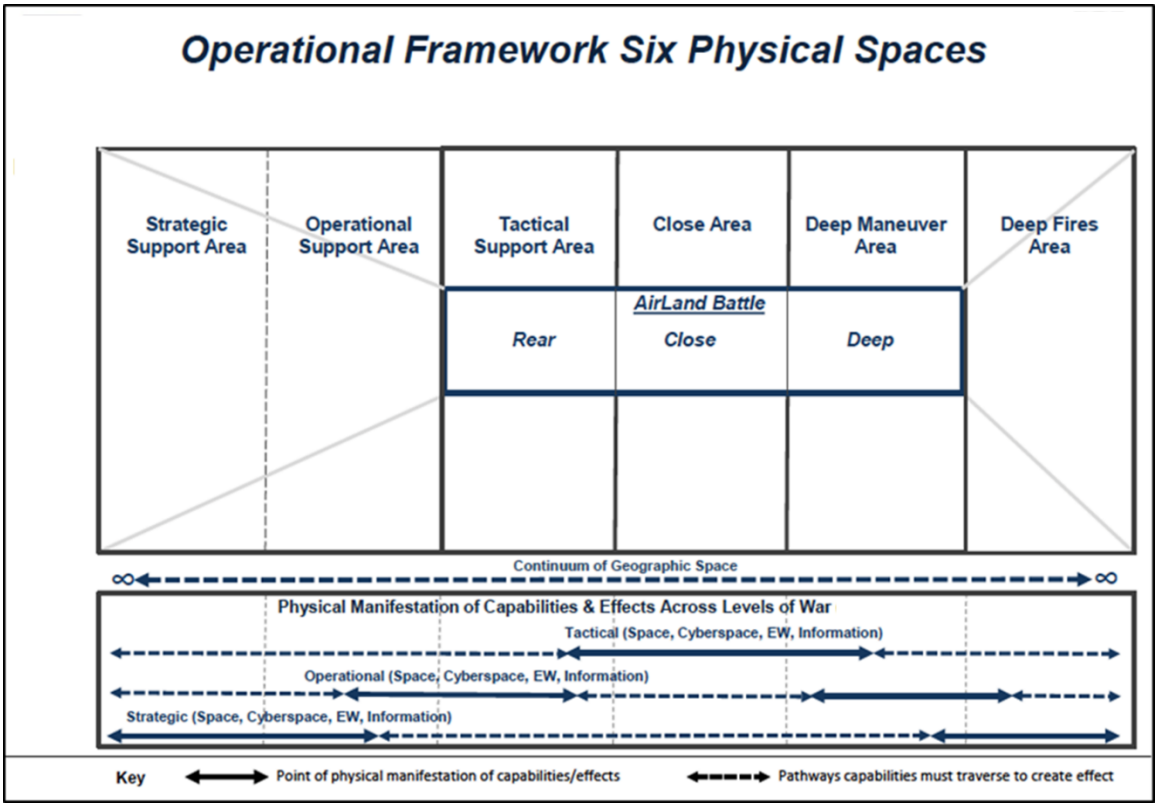

Figure 1: Six MDB operational zones and their relationship between operational domains.

Execution of operations in these interrelated zones will require layers of both simultaneous and sequential control s noted in Figure-1[10] To more clearly show the integration between the operational zones let us examine a notional scenario. In a future conflict an operational commander located in the operational support area becomes notified via strategic intelligence generated inside the strategic support area that a strategic level target will be moving in ten-minutes. Not having planned to prosecute this target the operational commander assess their environment and identifies that a two-ship of F-35s are the best assets to be used to prosecute the emerging target. The F-35s, though, are a lead element of a deep-strike bombing package tasked with providing an electronic attack (EA) mission to support a ground operation in the close area while enroute to neutralizing a critical air-defense node in the deep fires area. In retasking the F-35s the commander has created an operational problem in that two unsupported missions now exist – the F-35's original EA and deep strike missions. In assessing the situation the commander is made aware that both strategic and tactical level cyber assets can accomplish the F-35's original missions form the strategic support area and close area. Through rapid information processing the commander is able to resynchronize his forces to enable capitalizing on the unforeseen strategic target while simultaneously supporting the other planned actions. This example may be fictitious but it emphasizes the complexity present in MDB. Furthermore, when multiplied a hundred times over with each action being conducted simultaneously, one can begin to appreciate the challenges the MDB concept generates at both the tactical and operational levels for commanders

[10] David L. Goldfein, *CSAF Focus Area: Enhancing Multi-Domain Command and Control…Tying It All Together*, (Washington DC: March 2017).

and their staffs underscoring the importance of having an equally sophisticated C2 system.

MDB will require a far more advanced operational C2 system than previous operational concepts did. Specifically it will have to be capable of integrating forces versus coordinated them. Unlike coordination, which is having different components work efficiently together, integration implies fusion or linkage of disparate components to achieve a common goal. Many senior military leaders agree that the services have mastered the art of coordination and must now evolve to become a highly integrated joint force.[11] Thus, MDB's success is reliant upon an equally sophisticated C2 system, form which commanders can achieve unprecedented integration. Specifically it must be a system capable of employing forces and functions within and between the close, support, and deep areas, while simultaneously tracking and interpreting actions in time and space for the strategic support zone, the operations support zone, and the deep fires zone.

In his book, *Command in War*, Martin Van Creveld shows that, historically, successful commanders have been ones that effectively organize their C2 system to enable them to apply operational art. He expands upon this idea by asserting that C2 systems have two conceptual perspectives - cognitive and physical.[12] The cognitive perspective, he reasons, is command itself, which is defined as a commander's ability to navigate uncertainty and operate with limited information.[13] It is also how a commander processes information, which occurs in four unique ways. They process impressions gained from disparate bits of information that touch specific sensibilities acquired

[11] Ibid, 1.
[12] Van Creveld, Command In War, (Harvard University Press, 1985), 268-275.
[13] Ibid, 268-275.

through experience. They process inputs from trusted sources, such as staffs and fellow commanders. They continually assess how their vision and intent are unfolding. Last, they analyze how the correlation of forces, friendly and enemy, during every phase of an operation. In whole, these actions equate to the application of operational art, which defined by joint doctrine, is the "the cognitive approach by commanders and [their] staffs, supported by their skill, knowledge, experience, creativity, and judgment – to develop strategies, campaigns, and operations to organize and employ military forces".[14]

They physical perspective of a C2 system is comprised of the people (staffs), equipment, and structural organization of the physical parts.[15] People, like the commander, Van Creveld argues must be operational artist or they will not be capable of supporting a commander.[16] Equipment must be able to process and present information to enable staffs and commanders to accurately assess their environment and make decisions. And organizations must facilitate efficient and concise transference of information at all levels of command in order to support a commander.

In sum, Van Creveld, concludes that historically, how well commanders develop both the cognitive and physical aspects of their C2 systems: how they structure it, train the personnel that operate it, and apply technology to support it, directly correlates to their rate of operational success.[17] He also emphasizes that technology is vital but not a silver bullet that provides a panacea to developing an effective C2 system. There must be a balance between highly trained C2 personnel coupled with advanced technology.[18]

[14] Joint Publication 5.0, (Washington DC: June 16, 2017), IV4-IV5.
[15] Van Creveld, Command In War, (Harvard University Press, 1985), 268-275.
[16] Ibid.
[17] Ibid.
[18] Ibid.

Using this framework one must begin to question if current military C2 systems are suitable and capable of supporting MDB operations, specifically the U.S. Air Force who operates in three of the five doctrinally recognized operational domains.

Air Force General David L. Goldfein gained an appreciation of the importance of C2 on the modern battlefield as the Central Command's Joint Force Air Component Commander. Before taking the positon he believed he would be responsible for air operations, but quickly after being in the job he states that he realized that he was responsible for far more than just air planning and execution. Indeed, he was responsible for providing C2 for the entire region, and as the Joint Force Air Component Commander, he was charged with orchestrating the capabilities of components across all operational domains to overcome adversaries in time and space.[19]

Now as the Chief of Staff of the Air Force, he recognizes that MDB's success is predicated on the Air Force's ability to operate and deliver a C2 system that supports both joint and combined operations in multiple domains. The Air Force has identified the requirements of a future C2 system to support MDB, which it calls multi-domain command and control (MDC2) in a document issued in 2017 titled *Air Force Future Operating Concept: A View of the Air Force in 2035.* In examining the concept its evident the Air Force's current C2 system is not capable of supporting MDB operations, and General Goldfein would be the first to admit this. Knowing this, General Goldfein has reemphasized the Air Force's commitment to MDC2 by making it his one of his top three priorities.[20]

[19] David L. Goldfein, presentation at Air Power Conference, (London England, Jul 17).
[20] David L. Goldfein, *CSAF Focus Area: Enhancing Multi-Domain Command and Control…Tying It All Together*, (Washington DC, March 2017).

As General Goldfein has recognized, the Air Force's current system is not ready to support MDB operations. Therefore it is critical that the Air Force identify what the essential modification and capability requirements are in order to facilitate changes to enable it to support MDB operations. Using the MDB framework, provided, it is possible to do this, which is what this paper will do. The following chapters will describe the physical elements of a C2 system from which a MDBC2 framework will be established, then it will analyze the current Air Force C2 system using the established MDBC2 framework, and it will provide recommendations for improving the Air Force and joint force C2 systems.

CHAPTER 2: MULTI DOMAIN C2 REQUIREMENTS: TWO ESSENTIAL ELEMENTS

"There is a lot of important and complicated stuff happening in those lightning bolts" – Anonymous U.S Air Force General[1]

An effective C2 system links the commander and an organization together through two elements - physical and functional. The physical element has two sub-elements; equipment and personnel of which the equipment sub-element relates to the application of technology in C2 systems, and the personnel sub-element deals with how C2 staffs are trained to support a commander in applying operational art. The functional element relates to how the staffs in a C2 system effectively conduct operational art. Academically, these elements are often discussed in isolation where in reality they actually work together in a building block manner in which the sub-elements of the physical element inform and support each other to enable the actualization of functional element. Using this framework this chapter describes each element and sub-element, starting with the physical followed by the functional, in order to identify the qualitative outputs each yield, and from these outputs the requirements for an effective MDBC2 system will be ascertained.

2.1: Physical Element – Equipment and Personnel

The functional element is comprised of two sub-elements. The equipment sub-element that informs and supports the physical element. In the equipment sub-element

[1] In operational campaign briefings a U.S. Air Force general referred to the lightning bolts, which are commonly used to depict the C2 function on graphical images, as having a lot of complicated and important stuff happening inside them, which implies they understand the complexity of C2 but did not fully appreciate the technical or conceptual aspects of it.

effectiveness has historically been related to security, network capability, and ability to conduct data processing.[2] Being able to maintain security of all lines of communication (LOCs) and telecommunication nodes has always been a critical aspect of a C2 system[3] Preventing enemy forces from being able to ascertain what one knows or does not know is vital and C2 equipment must be secure enough to prevent enemy intrusion. In a the future battlefield, in which cyber technology is highly relied upon, establishing and maintaining C2 security will be challenging yet incredibly important. Just as in the past adversaries in MDB operations will have to be prevented from accessing our equipment and networks. Having said this, future C2 equipment must be capable of preventing enemy intrusion and action against our C2 equipment.

Having C2 equipment be interoperable has also historically been a requirement for an effective C2 system, but in the digital age this is requirement has become more complex.[4] Now machines are connected to a myriad of other machines at an unprecedented level resulting an astonishing rate of development and integration of how computer system can pass information between each other, over great distances and with rapid speed. Thus an effective MDC2 system will have to be supported by machines that are networked, interoperable, and connected to all existing and future intelligence and battlefield information systems.[5]

To support commanders in assessing their environment and decision making successful C2 system have traditionally relied upon the most advanced technology to

[2] Maykish, Paul, "C2 Rising", *Air & Space Power Journal*, (Jul – Aug 2014), 36-40.
[3] Ibid, .
[4] Ibid, 47-51.
[5] David L. Goldfein, presentation at Air Power Conference, (London England, Jul 17).

processing raw data into decision quality making information.[6] This will be no different for an evolving MDBC2 system. It will need to be able synthesize raw data rapidly from across all operational domains and then further synthesize the data into information of decision making quality.[7] Lastly, the system must be able to present the information to users at all levels in a manner in which they can rapidly and easily understand it and apply it to decision making, which will be discussed in greater detail in the discussion of the functional element.

In the personnel sub-element effectiveness has normally been attributed to the quality of operational artist the C2 personnel are, the level of their C2 knowledge, and their level of operational experience. Again, Creveld, shows that historically operational success has been correlated to the propensity C2 personnel are in understanding the concept of operational art. In making this assertion he determines that C2 personnel will be effective in understanding the commander's operational design, their vision and operational requirements. They will also be able to assess and better understand the operational environment allowing them to provide the commander with a complete picture of the enemy and friendly situation within considerations of time and space. They also have been effective in understanding the nature of the myriad of problems that arise during operations, and have historically been capable of make the right assessments required to support a commander's decision making process to overcome operational problems. For MDBC2 the need for C2 personnel to be operational artist will not change,

[6] Maykish, 38-41.
[7] David L. Goldfein, *CSAF Focus Area: Enhancing Multi-Domain Command and Control…Tying It All Together*, (Washington DC, March 2017).

and in fact, it will be of greater importance than ever before due to the increased complexity associated with MDB operations.

Effective C2 personnel have also normally possessed both a conceptual understanding of C2 and a base of experience at the tactical and operational levels of war[8]. Understanding the structure and purpose of operational level C2 enabled C2 personnel to be able to assess and monitor the health of a C2 system, since they knew what it should be doing and at what level. Having C2 personnel with operational experience has historically provide a C2 systems with temperament allowing it to be resilient during high intensity operations.[9] Additionally, practical operational experience enables credibility required during face-to-face interactions between C2 staff and other senior operational commanders as they process and work through problems so support the commander in his decision making process.[10] Again, like all the other qualitative outputs an MDBC2 system will need to have C2 personnel that possess both a working knowledge of C2 and some degree of operational experience.

Depicted in Figure-2 is the informing-supportive relationship between the two sub-elements of the evolutionary physical element with the qualitative outputs. Of each one labeled in the boxes located inside each circle. The equipment must be securable, networked and capable of data processing, and the personnel must be operational artist who possess both a working knowledge of C2 and operational level experience. Having presented a working understanding of this element the next section will explore the

[8] Lyle, David., "The Rest of the C2 Iceberg", *Air & Space Power Journal*, (Jul – Aug, 2014), 66.
[9] Ibid, 67.
[10]Ibid.

functional element and underscore how it's fundamentally supported by the physical element.

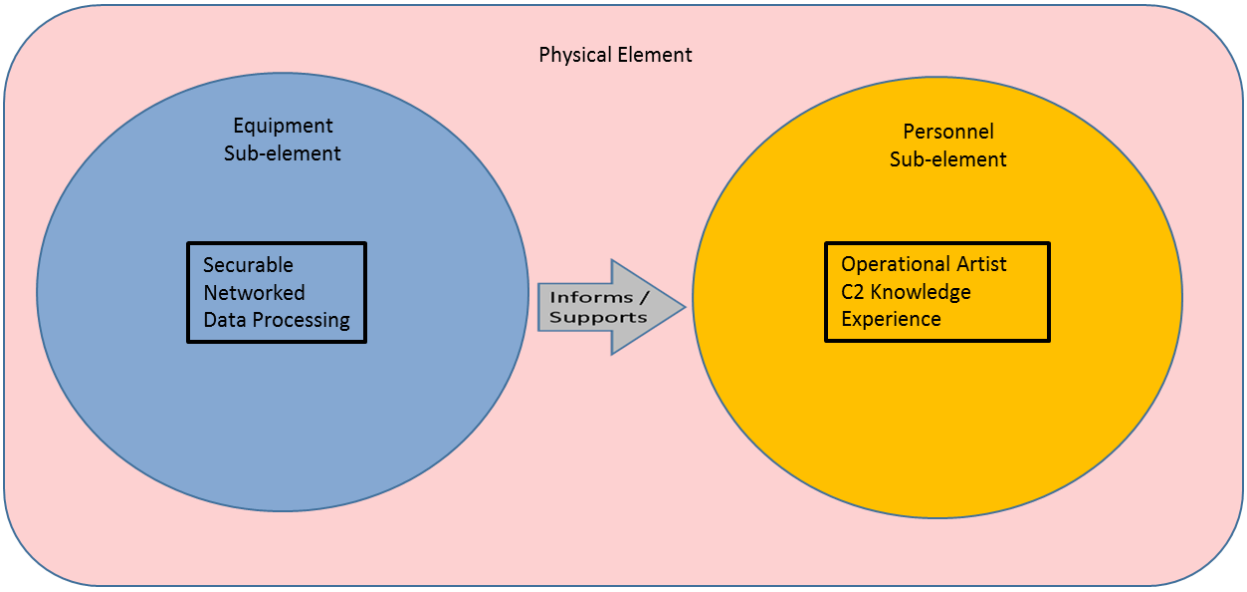

Figure 2: Relationship between the sub-elements (equipment and personnel) of the physical element of a C2 system with the qualitative outputs of each identified in the boxes.

2.2 Functional Element

Only when we gather the work of several scholars – Van Creveld's discussion on command; Paul Maykish's historical overview of C2, and David Lyle's examination of the functionality of C2 – are we able to identify the qualitative outputs of the functional

element of an effective C2 system, which are information management, providing situational awareness (SA), producing operational art, and enabling mission control.[11] Before discussing information management the differentiation between it and data or information processing must be addressed. The later deals with how raw data is processed into useable information and pertains to the qualitative output presented in the previous section labeled data processing whereas information management deals with how information is used by C2 personnel, which will be discussed next.

Maykish presents the immutable aspect information management has played in regards to C2 systems throughout the last two-hundred years starting with Napoleon and ending in the current era. In the discussion he underscores that information and the ability to process it has always been a critical element for an operational commanders, and he asserts that commanders that could process information more accurately and rapidly than their adversary have always been able to maintain a decisive operational advantage.

In the first stage Maykish explains that Napoleon transitioned from executing highly scripted military operations to flexible ones that he could change in real time during a battle through the use of signals. This, he asserts, allowed him to seize opportunities as they arose, enabling him to achieve unparalleled military success.[12] Less than a century later, using railroad and telegraph, Helmut von Moltke, could pass vital information to large units across great distances enabling him to direct them to mobilize and move from multiple locations to pre-designated assembly points from which they would begin to operate.

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[11] Van Creveld, Command In War, (Harvard University Press, 1985); Maykish, Paul., "C2 Rising", *Air & Space Power Journal*, (Jul – Aug 2014); Lyle, David., "The Rest of the C2 Iceberg", *Air & Space Power Journal*, (Jul – Aug, 2014).
[12] Maykish, 28-29.

In the inter-war period, Maykish discusses how, M.V. Tukhachevskii and Heinz Guderian, advocated for the necessity of coordinating cross-domain activities using wireless communications between air and land forces.[13] Then, shortly after World War II, Air Chief Marshall Hugh Dowding, realized he could achieve a formidable defensive network by pairing fighter aircraft with ground based long range radar information by pairing radios, ground controllers, and fighter aircraft. In doing this he had controllers direct fighter aircraft against in bound targets, which in the most sever situation meant there were more targets then fighter aircraft, thus birthing target prioritization. Knowing the most informed person in this process was the ground controller, Dowding made them decision authority for sorting and targeting aircraft against targets. This subtle change in the distribution of authority was significant, in that it expanded the decision making beyond the commander to others inside the C2 system, specifically the controllers.[14]

Thirty years later the information age built upon Dowding's concept by imbuing C2 systems with even larger volumes of information giving birth to John Boyd's Observe-Orient-Decide-Act (OODA) loop concept, which required greater involvement by the commander their staffs than ever before.[15] The current generation of 1980s C2 systems, focuses on controlling and coordinating joint forces in an expanded battlespace relying upon the use of information to an unprecedented level.[16] Developments in cyber and network operations is driving information management to an unprecedented level of complexity, which unlike in the past may require specific training versus pure

[13] Ibid, 31.
[14] Ibid, 33.
[15] Ibid, 36
[16] Ibid, 35

institution.[17] Based upon this discussion it evident that MDBC2 operators, like their ancestors, will need to be highly trained information mangers capable of synthesize information into formats that enable the establishment and maintenance of SA.

The National Research Council, defines SA as having the ability to process system information cognitively in order to operate or manipulate that system in a manner to achieve a desired outcome.[18] Applying this definition at the operational level of war, SA is having both the ability to visualize forces in time and space (the operational environment) and have the ability to process that information cognitively so that inputs required to adjust the different elements (forces) inside the environment can be made in order to achieve the commander's desired end state. In developing C2 systems, the ability to establish and maintain SA across multipole domains with rapid speed will be challenging but an important requirement none the less.

In the personnel sub-element of the physical element personnel must be operational artist. Specifically they must be able to support a commander in developing and transmitting their operation concept. Ultimately, the command concept is owned by the commander but an informed C2 system supports the commander in developing it. An effective C2 system provides insight to the commander by tapping into the staff's experience, pulls information from myriad of sources, and assists in identifying time, force, and space limitations[19]. Last, once developed, the C2 system applies operational art in determining how best to communicate the commander's concept, vision, and intent,

[17] Ibid, 39-40.
[18] National Research Council, *Modeling Human and Organizational Behavior: Application to Military Simulations*, (Washington DC, The National Academies Press, 1989), 172.
[19] Lyle, 65-75.

enabling a shared understating throughout the organization.[20] Again, the need for this task to be accomplished will not change with MDB. In fact, it can be reasoned that it will be even more important than in the past, since MDB operations are dependent upon multiple operations occurring across multiple domains simultaneously Knowing this and recognizing that subordinate units will lose communication at times in future operations the importance of having a shared understanding of the commander's intent produced by operational art is evident because it will enable mission command

Mission command is the ability to monitor joint force components and direct changes to them based upon the commander's intent.[21]To accomplish effective mission command subordinate and supporting commanders must poses clear and unambiguous understanding of the operational environment and the operational commander's intent. Only when this happens will they be able to foresee every action as a reaction and therefore be able to direct components, and resynchronize efforts so that they can dominate an enemy in time and space, reducing the enemy's options to two choices: surrender or be destroyed. Enabling mission command in MDB will be a critical output for its supporting C2 system. The complexity and tempo of operations of which MDB will demand means that commanders at every level must be supported in their application of mission command – failure to do so will potentially prevent decisive action.

Depicted in Figure-3 is the described foundational relationship between the two essential elements of an effective C2 system with the qualitative outputs of each identified in boxes located inside their respective element or sub-element. Furthermore, what the visualization conveys is that an effective C2 system is reliant upon the health of

[20] Ibid.
[21] Martin E. Dempsey, *Mission Command White Paper*, (Washington DC, 3 April 2012).

the physical element. It is the underpinnings of the functional element and therefore the entire C2 system. Without it working correctly, either because equipment is technologically irrelevant or people are not properly rained, the impact to the qualitative outputs of the functional element will be negative.

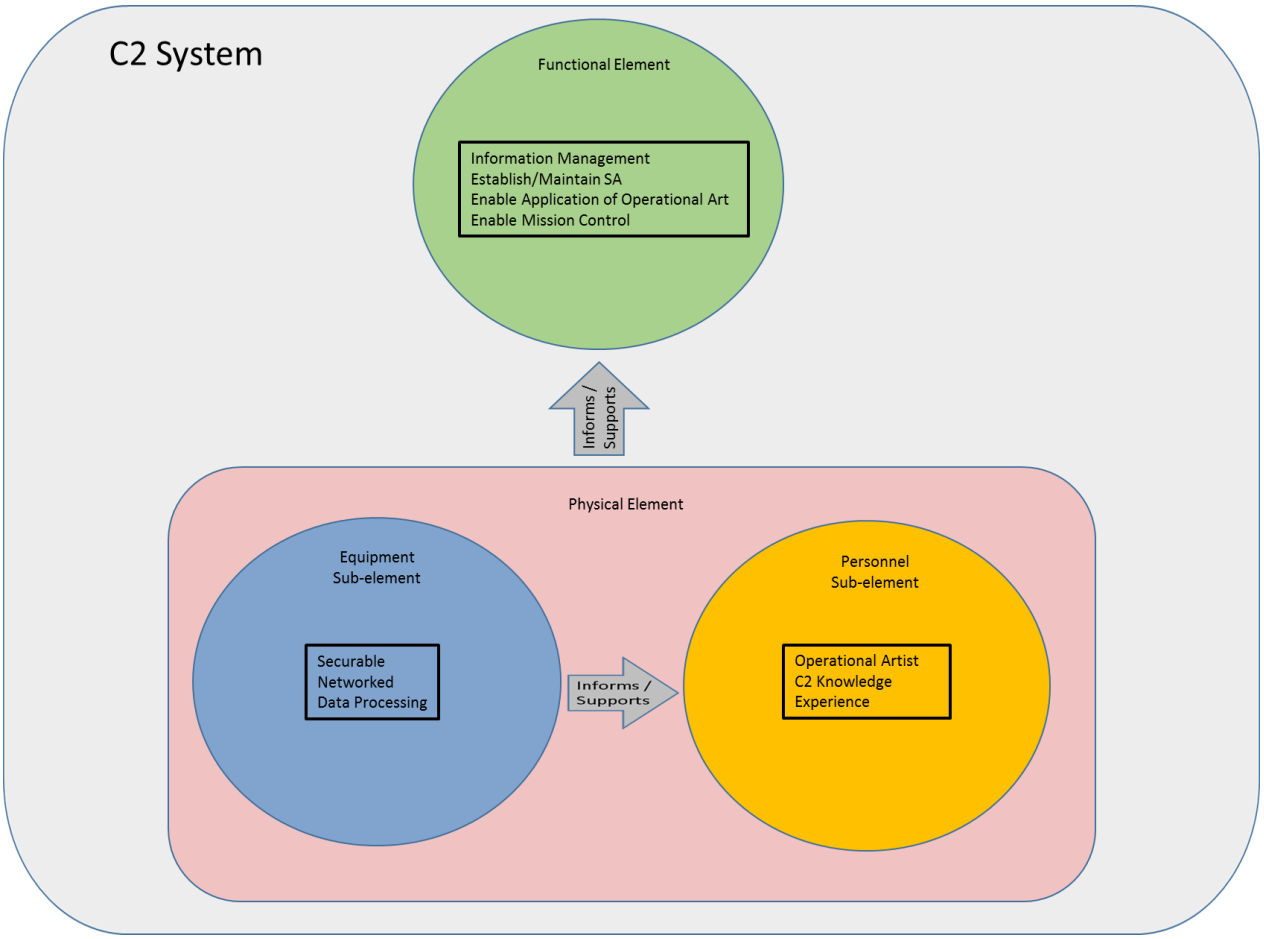

Figure 3: Relationship between the elements and sub-elements of a C2 system with the qualitative outputs of each labeled in boxes.

Understanding the structure of a C2 system it can be reasoned that an MDBC2 system will have to mold current and developing technologies into a network that spans multiple operational domains and zones. MDBC2 equipment will also be required to

process and synthesize significant quantities of raw data into useable decision making quality information at rapid speed – unlike any previous C2 system has ever done. The equipment will also need to be highly secure in order to prevent gaps in information and to prevent injection of false data. As for MDBC2 personnel, they will need to be operational artist, possess a working knowledge of C2, and have experience in how operations are planned and executed in all operational domains and every level of war. Using this framework the next chapter will evaluate the Air Force's current C2 system to determine its potential to support MDB operations. Specifically, it will examine the physical element, because as discussed, it is the foundational element from which the functional element's success is derived.

CHAPTER 3: ANALYSIS OF CURRENT AIR FORCE C2 SYSTEM TO SUPPORT MDB REQUIREMENTS

This chapter will analyze the current Air Force C2 system, commonly referred to as the Theater Air Control System (TACS), to determine to what degree it is capable of supporting the MDB concept. To do this it will use the established criteria identified in chapter two pertaining to the physical element of a C2 system of which there were two sub-elements; equipment and personnel. In each of these the qualitative outputs identified in the previous chapter are what will be specifically examined to determine the TACS suitability to support the MDB concept. For equipment the outputs are securable, networked, and able to conduct data processing, and the personnel outputs are operational artist, possessing C2 knowledge, and having operational level experience.

The Air and Space Operations Center (ASOC), is the most senior element of the TACS tasked to provide operational level C2 for air operations by providing two critical elements for a commander; a staff (C2 personnel) and an organization.[1] An ASOC is traditionally comprised of a plans and operations division, which is charged with executing the joint force commanders (JFC) operational design and supporting the operational art.[2] The ASOC C2 equipment is highly networked into the intelligence community's multiple data reservoirs, and it has many data processing systems, all of which, are highly effective in synthesizing and transforming raw data into decision-level quality information rapidly.[3] Nevertheless, securing the ASOC's information networks does provide a significant

[1] Air Force Instruction 13-AOCV3, *Operational Procedures-Air Operations Center*, (Nov 2011), 10-11.
[2] Ibid, 12.
[3] Weems, Max, C., "Command and Control in the Anti-Access/Area Denial Environment", (Masters Thesis, Air University, Feb 2014), p 7-8.

challenge.[4] All of the ASOCs are completely dependent upon satellite and cyber communications to maintain SA and perform command functions.[5] Any degradation or denial of access to these domains can completely negate the ASOC's ability to conduct operations.

The control and reporting center (CRC) is one of the three operational-tactical C2 nodes of the TACS. Its primary role is to provide tactical level C2, but it is capable and prepared to provide operational-level C2 for joint air operations. Specifically, the CRC provides decentralized C2 of joint operations through threat warning, battlefield management, theater missile defense, combat identification, and strategic communications.[6] To accomplish this, C2 personnel rely upon equipment that is networked to the intelligence community and is capable of processing and fusing large amounts of raw data into usable decision-making level information quickly. CRC security is dependent upon its location and level of C2 authority when operational or tactical. If it is forward located and supporting primarily tactical C2 operations it is secure. If tasked to conduct operational level C2, is reliant on cyber and satellite communication.

The Airborne and Warning and Control System (AWACS) and the Joint Surveillance Targeting and Attack Radars System (JSTARS) are the aircraft that conduct operational-tactical level C2 elements of the TACS; sensor support to ground operations for JSTARS and sensor-support to air operations for AWACS. Like the CRC, their primary roles are to provide tactical level C2, but they are also capable and prepared to take on the role of the ASOC in providing operational level C2 for joint air operations in

[4] Ibid.
[5] Weems, 7-8.
[6] US Air Force, *Control and Reporting Center (CRC),* US Air Force Fact Sheet, (6 Dec 16).

the event the ASOC is unable to do so.[7] Both systems provide decentralized C2 of joint operations through threat warning, battlefield management, theater missile defense, combat identification, and strategic communication within their distinct mission focus. Both system's networks capabilities are capable of fusing large amounts of raw data into usable decision-making level information. Security of both systems, is dependent upon where they are located and their assigned C2 roles whether operational or tactical. As with all of the other system they are more secure at the tactical level then the than they are if tasked to conduct operational level.

Table-1 summarizes that current TACS equipment are limited in their capacity to support MDB operations. Fully networked capability, meaning a system is able to completely integrate into the greater intelligence network, is limited to the ASOC and CRC. Security is a concern, since all systems rely heavily upon satellite communication, which means any successful attack or denial on that system could impact functionality of the overall C2 system. Current data processing capacity is good, but if not monitored and continually enhanced to keep pace with technological developments degradation is possible. From this synthesis of data the conclusion is obvious: the Air Force's current C2 equipment, if not improved upon, will prevent it from fully MDB operations.

[7] U.S. Air Force, *E-3 Sentry (AWACS),* US Air Force Fact Sheet, (15 Jun 2010); U.S. Air Force, *E-8C JOINT STARS,* US Air Force Fact Sheet, 15 Jun 2015.

Current USAF TACS Equipment

	Networked	Securable	Data Processing
ASOC			
CRC			
JSTARS			
AWACS			

Table 1: Analysis of current Air Force TACS equipment ability to support MDB C2 requirements. Green is fully capable. Yellow is partially capable, and red is non-capable.

Air Force C2 personnel are organized into two groups; specially trained individuals, officers referred to as air battle managers (ABM) and enlisted personnel labeled C2 battle management operators and all other officers and enlisted personnel from other career specialties in the Air Force. This paper will focus on the officers of each group and evaluate their ability to support C2 operations using the established qualitative outputs for the personnel sub-element of the physical element of a C2 system defined in the chapter two which were being an operational artist, possessing C2 knowledge, and having operational level experience.

Analysis of the training syllabi and career development of ABMs show that they are deliberately trained and developed to be tactical level C2 experts. There is no focus on the application of operational art building skill to allow them to understand the complexities of an operational environment and interpret an operational commander's decisions within requirements.[8]

ABMs are trained on how to account for forces on the battlefield, but are not trained on how to use this information to influence the operational commander in decision making.[9]As ABMs advance from initially qualified ABM to senior ABM, the importance of force accountability and enemy disposition are expanded, but the undertaking of how this information influences the operational commander's decision making process is haphazard. The operational art is simply not found in any of the ABM training material, nor do ABMs learn about the multiplicity of assets capable of operating in each domain. Instead training is focused on the air domain..

[8] U.S. Air Force, *Air Education and Training Command, Undergraduate Air Battle Manager Training*, (July 2017), 1-2.
[9] Ibid, 2.

Upon completion of initial ABM training ABMs are assigned to either JSTARS, AWACS, or the CRC from which they could potentially remain until they leave the service. For most ABMs, though, their operational duty is interrupted by a staff assignment or attendance at a professional military education institution. Unfortunately, as Figure-3 shows, these pauses do not promote operational level development but instead are simply breaks in a career cycle that operates completely inside the tactical level. In having this system, the Air Force has ensured its ABMs are C2 experts at the tactical levels, but it does not advance or train them to be operational C2 experts capable of functioning at the operational level or supporting a joint force commander's decision making within the MDB concept.

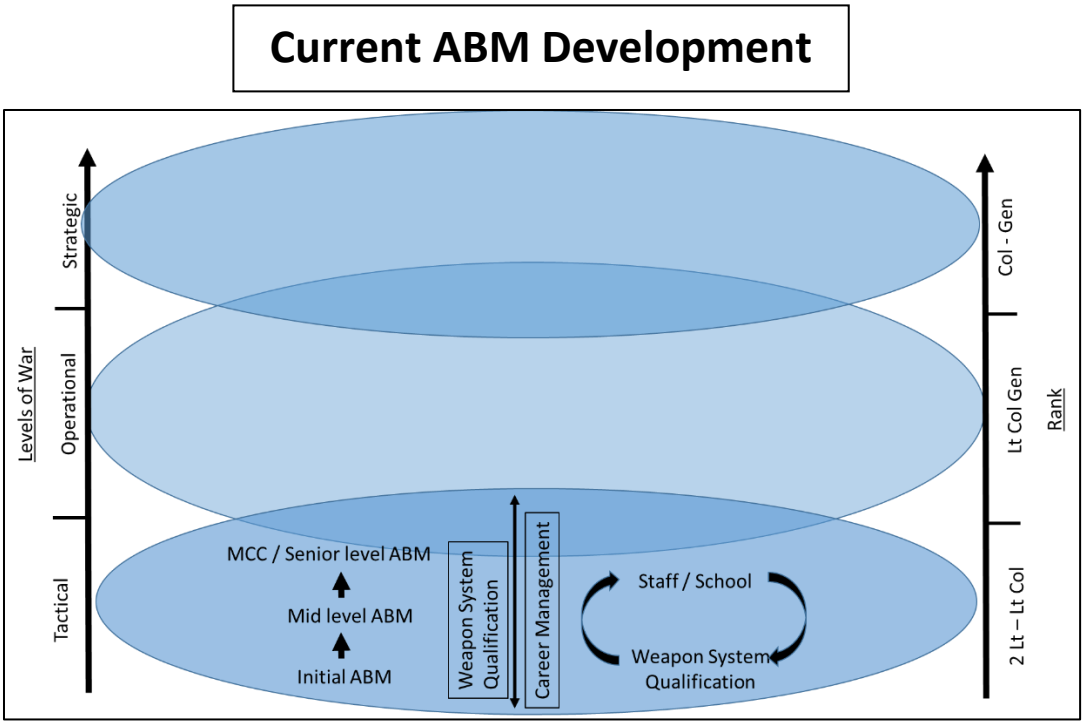

Figure 3: Depiction of ABM weapon system development and career management in relationship to levels of warfare and grade.

The group of officers the Air Force taps to conduct operational level C2 and run the ASOC are pulled from a myriad of career fields such as cyber, intelligence, aviation (pilots and navigators), and space as well as more ABMs. With the exception of the ABMs, these other officers have no formal or specialized training in C2. Furthermore, these C2 personnel, to include the ABMs, are not permanently assigned to the ASOC. They are either working in the ASOC as a temporary duty or as a career broadening assignment.

The Air Force conducts training for all officers assigned to work in the ASOC, but analysis of the formal training found that it, like ABM training, does not teach operational art. It focuses on teaching operators how the ASOC works[10]. It educates them on using the equipment within the ASOC system, it teaches them what ASOC products such as the air-tasking order and the intelligence surveillance and reconnaissance collection deck, and it instructs students on how the ASOC connects to the other C2 nodes in the TACS. The training does not address the concepts of understanding commander's intentions, the operational environment, the ability to understand and translate enemy and friendly force disposition to a commander, or the appreciation of decision making at the operational level. It also does not cover the subject of multi-domain assets. ASOC training syllabus does not yield individuals prepare to provide operational level C2. Instead what it produces are personnel trained to support the ASOCs functions as opposed to an organization linked to a commander's operational intent and vision.

As Table-2 shows, the Air Force's C2 training does not produce personnel does not produce operational level C2 personnel. It does provide a basic understanding of operational art and its sub-components but as the previous discussion eluded to this is primarily done at the tactical, which means the benefits depicted in yellow for ABMs in the table is a byproduct of their tactical level training. The same byproduct of tactical level training can explain the limited understanding of operational level C2 knowledge

[10] A review of the current ASOC training syllabi and training task list identified that the concept of operational art is not a trained objective or desired outcome of any of the training – U.S. Air Force, *Joint Air Operations Command and Control Couse Syllabi* (2017), U.S. Air Force, *Air Operations Center Combat Plans Division Initial Qualification Course* (2017), U.S. Air Force, *Air Operations Strategy Division Training Task List* (2016), and U.S. Air Force, *Air Operation Center Intelligence, Surveillance and Reconnaissance Division Training Task List* (2016).

for ABMs, and the eighteen years of continuous combat operations in Afghanistan and Iraq allow form the green marks in the operational level experience column. Overall the marks are not high enabling one to conclude that the Air Force's C2 personnel are not currently prepared to support MDB operations. This should be concerning, since as identified in the previous chapter, the personnel sub-element of a C2 system is in fact the essence of a C2 system. As van Creveld noted, even with the most advanced equipment, if the personnel in a C2 system are not trained the system will fail to support the commander thus preventing operational success.[11]

[11] Van Creveld, 275.

Current USAF TACS Personnel

	Operational Artist			Operational level C2 knowledge	Operational level experience
	Trained to understand commander's concept, intent, vision, and requirements	Trained to asses/present enemy and friendly force's situation in regards to time and space	Trained to inform and support commander's decision making		
ABM					
Non-ABM					

Table 2: Analysis of current Air Force C2 personnel ability to support MDB C2 requirements. Green is fully capable. Yellow is partially capable, and red is non-capable.

In sum, the Air Force's C2 system, both equipment and personnel, does not meet the MDB C2 requirements. Much of the equipment and personnel training were developed during an earlier evolutionary C2 period, which is no longer suited for the modern battlefield in which MDB seeks to contend with. Instead, the current Air Force system is one that is highly effective at the tactical level, but is severely limited at the operational level. To overcome these obstacles and ensure the Air Force's C2 system is

capable of supporting the joint team in executing the MDB concept reforms must be made in both equipment and personnel.

CHAPTER 4: MODERNIZING THE AIR FORCE AND JOINT SYSTEMS TO SUPPORT MDBC2

> *"[E]volution in our command and control capabilities requires new thinking, new training, and perhaps new technologies or new ways to use older technology."* General David Goldfein[1]

This chapter will provide several recommendations for how the Air Force and the joint team could improve its current C2 system in both equipment and personnel to support the MDB concept. Section one will present recommendation for improving Air Force C2 equipment and section two will provide recommendations for how the joint team could potentially assist in developing a broader and more compressive approach to developing the requisite C2 expertise. Each section will provide recommendations for upgrading or changing current practices while presenting potential risks and associated costs for each recommendation.

The Air Force should work to improve the ASOC and CRC since they represent the core of any MDC2 future system. The ASOC as the primary senior operational level C2 node, should be supported by the CRC as a secondary system. Developing and improving both system's LOC security is a first essential step. This would enable both to be located anywhere in the world. By mitigating the potential of being marginalized or neutralized due to the inability to communicate with forward or rear forces the ASOC and

[1] David L. Goldfein, *CSAF Focus Area: Enhancing Multi-Domain Command and Control…Tying It All Together*, (Washington DC: March 2017).

CRC would maintain the ability to synchronize forces in time and space, an essential requirement for MDBC2.[2]

Improving AWACS and JSTARS starts with upgrading their ability to be integrated into the greater intelligence community. AWACS and JSTARS specifically are not capable of receiving and processing at higher classification levels. Upgrading both aircraft to overcome this challenge would significantly increase both platform's ability to support MDB operations.[3]

The Air Force could broaden the ABM career field requirements to include operational level C2 or it could create a new operational C2, career field. ABMs, need both practical experience and a sound academic education covering the concepts of operational art and all the functional assets in each operating domain, as a basic requirement to support MDB.

A completely new career field could be built upon the current ASOC personnel system. To make this system support MDC2, the Air Force would need to overhaul the current ASOC training so that it instructs the concepts of operational art and operational C2. This new career field should draw on airmen who have completed a pre-determined number of years in their primary operational career field. In developing a career field assembled from the all operational specialties (ABMs and all others). The ABMs in the new career field will enabling the new career field to meet the MDBC2 requirements.

The first recommendation is highly cost prohibited in both time and personnel quality of life. To facilitate it, ABM training would have to be significantly re-scoped to

[2] Weems, 7-8.
[3] Nicholson, Tom and Rouleau, Nelson "Order In Chaos: The Future of Informed Battle Management and Command and Control", *The Mitchel Forum,* (March 2017), 5.

resulting in a longer training timeline and increased financial cost. A hidden cost is that making an operational level C2 subject matter expert at an early age guarantees that those individuals will be cast to a career of staff assignments that would potentially will drive them to separate from the military earlier than their peers who are allowed to experience tactical and operational life. Based upon these costs this paper recommends the Air Force redevelops its current ASOC personnel system and establish a new C2 career field. Unfortunately, even if the Air Force does this and succeeds the greater joint force will still be left with an MDBC2 problem, since the Air Force only operates in three domains of the five operational domains; air, space, and cyber, the remaining land and maritime domain's C2 needs would still need to be addressed, which leads to a broader joint discussion.

The senior most level of command in the Department of Defense is a joint force headquarters (JFHQ), which is found inside either a combatant command or within an established joint task forces.[4] Although staffs of each are organized in a manner to support the respective commander in administrating and leading the organizations, the operational and C2 leadership within a JFHQ is located in the Joint Operations Center (JOC).[5] The joint publication that governs the functions of JFHQ, does not direct how a JOC of should be organized or structured. JFHQs over the past decades have often been organized on an ad hoc basis and comprised of temporally assigned personnel with varying levels of expertise and skills.[6]

[4] Joint Publication 3.0 (Washington DC: Jan 17, 2017), IV-8
[5] Joint Publication 3.33 (Washington DC: July 30, 2012), xv-xvi.
[6] Bonds, Hura, and Young, *Enhancing Army Joint Force Headquarters Capabilities*, (Santa Monica, CA: RAND Corporation, 2010), 18-20.

To overcome this limitation it is recommended that the joint team reassess how joint officers are assigned and reclassify some billets inside the JFHQs as permanent assignments. Additionally, officers being assigned to these redesigned joint billets be required to complete operational C2 level training that teaches the concepts of operational art and C2.

In summary, it is apparent that upgrading equipment and improving the development of personnel are both required to improve the Air Force and Joint team's ability to conduct operations. Improving one without the other, though, will not overcome the challenges the joint team faces. Recognizing this, the Air Force and Joint team, could move forward along several lines of efforts. The Air Force could upgrade its legacy C2 equipment, develop a new operational level C2 career field, and transition to a co-located tactical and operational level c2 functional headquarters. The joint team must reassess how it conducts operational level C2 and redefine the JOC construct to take on a more significant role in leading joint operations. Only in doing all of these things can both the air Air Force and Joint team be prepared to transition to an MDBC2 structure.

CHAPTER 5: CONCLUSION

> *"To believe that the wars of the future, thanks to some extraordinary technological advances yet to take place in such fields as computers or remotely controlled sensor will be less opaque and therefore more subject to rational calculations than their predecessors is, accordingly sheer delusion."* Van Creveld[1]
>
> *"Future conflict will be, [multi-domain, multi-component, multi, national, and it will be fast.]".* General David Goldfein.[2]

The character of warfare is constantly evolving as the technologies use to wage war change. Weapons systems have become highly interconnected. They operate globally, changing the understanding of the operational level of war. Operational domains are becoming increasingly blurred, and in some cases, completely dissolved. With these developments in mind, one can reason that modern warfare has transitioned from being a set of highly coordinated actions to one of intense and complex integration. In navigating this evolutionary step, the Unites States military is becoming an organization that is capable of accomplishing highly integrated maneuvers simultaneously in time and space, yet multi-domain battle requires a higher level of sophistication, integration, and skill, which means it has to be supported by and equally sophisticated C2 system.

Appreciating this reality, the Air Force and the Joint team must collaborate together in order to overhaul and upgrade their respective C2 systems to both equipment and personnel. More important than any piece of equipment in a C2 system are its personnel. The Air Force must recognize and address the limitations in its current C2 operator force. C2 operators who are not operational artist, lack C2 knowledge, and do

[1] Van Creveld 274.
[2] David L. Goldfein, Air Force Association Breakfast, (Jul 2017).

not possess operational level experience cannot support MDBC2. To overcome this challenge, the Air Force would best be served in developing a new operational level C2 career field. In doing this, the Air Force will be poised to support MDB in its respective operational domains of air, space, and cyber, and doing this in conjunction with the Joint team will address the harder aspects associate with delivering MDBC2.

Accepting that the Air Force can only solve part of the MDB C2 challenge the Join team must begin to explore how it can do more. The joint chiefs need to reassess how they provide C2 for the Joint team and look to the educational requirements and expertise located in JFHQ JOCs. The Joint Chiefs should establish an operational level C2 training program that builds expertise within the joint force.

Overall what can be concluded from this research is that the modern battlefield has changed and will continue to become even more complex, and the only way the United States military will be able to maintain its decisive advantage is directly related to its ability to organize effects in time and space faster than its adversaries through its ability to provide effective C2. This important warfighting capability cannot be accomplished for the Joint team by one service alone. Yes, one service may provide the lion's share of the equipment and personnel, but the full capacity of any joint C2 enterprise will require buy-in and support from across the entire Department of Defense. Such support will demand that barriers among services be removed and that trust among the different military instruments increase and mature to match pace with the evolving operational environment. Doing anything different is not an option since it would result in operational failure on the modern battlefield. In an effort to help prevent failure, this

paper recommends much needed changes for the Department of Defense and the Joint Chiefs to undertake, which can be used to begin to restructure the force for the future.

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