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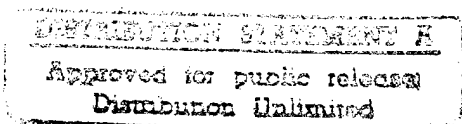
COMMAND AND CONTROL (C2) IN FUTURE WARFARE

by

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The Contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.



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6 March 1996

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19960501 212

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12 FEB 96
Date

REPORT DOCUMENTATION PAGE

1. Report Security Classification: UNCLASSIFIED			
2. Security Classification Authority:			
3. Declassification/Downgrading Schedule:			
4. Distribution/Availability of Report: DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.			
5. Name of Performing Organization: JOINT MILITARY OPERATIONS DEPARTMENT			
6. Office Symbol: C		7. Address: NAVAL WAR COLLEGE 686 CUSHING ROAD NEWPORT, RI 02841-1207	
8. Title (Include Security Classification): COMMAND AND CONTROL (C2) IN FUTURE WARFARE (UNCLAS)			
9. Personal Authors: LCDR MARK A. PAYLOR, USN			
10. Type of Report: FINAL		11. Date of Report: 6 March 1996	
12. Page Count: 25			
13. Supplementary Notation: A paper submitted to the Faculty of the NWC in partial satisfaction of the requirements of the JMO Department. The contents of this paper reflect my own personal views and are not necessarily endorsed by the NWC or the Department of the Navy.			
14. Ten key words that relate to your paper: COMMAND, CONTROL, (C2), C4I, DECISION CYCLE, OODA LOOP, OPERATIONAL FUNCTIONS, C4I FOR THE WARRIOR			
15. Abstract: Will the implementation of the 'C4I for the Warrior' concept justify the elimination of the operational commander from the military C2 process? No, technology enhancements that the 'C4I for the Warrior' concept is designed to provide do not justify the elimination of the operational level commander from the military C2 process structure. Although the 'C4I for the Warror' technologies appear to effectively bridge the strategic and tactical levels of the military C2 process structure, the operational commander (in reality) performs vital operational level functions in the C2 process. Three C2 process structures are presented and used as a means of comparing how the implementation of new technologies may allow and/or require a change in the C2 process structure as we have known it. New technologies will likely enhance the operational commanders ability to perform the operational functions. However, the potential for strategic level overcentralization/micromanagement of the operational/tactical levels and a reliance on technology without due regard for the Information Warfare (IW) threat will pose significant challenges for the operational commander as the military C2 process structure evolves.			
16. Distribution / Availability of Abstract:	Unclassified X	Same As Rpt	DTIC Users
17. Abstract Security Classification: UNCLASSIFIED			
18. Name of Responsible Individual: CHAIRMAN, JOINT MILITARY OPERATIONS DEPARTMENT			
19. Telephone: 841- 627 6461		20. Office Symbol: C	

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Will implementation of the 'C4I for the Warrior' concept justify the elimination of the operational commander from the military C2 process? No, technology enhancements that the 'C4I for the Warrior' concept is designed to provide do not justify the elimination of the operational level commander from the military C2 process structure. Although the 'C4I for the Warrior' technologies appear to effectively bridge the strategic and tactical levels of the military C2 process structure, the operational commander (in reality) performs vital operational level functions in the C2 process.

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COMMAND & CONTROL(C2) IN FUTURE WARFARE

Will implementation of the 'C4I for the Warrior' concept justify the elimination of the operational commander from the military C2 process?

INTRODUCTION

The Commercial Sector C2 Process. In the commercial sector, middle management positions are being removed from their original hierarchical structures as a result of computerized information transfer/sharing technologies. Spans of control are growing larger while organizations become flatter. The decision making process is also affected by these technology improvements. In order to beat their competitors, commercial organizations are using technology (much like the military) to speed through their decision cycles faster than their competitors.¹ Can the military also realize similar improvements in its decision cycle times by changing its original hierarchical structures through the use of technology improvements such as 'C4I for the Warrior' concept?

The 'C4I for the Warrior Concept.' 'C4I for the Warrior' is a concept developed to meet the joint war fighters ever increasing need for information that will enable the warrior to achieve (successful mission accomplishment) for any mission, at any time and at any place."² Among the benefits C4I systems bring is the concept of near real-time, shared battlespace awareness at all levels of war - strategic , operational and tactical. This near real-time secure picture of the battle space and communications path may truly and effectively bridge the strategic and tactical levels of war. Will implementation of the 'C4I for the Warrior' concept justify the elimination of the operational commander from the military C2 process?

Thesis. Technology enhancements that the 'C4I for the Warrior' concept is designed to provide do not justify the elimination of the operational level commander from the military C2 process structure. Although the 'C4I for the Warrior' technologies appear to effectively bridge the strategic and tactical levels of the military C2 process structure, the operational commander (in reality) performs vital operational level functions in the C2

process. Additionally, the continued emergence of information warfare (IW) will likely prove to be a significant threat to the technological bridge between the strategic and tactical levels thus ensuring that the operational level commander remain as a vital link in the C2 process regardless of its structure.

BACKGROUND

Operational Level Functions. The operational commander is responsible for many operational level functions. The principal operational functions are Command, Control, Communications, Computers & Intelligence (C4I); Information Warfare/Command and Control Warfare (IW/C2W) Architecture; Operational Fires; Operational Logistics and Operational Protection.³ The scope of this paper will be limited to the national vice coalition perspective and will focus specifically on the implications of two of these functions: 'C4I for the Warrior' technology enhancements and the IW/C2W threat to these systems.

Defining the Issues. Before discussing Command and Control in future warfare, a common understanding of the terms to be used must be established. Command and Control (C2), as defined in Joint Pub 1-02, is "the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning directing, coordinating, and controlling forces and operations in the accomplishment of the mission."

Command and Control Warfare (C2W), as defined in Joint Pub 1-02, is "the integrated use of operations security (OPSEC), military deception, psychological operations (PSYOP), electronic warfare (EW), and physical destruction, mutually supported by intelligence, to deny information to, influence, degrade, or destroy adversary command and control capabilities, while protecting friendly command and control capabilities against such actions. C2W applies across the operational continuum and all levels of conflict."

Information Warfare (IW) does not have an official, open-source U.S. government definition. Although not officially defined, the Department of Defense (DoD) does include

its current thinking and approach to information warfare within its current C2W concept.⁴ Information warfare can include both psychological and physical aspects. From a psychological standpoint information warfare can be directed at the way humans think and, probably more importantly, the way humans make decisions. This involves the modification of information the adversary uses to make his decisions. The physical aspect of IW, however, refers to attacks against the communication nets of a society or its military, satellites and computers. This involves the denial of vital information the adversary requires to make his decisions. Whether psychological or physical, the ultimate "targets of information warfare...are the decisions in the opponents mind."⁵

COMMAND AND CONTROL (C2)

The Decision Cycle. The C2 process can be described as a process of making, disseminating, and implementing informed command decisions in order to obtain optimum effectiveness of the nations military forces in peacetime or conflict. Four basic functions have been associated with the decisions and actions made within the C2 process. The observe, orient, decide, act (or O-O-D-A) loop shown in figure (1) provides a simple way to view this process.

As seen in figure (1) the OODA loop can be used as a model for comparing the C2 process as it has evolved throughout history. It shows that the continued use of technology improvements has dramatically reduced the time that elapses within the C2 process.

"During the Revolutionary War, leaders had months to make decisions, while today modern technology and weapon delivery systems require that leaders make decisions in minutes."⁶ "Throughout history, soldiers, sailors, Marines and airmen have learned one valuable lesson: If you can analyze, act and assess faster than your opponent, you will win!"⁷

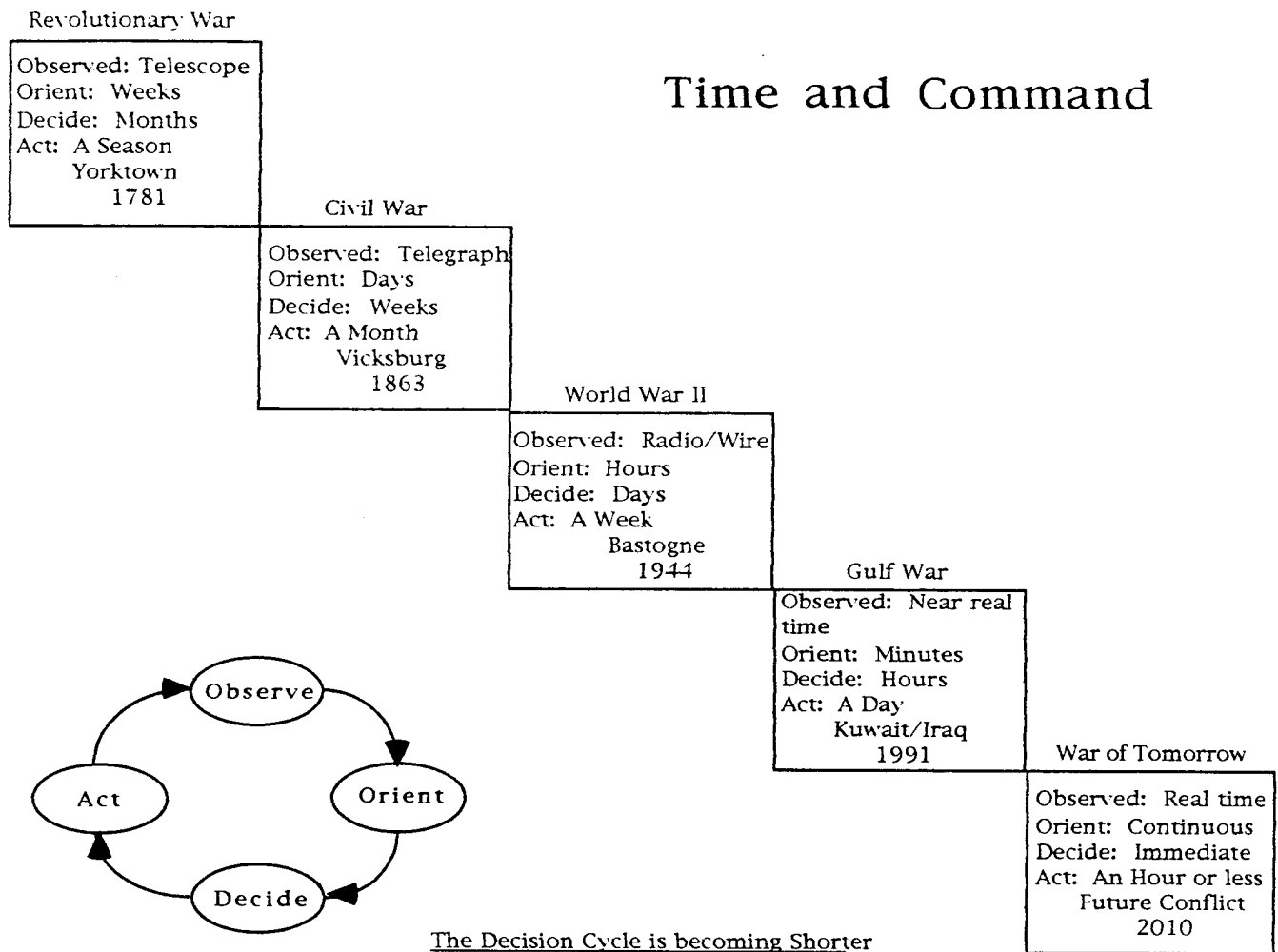


Figure 1⁸

Implementation of new technologies may allow and/or require a change in the C2 process structure as we have known it. As a means of comparison, three C2 process structures will be considered.

C2 Process Structure before 'C4I for the Warrior.' Before the implementation of C2 support systems such as the "C4I for the Warrior" concept, C2 systems could be generally depicted as in figure (2).

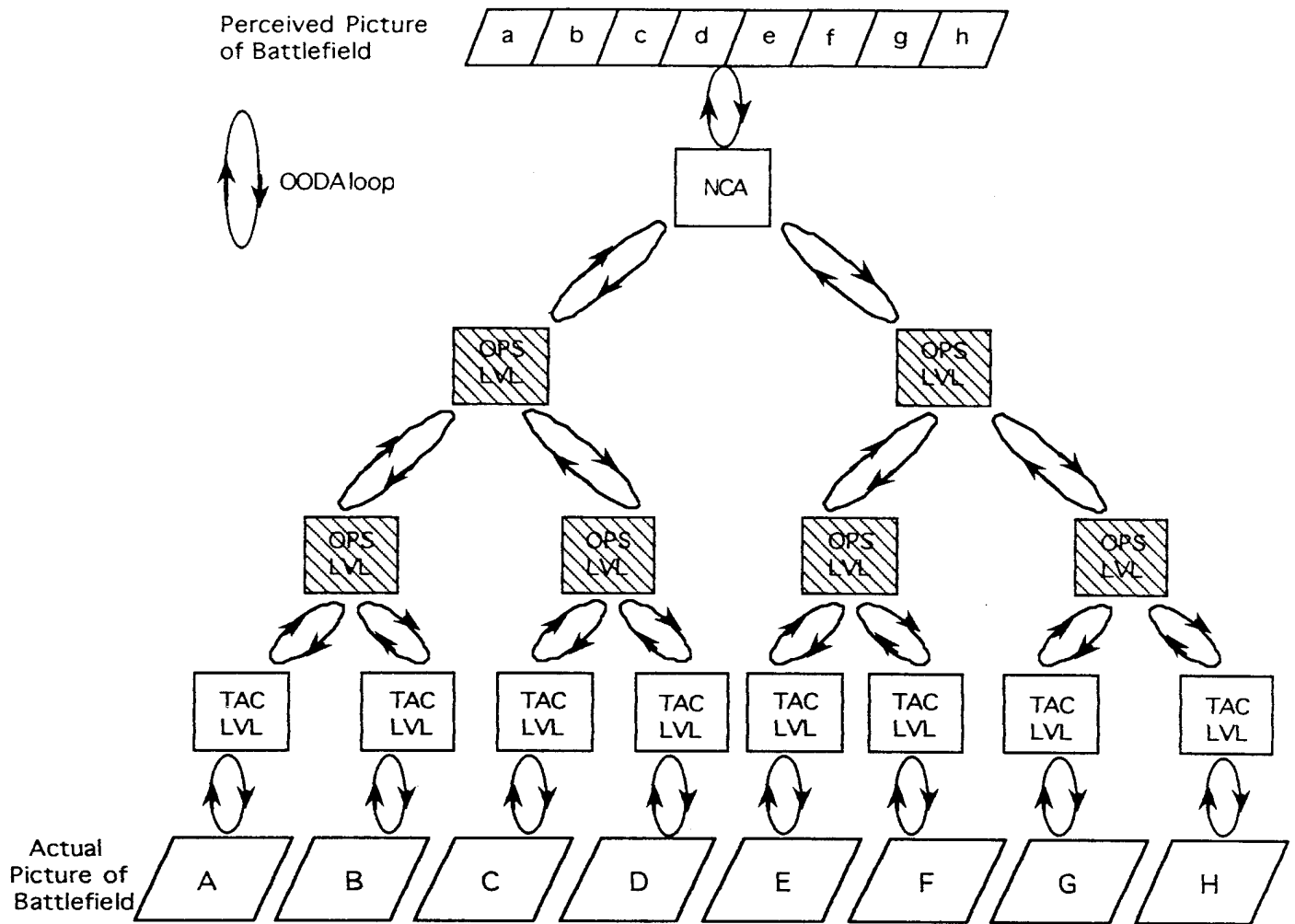


Figure 2⁹

Beginning at the bottom of figure (2), A-H represents the 'Actual Picture of the Battlefield.' The subordinate units, at the tactical and operational levels, send reports up to the National Command Authority (NCA) or strategic level. The NCA then pieces together these reports to create an inexact, or 'Perceived Picture of the Battlefield.' The NCA then makes decisions and issues orders based on its perception of the battlefield. However, only the NCA has access to the entire perceived picture (at the top of the figure).

In order to be effective, this C2 structure must rely on centralized command and decentralized execution. The dynamics of the battlefield and the time information takes to reach the strategic level forces the NCA to rely on the judgment and initiative of the operational and tactical level commanders. The NCA, however, may attempt to control the

battlefield by issuing specific orders to the operational and tactical levels and/or requiring strategic level approval for actions taken at the tactical level. When a unit operating at the tactical level finds that its orders do not seem appropriate to its view of the rapidly changing situation, confusion and threat of life can result. In Panama during Operation Just Cause, tactical units were required to get approval at the strategic level simply to return artillery fire.¹⁰

The nature of future threats, combined with new technologies will likely increase strategic involvement in tactical events. The regional focus of recent (and likely future) conflicts continue to heighten national strategic interest in tactical events on the battlefield. Military actions in Turkey and Bosnia involved tactical actions directly supporting strategic goals of providing humanitarian aid or enforcing no-fly zones. These "operations other than war" (OOTW) demanded vigilant strategic supervision of tactical military actions.

This threat environment and the use of integrated technologies may lessen the gap between strategy and tactics, resulting in centralized command structures and simultaneously reducing and possibly eliminating influence at the operational level altogether. What would a new centralized C2 process structure look like? How would technology be used to ensure that our decision cycle times are faster than future adversaries?

C2 Process Structure - 'C4I for the Warrior' technologies implemented.

Figure (3) is a modified C2 process structure that shows how use of improved C2 support technologies (such as the 'C4I for the Warrior' concept) might change the C2 process structure by effectively bridging the strategic and tactical levels and eliminating the operational level commander.

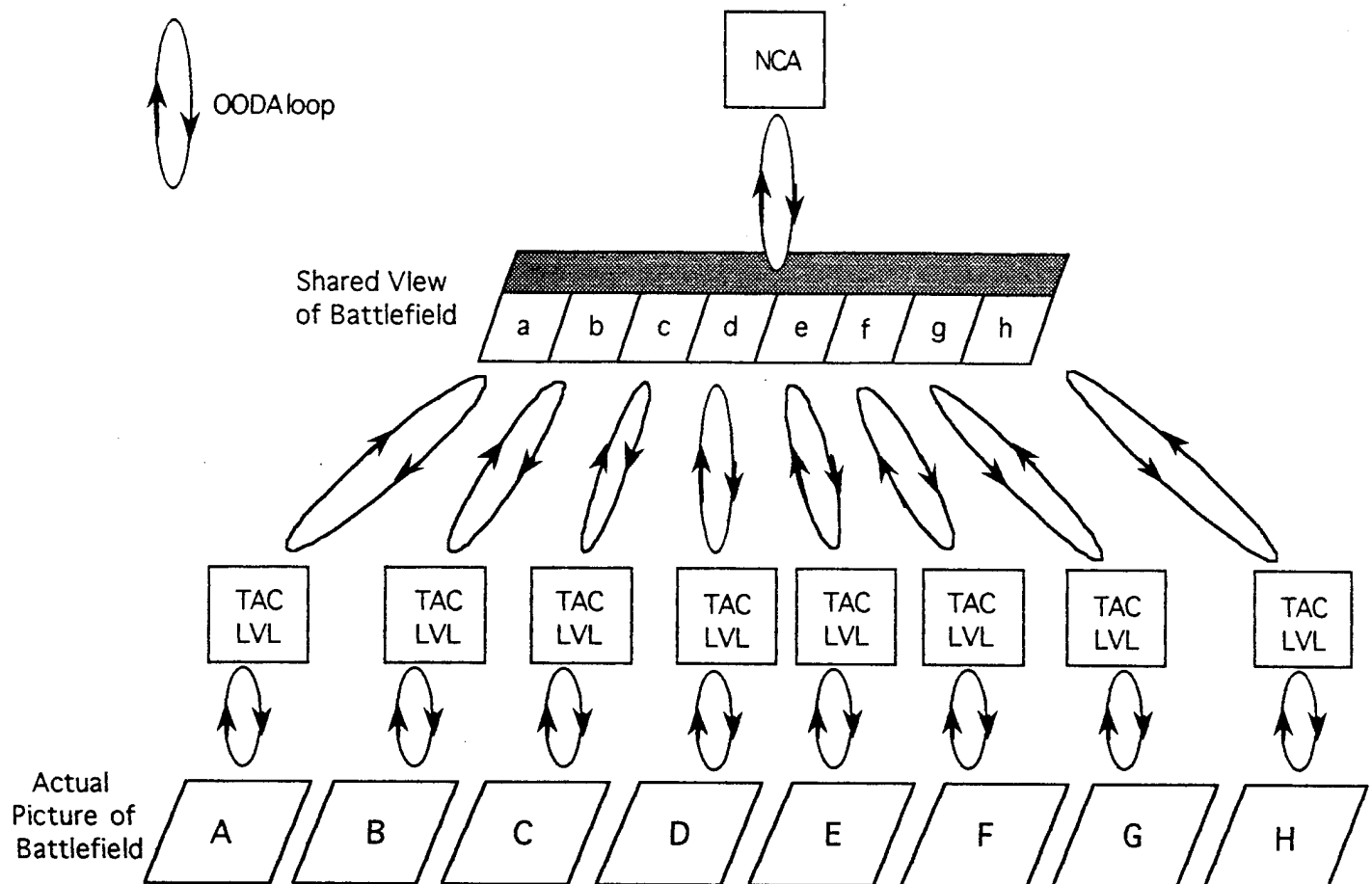


Figure 3¹¹

Starting at the bottom of the figure, the units at the tactical level have direct access to the 'Shared Picture of the Battlefield.' This is achieved by linking all of the units, at the tactical level, together in a single data network. The ongoing contribution of all tactical units creates a constantly updated 'Shared Picture of the Battlefield', where a user (at any level) can zoom in or out of areas of interest.

Although this structure lends itself to centralized command and control with decentralized execution, the NCA does not (ideally) issue explicit orders but instead identifies mission objectives and a focus of main effort. This would allow the NCA to maintain 'the big picture' without becoming overwhelmed with the details of the battlefield. The tactical level commanders can then access the 'Shared View of the Battlefield' and pull out the information they need to translate assigned strategic objectives into tactical actions that will accomplish these objectives. The tactical level units are given wide latitude in

conducting their missions. "Coherence is achieved because all of the units share a common doctrine, a common goal, and a common view of the situation."¹²

Although each tactical unit may not do exactly as the NCA would have wished, the result (on the average) is expected to be the same and is likely to be achieved in much less time. Instead of waiting for exact orders to funnel through intermediate units (at the operational level), each tactical unit will compare its mission order against the 'Shared View of the Battlefield' and act accordingly. The C2 principle for this structure is not "centralized control - decentralized execution" but instead, "centralized command - decentralized control and execution."¹³

This structure raises some serious questions however. Who will be responsible for and provide a check and balance on this 'Shared Picture of the Battlefield?' Without the operational level commander, it is likely that a new staff position(s) will be required at the strategic level (NCA) to provide this check and balance of the 'Shared Picture of the Battlefield.' The many actors looking at the same 'elephant' from different perspectives will likely have both inconsistencies and conflicts as to what the ground truth really is. Someone, at some level (strategic, operational, tactical) will need to put a sanity check on the picture being seen by all. Is the operational commander (in theater) that someone or will one of the tactical commanders be required to attempt these tasks in addition to his tactical level responsibilities?

The idea of decentralized control at the tactical level raises other questions in the event that the communications link between the NCA and the tactical level commanders is degraded or destroyed. Which tactical commander will be designated to be the one to coordinate and synchronize actions at the tactical level? Additionally, will this tactical commander also be the one to perform the other operational (in theater) functions previously performed by the operational commander and his staff? Has he been trained to perform these functions and does he have the necessary resources (personnel and equipment)?

Although there may be acceptable answers to these questions, it does not seem likely that technology alone can be used to improve the speed and effectiveness of decisions made

in the C2 process structure. Additionally, operational level functions will still need to be performed by someone. Integrating new technologies and maintaining the operational commander as a vital span between the strategic and tactical levels appears to be the best answer.

OPERATIONAL COMMANDER - A Vital Link

Operational Functions. The argument can be made that the elimination of the operational commander and his staff could help the continuing efforts to make cut-backs in personnel and budget expenditures. However, this assumes that the operational commander can be literally replaced by integrated technologies. The operational level functions would still need to be performed by someone at either the strategic or tactical levels. It is not likely that existing personnel (at either the tactical or strategic levels) could perform these operational level functions effectively.

Selecting a single tactical level commander to perform the operational functions would essentially make him a 'pseudo' operational commander. This would be a shaky attempt at maintaining the unity of command previously realized with the operational commander. Additionally, this single tactical level commander would likely lose effectiveness in performing his tactical level responsibilities.

If responsibility for the performance of operational functions were shared among the tactical level commanders in theater, confusion would likely follow without unity of command. As mentioned before, performing these 'collateral' operational functions would only serve to distract the tactical commanders from their primary functions at the tactical level. Additionally, the lack of a single point of contact and coordination could also make the performance of these functions inconsistent and difficult if not impossible. Performing these functions from the tactical level does not appear to be the answer. How about the strategic level?

Attempting to perform the operational functions from the strategic level does not fare any better. Although integrated technologies provide the capability to perform tasks from great distances (out of theater), the strategic level (NCA) faces two difficult problems. First, the challenge of performing these operational functions from great, 'impersonal'

distances. There are elements of command that cannot be 'shared' vicariously through near real-time technologies. Elements such as troop morale, real or perceived threats (theater atmosphere) and the environment have not been incorporated into the technologies that would replace the operational level commander. With more focus on operations other than war (OOTW), being in touch with these elements becomes increasingly important and may be considered vital to the successful accomplishment of desired objectives. This point supports the need for a commander in theater (close to the action) dedicated to the performance of the operational functions (the operational commander).

Another problem faced by the strategic level's attempt to perform operational functions from great distances is the potential C2W/IW threat to communications. Who will coordinate and direct unity of effort and synchronization of our forces in theater when the C2 support systems are degraded or destroyed by the adversary? Someone must maintain a local (in theater) 'big picture' awareness of the theater in the event disruptions occur that prevent the near real-time flow of information back to the NCA at the strategic level. Additionally, when these disruptions do occur, other means to collect information and establish communications in theater will need to be established in order to ensure the other operational level functions can be performed (operational fires, operational logistics and operational protection).

The use of advancing technology to replace the operational commander in the military C2 process structure cannot be supported. Although these technologies may greatly enhance the operational commanders ability to perform his duties, it cannot replace him. The operational level commander must remain as vital span in the C2 process bridge between the strategic and tactical levels. He is best suited to perform the critical operational functions as well as providing a hedge against the C2W/IW threat to the communications paths. How should the C2 process structure be modified to include new technologies with retention of the operational commander?

Proposed C2 Process Structure. The C2 process structure in figure (3) does suggest that both the technology enhancements of C2 support systems and the elimination of the operational commander (as an intermediate span of the bridge) might provide the

capability to greatly reduce our decision cycle time. However, the recognized importance of the operational level functions and the need to maintain realistic and manageable spans of control will more likely lead to a C2 process structure as depicted in figure (4).

Figure (4) adopts the benefits of figure (3), however, it retains the operational commander in the C2 process structure. As before, all levels are able to share the common view of the battlefield and realize all of the opportunities that technology brings to the structure. But certainly there are challenges to be faced with this type of technology enhanced structure. What are the implications of this new structure and how will they impact the operational commander in future warfare?

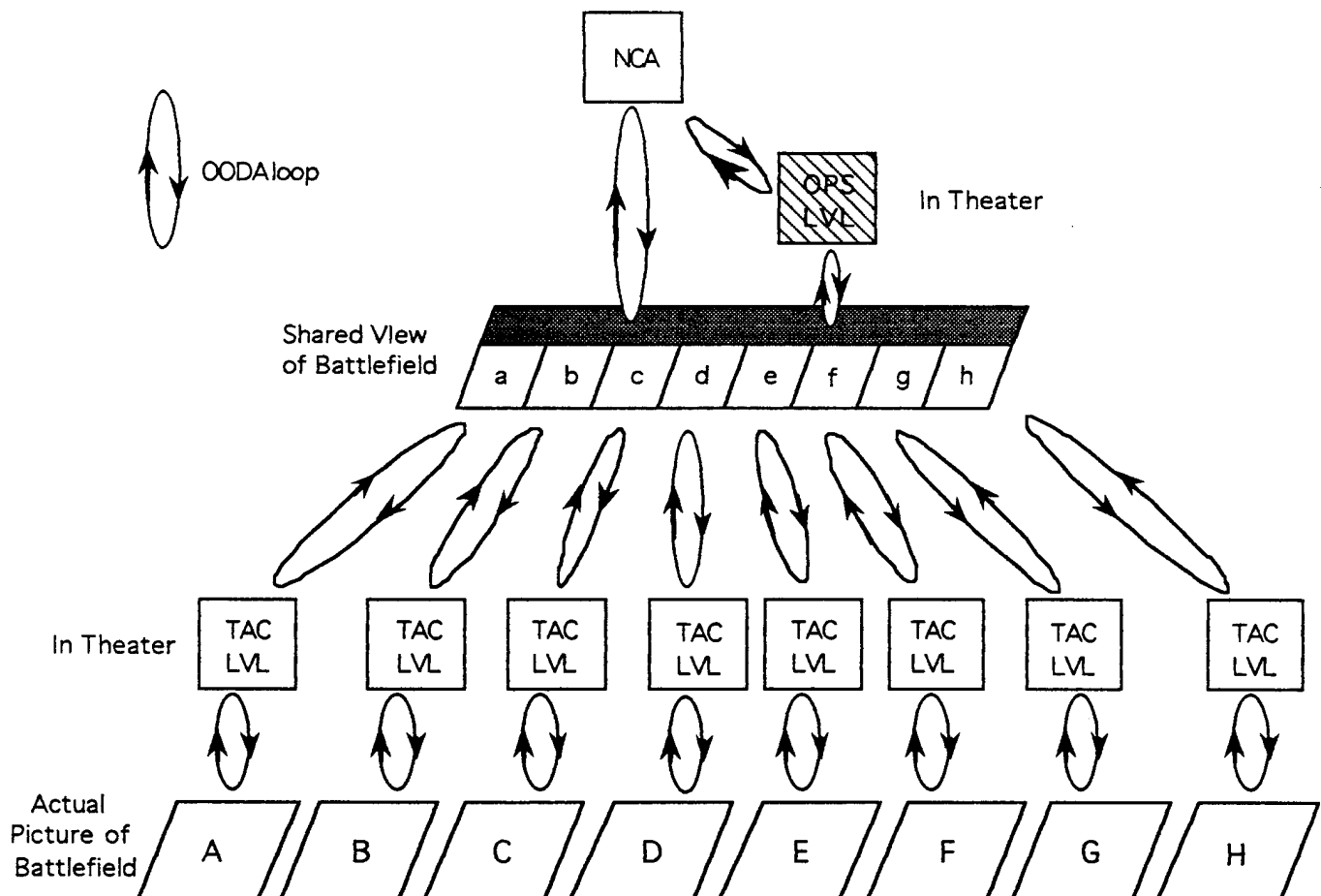


Figure 4¹⁴

CONCLUSION:

So what for the Operational Commander?

Opportunities. Several opportunities for improvement can be realized by the operational commander in the performance of his operational functions as a result of the new technologies of the 'C4I for the Warrior' concept. The use of these new technologies will likely improve our C2 OODA loop. The doctrine that supports this new technology, however, will need to identify and address how to gain the maximum efficiency from an evolving C2 process structure.

If our military recognizes IW as a serious threat to our C2 process and trains with this threat always in mind, it will likely improve our abilities to identify and exploit our adversary's weaknesses with more effectiveness.

The shared view of the battlespace that integrated technology promises may increase our effectiveness in conducting operational fires in support of operational and strategic objectives. This shared view may provide all levels the ability to better coordinate and observe the actions of our forces and of our enemy's. An increase in our decision cycle time could enable our forces to apply operational fires with greater effect and with greater (and faster) awareness of the results of those fires.

The shared view of the battlespace may also enhance operational logistics. A near real-time awareness of our fighting force's needs may improve our force readiness dramatically. Status of forces as well as a timely response to supply needs may give our forces an added advantage over their adversaries.

Identification and continued awareness of enemy forces through the use of integrated technologies will likely improve the operational commander's ability to protect his forces in theater. Since the most recent Haiti Crisis began in October 1994, USACOM has used GCCS to view the tactical situation in near-real-time and to monitor the readiness and deployment status of the joint task force. During the crisis, a collective laydown of red and

blue ground, seaborne and airborne forces operating in the joint operating area were viewed on a single C2 screen.¹⁵

Although these technologies suggest the capability to distribute 'battlefield awareness' to all levels, again, as stated earlier, elements such as troop morale and battlefield atmosphere cannot be truly realized with technology alone. However, the enhanced awareness that the strategic and tactical levels are able to attain through technology may benefit the operational commander and the overall C2 process. Giving the strategic level commander the ability to see (in near real-time) the 'big picture' (the impact of tactical operations on the strategic issues) may enable him to take advantage of opportunities at the strategic level that might have been missed otherwise. Perhaps opportunities for peace will be easier to recognize and take advantage of these near real-time capabilities. This in turn may result in more effective and timely guidance to the operational and tactical levels.

Challenges. As DoD takes more of an interest in IW, one of the greatest single threats faced is that we will yield to our usual temptation to adopt the new technologies, especially information technologies, as merely force multipliers for the current way we do business.

Overcentralization/Micromanagement. If the strategic level commanders are to use technology improvements to their fullest potential, they will have to ensure that they guard against overcentralization and micromanagement of the operational and tactical levels. Strategic level commanders may intervene at the operational and tactical levels at times and places where their intervention would be counter-productive and might adversely affect the outcome of the conflict. In Libya, when surface-to-air missiles were fired at U.S. airplanes, Washington immediately demanded to know why pilots had not shot back.¹⁶ Technology enabled Washington's interference in an almost real-time manner.

The impact to the strategic side of the overcentralization and micromanagement issue is also of concern to the operational commander. In addition to the possibility of adversely affecting operational and tactical level operations through near real-time communications capabilities, the strategic level commanders may find themselves

losing sight of the critical issues at the strategic level. Overcome with the lower level issues and the centralized management of operational and tactical level actions through the shared view of the battle space, the strategic level commanders could miss a diplomatic signal from the adversary and/or allies based on the results (real or perceived) of lower level operations. The end result and impact to the operational commander may be ineffectual or misguided directives from the strategic commander.

Training at all levels. Military doctrine and procedures continue to focus on technology dependence. With budget cuts and the resultant downsizing of the military, a rapid growth in simulation and gaming dependency for U.S. forces is taking place. Simulations, gaming and their assumptions, however, may be incomplete. In fact, it is more likely that they are unable to take into account the key determinants of IW on future warfare outcomes and thus they will be misleading or wrong.

Current gaming and simulation exercises are failing to address the IW threat to our C2 process regardless of its structure. Simulation and gaming are being used for everything from individual training to supporting large-scale exercises and mission planning. "Large-scale, interactive simulations ... will be used to support training, mission planning, practice, and operational planning. In view of the critical part that these information systems will play in the future U.S. military, it is important to note that practically none of them address operational or strategic level vulnerabilities of U.S. forces to information attacks. Although some attention has been paid to offensive information actions, information-warfare attacks against U.S. forces in such simulations primarily are just assumed away."¹⁷

Although some games have introduced IW attacks, the disruption has generally brought the game to a halt. Rather than analyzing whether the disruption might truly reflect a potential wartime outcome, such results have been banished from games as being disruptive of game play and an interference with higher objectives of the game. "Modeling the impact of information warfare always has been difficult and therefore has not been done." Training our forces without due regard for the threat(s) of IW could spell disaster in future conflicts with an adversary that uses IW.¹⁸ The bottom line is that our

military must train just like they plan to fight or they will likely experience unwelcome surprises during the next contingency or regional conflict they are called on to support.

Reliance on technology. We are training for and developing a reliance upon a potential Achilles heal, C2 support system technology improvements. Joint field training exercises such as Agile Provider 94 demonstrated the capability of Global Command and Control System (GCCS) to provide a common view of the battle space. This exercise was designed to train forces in the planning and conduct of joint combat operations.¹⁹ Discussions with several representatives of the military services suggests that the increased emphasis and reliance on technology for the planning and conduct of operations is already leading to the loss of basic manual operating skills and proficiency in these backup methods. The military services must have alternative capabilities and/or doctrine to continue the C2 process effectively should its continuing technology enhancements fail or become exploited by its adversaries through C2W (specifically IW).²⁰

C2W Protection. Our military's use of integrated technologies in its C2 process must consider the potential they have in making our C2 process a critical vulnerability. Retaining the operational commander in our C2 process can be seen as a means of providing an element of C2W protection. Maintaining the operational commander in theater provides (at a minimum) a means to continue the basic C2 process at the lower levels. Being located in physical proximity to his forces gives the operational commander the flexibility to compensate for any potential disruptions in intra-theater C4I support to C2. However, our military must ensure that commanders at all levels retain the capability, experience and authority to prosecute war if C4I support technologies are disrupted.

The Bottom Line. Future conflicts are likely to be regional in nature (vice global) and this will heighten national strategic interest in tactical events on the battlefield. Enhanced communications technology can provide the means to control operations thousands of miles away from the action. However, the operational commander is a vital span in the bridge between the strategic and tactical levels of the C2 process and cannot be replaced by the integration of new technologies.

While such connectivity might be essential for reporting, it is incumbent upon the authorities at these distant locations not to insert themselves into the tactical decision process. The on-site commanders need autonomy. Definitive guidance and decision criteria must be clearly established before an operation is underway. Beyond that, authorities must rely on their ability to select the right leader for the job; one who is also capable of initiative and has the competence to make the right decisions.²¹

Implementation of concepts such as 'C4I for the Warrior' will continue to play a critical role in the U.S. military's efforts to make its C2 process better, and above all faster than its adversaries. The operational commander must exploit the opportunities that new technologies provide, however, he must play an every increasing role in resolving the challenges described as the C2 process structure continues to evolve.

END NOTES

¹ James Dubik and Gordon Sullivan, War in the Information Age (Carlisle Barracks, PA: Strategic Studies Institute, 6 June 1994), p. 8.

² Joint Staff, C4I for the Warrior, Global Command and Control System, From concept to reality, Architecture and Integration Division (J6I), (Washington, D.C., 1995), p. 3.

³ Milan N. Vego, Operational Functions (The United States Naval War College: Joint Military Operations Department, Operational Art: A Book of Readings, September 1995), p. 1.

⁴ George J. Stein, "Information Warfare," Airpower Journal, Spring 1995, p. 31.

⁵ Ibid., pp. 32-35

⁶ Wayne J. Rowe, Information Warfare: A Primer for Navy Personnel, (United States Naval War College: Strategic Research Department Research Report 6-95), p. 7.

⁷ General Ronald R. Fogleman, USAF, "Information Operations: The fifth dimension of warfare," Defense Issues, vol 10, num 47, p. 2.

⁸ Dubik, p. 5.

⁹ 1st Lt Gary A. Vincent, USAF, "A New Approach to Command and Control: The Cybernetic Design," Airpower Journal, Spring 1995, p. 31.

¹⁰ Lorenzo Crowell, "The Anatomy of Just Cause, " in Operation Just Cause, The US Intervention in Panama eds. Bruce Watson and Peter Tsouras, (San Francisco: Westview Press, 1991), p. 81.

¹¹ Vincent, p. 32.

¹² Ibid., p. 30.

¹³ Ibid., p. 31.

¹⁴ Ibid., p 32. (Adapted from figure 2 Massively Parallel Design)

¹⁵ Joint Staff, C4I for the Warrior, Global Command and Control System, From concept to reality, Architecture and Integration Division (J6I), (Washington, D.C., 1995), p. 15.

¹⁶ David Martin and John Walcott, Best Laid Plans: The Inside Story of America's War Against Terrorism, (New York: Harper and Row, 1988), p. 277.

¹⁷ CDR George F. Kraus, Jr., U.S. Navy (Retired), "Information Warfare in 2015," Proceedings, August 1995, pp. 44.

¹⁸ Ibid., p. 45.

¹⁹ Joint Staff, C4I for the Warrior, Global Command and Control System, From concept to reality, Architecture and Integration Division (J6I), (Washington, D.C., 1995), p. 16.

²⁰ Kraus, p. 45.

²¹ Stephen E. Annon and William E. Einspahr, "The Iranian Hostage Rescue Attempt," Command and Control and Communications Lessons Learned: Iranian Rescue, Falklands Conflict, Grenada Invasion, Libya Raid, (Air War College Research Report, No. AU-AWC-88-043, Air University, U.S. Air Force, Maxwell Air Force Base, Alabama) p. 17.

BIBLIOGRAPHY

- Annon, Stephen E. and William E. Einspahr, "The Iranian Hostage Rescue Attempt," Command and Control and Communications Lessons Learned: Iranian Rescue, Falklands Conflict, Grenada Invasion, Libya Raid, (Air War College Research Report, No. AU-AWC-88-043, Air University, U.S. Air Force, Maxwell Air Force Base, Alabama).
- Anson, Peter and Dennis Cummings. "The First Space War," in The First Information War. ed. Alan Campen. Fairfax, VA: AFCE International Press, 1992.
- Campen, Alan. The First Information War. Fairfax, VA: AFCE International Press, 1992.
- Clausewitz, Carl Von. On War. Princeton, NJ: Princeton University Press, 1976.
- Correll, John, "Fogbound in Space." Air Force Magazine, January 1994.
- Crowell, Lorenzo, "The Anatomy of Just Cause, " in Operation Just Cause, The US Intervention in Panama eds. Bruce Watson and Peter Tsouras, (San Francisco: Westview Press, 1991).
- Dubik, James and Gordon Sullivan. Land Warfare in the 21st Century. Carlisle Barracks, PA: Strategic Studies Institute, 1993.
- Dubik, James and Gordon Sullivan. War in the Information Age. Carlisle Barracks, PA: Strategic Studies Institute, 1994.
- Fogleman, General Ronald R. , USAF, "Information Operations: The fifth dimension of warfare," Defense Issues, vol 10, num 47.
- Grin, John, William Smith, and Lev Voronkov, eds. Military Technological Innovation and Stability in a Changing World. Amsterdam: Vu University Press, 1992.
- Joint Chiefs of Staff. National Military Strategy of the United States of America. Washington D.C.: U.S. Government Printing Office, 1995.
- Joint Chiefs of Staff brochure. *C4I for the Warrior, Global Command and Control System, from concept to reality*, 12 June 1994.
- Joint Publications System. Joint Publication 3-0. Doctrine for Joint Operations. Washington D.C.: U.S. Government Printing Office, 1995.
- Joint Publications System. Joint Publication 6-0. Doctrine for Command, Control, Communications, and Computer (C4) Systems Support to Joint Operations, Washington D.C.: U.S. Government Printing Office, 1995.
- Kraus, CDR George F., Jr., U.S. Navy (Retired), "Information Warfare in 2015," Proceedings, August 1995.
- Martin, David and John Walcott, Best Laid Plans: The Inside Story of America's War Against Terrorism, (New York: Harper and Row, 1988).

- Metcalf, Joseph, III. "Decision Making and the Grenada Rescue Operations." Ambiguity and Command, (Pitman Publishing, Marshfield, MA: 1986).
- Metz, Stephen. "The Operational Level of Nuclear War Fighting: Missing or Unnecessary?" Airpower Journal, Spring 1993.
- NWC 3152. "Command and Control." Capt Gene Nielsen, Newport, RI: September 1993.
- NWC 3163. Air Force Deputy Chief of Staff, Command, Control, Communications, and Computers, "Horizon, Air force C4I Strategy for the 21st Century."
- NWC 3165. "Command and Control Warfare." CJCS Memorandum of Policy, No. 30, 8 March 1993.
- NWC 3169. Stewart, MGen John F., Jr. "Command and Control Warfare and Intelligence on the Future Digital Battlefield." *Army Research, Development and Acquisition Bulletin*, Nov-Dec 1994.
- NWC 3193. Office of the Secretary of the Army, Director of Information Systems for Command, Control, Communications and Computers, "The Army Enterprise Vision" 20 July 93.
- NWC 3233. Klaus, Leigh Ann. "ATM-the Future of Battlefield Communications." *Defense Electronics*, Jan 1994.
- Office of the Secretary of Defense. *Defense Science Board Summer Study Task Force on Information Architecture for the Battlefield*, Washington D.C. 1994.
- Pay, D.J. "The Battlefield Since 1945." in Warfare in the Twentieth Century: Theory and Practice. eds. Colin McInnes and G.D. Sheffield. London: Unwin Hyman Ltd, 1988.
- Rowe, Wayne J. Information Warfare: A Primer for Navy Personnel. Strategic Research Department Research Report 6-95, U.S. Naval War College, 1995.
- Shalikashvili, John. "A Word from the Chairman." Joint Force Quarterly, Autumn/Winter 94/95.
- Slagle, James. "New Russian Military Doctrine: Sign of the Times." Parameters, Spring 1994.
- Stein, George J., "Information Warfare," Airpower Journal, Spring 1995.
- Toffler, Alvin and Heidi Toffler. War and Anti-War. New York: Little, Brown & Company, 1993.
- Vego, Milan N., Operational Functions. The United States Naval War College: Joint Military Operations Department, Operational Art: A Book of Readings, September 1995).
- Vincent, 1st Lt Gary A., USAF, "A New Approach to Command and Control: The Cybernetic Design," Airpower Journal, Spring 1995.

White House. A National Security Strategy of Engagement and Enlargement. Washington
D.C.: U.S. Government Printing Office, 1995.