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The State of the Art and the State of the Practice

RETHINKING COMMAND & CONTROL

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ABSTRACT

Established characteristics bounding the conduct of Command and Control going back to the days of Sun Tzu specifically describe the intended implementation of C2 operations. These can still be seen aboard a variety of warfighting assets and in training facilities both at home and deployed. Military posturing has changed with the advent of information systems and Moore's Law. This has naturally led to the need for "information superiority" which in turn highlights the necessity for new policies, processes, procedures, strategies and tactics. At issue is that the term "Command & Control" may need to be redefined, or that it is no longer applicable in this new age of agile organizations. The consequences of recent warfighting actions have led some to believe that the role of C2 is being eroded by the advent of huge databases and ubiquitous services. In short, traditional Command & Control works well in a military that is trained in a limited communications environment, experienced and semi-autonomous. Moving as we are, to a military that is becoming dependent upon automation will require it to replace training, experience, and autonomy with a more centralized control, and dependence upon automation. Otherwise, the authors suggest that "Command and Control" is a relic in today's modern warfare environment.

1.0 INTRODUCTION

The definition of "Command & Control" (C2) is still being debated within the U. S. Department of Defense (DoD), allied and coalition militaries, the private sector and academia, and a consensus has yet to emerge [Curts, 2005]. As historically shown, striving for a common language, or lexicon in any domain tends to be difficult at best. It has been said that current terminology discussions are more closely aligned with technology issues than the real essence of Command, Control or Command & Control. The technological environment in which C2 operates is certainly important but wherever possible the environment must be used to support C2 rather than C2 blindly adapting to the environment.

In its most basic form "Command & Control" was always meant to convey commander's intent. Successfully conveying such intent implies a shared understanding of "Command & Control" (i.e., the "domain") amongst the participants and, more importantly, that the sharing of diverse information sources be interoperable and understandable throughout both the Information and Cognitive Hierarchies.

Since the inception of Navies, the maritime service has allowed and encouraged ships and their commanders to operate as autonomous, or at least semi-autonomous units. Early in naval history this was, of course spawned by necessity – once a ship left port, communication was virtually non-existent, sparse at best. However, even in today's navies, commanders are given orders before they embark and are expected to carry-out those orders, handling unique circumstances along the way, using the training, experience, judgment and wisdom that won them command in the first place. Perhaps what is needed today is a little more focus on the human aspects of Command and a little less Control.

What is Command & Control? As simply as possible, Command & Control has been historically defined as the actual process of directing and controlling forces. It is the authority that a commander exercises over his subordinates by virtue of his rank or assignment. A generic Command & Control process overlaid with Col. John Boyd's Observe, Orient, Decide and Act (OODA) paradigm is depicted in Figure 1 below [IWIP, 1996].

As defined in U.S. Joint Chiefs of Staff (JCS) Publication 1-02, Command & Control is "…the exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission." Command & Control is 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 [JP 1-02, 1994].

Previously at a Command and Control Conference in Canada [Pigeau, 1995], at the Second International Command and Control Research and Technology Symposium (ICCRTS) in the United Kingdom [McCann, 1996], and at the 1999 CCRTS at the U.S. Naval War College in Newport, Rhode Island [McCann, 1999], McCann and Pigeau offered definitions that highlight the human aspects of Command and relegate Control to more of a support function:

Command: *The creative expression of human will necessary to accomplish a mission.*

Control: *Those structures and processes devised by Command to manage risk.*

Command and Control: *The establishment of common intent to achieve coordinated action.*

Similarly, NATO definitions include [NATO, 1988]:

Command: *The authority vested in an individual of the armed forces for the direction, coordination, and control of military forces.*

Control: *That authority exercised by a commander over part of the activities of subordinate organizations, or other organizations not normally under his command which encompasses the responsibility for implementing orders or directives.*

Command and Control: *The exercise of authority and direction by a designated commander over assigned forces in the accomplishment of the force's mission. The functions of command and control are performed through an arrangement of personnel, equipment, communications, facilities and procedures which are employed by a commander in planning, directing, coordinating and controlling forces in the accomplishment of his mission.*

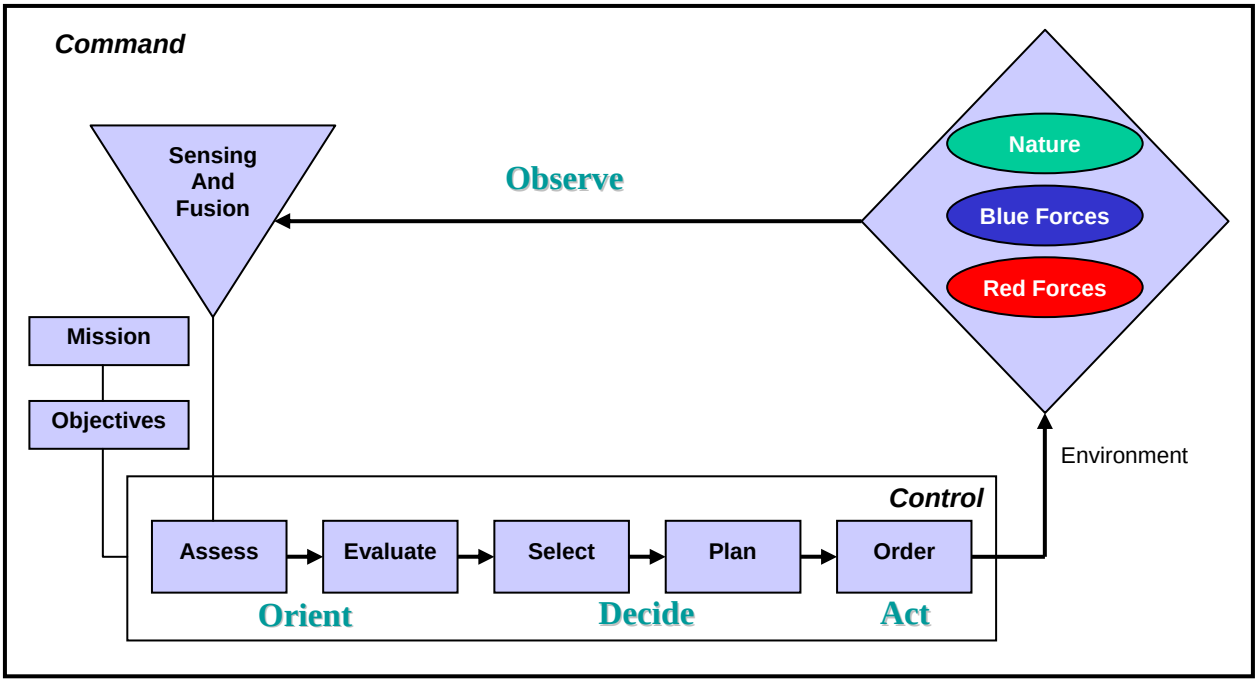

Figure 1. A Generic Command and Control (C2) Process. [IWIP, 1996]

2.0 C2 DIRECTIVES AND SYSTEMS

When this writing began in the Fall of 2005, the only existing U.S. Department of Defense (DoD) C2 Policy directive was DoD Directive 5100.30 dated 2 December 1971 (Change 1 dated 16 May 1974) and titled "World-Wide Military Command and Control System (WWMCCS)." This directive cancelled DoD Directive S-5100.30; "Concept of Operations of the World-Wide Military Command and Control System" dated 16 October 1962. The original directive set the overall policies for the integration of the various command and control elements that were rapidly coming into being in the early 1960s [DoDD 5100, 1971]. As initially established, WWMCCS was an arrangement of personnel, equipment (including Automated Data Processing equipment and hardware), communications, facilities, and procedures employed in planning, directing, coordinating, and controlling the operational activities of U.S. military forces. This system was intended to provide the president and the secretary of defense a means to receive warning and intelligence information, assign military missions, provide direction to the unified and specified commands, and support the Joint Chiefs of Staff in carrying out their responsibilities. A revision to this very dated directive was finally released For Official Use Only (FOUO) in January 2006.

Despite the original intent, WWMCCS never realized the full potential that had been envisioned for the system. The services' approach to WWMCCS depended upon the availability of both technology and funding to meet individual requirements, so no truly integrated system emerged. Indeed, during the 1960s, WWMCCS consisted of a loosely knit federation of nearly 160 different computer systems, using 30 different general purpose software applications at 81 locations (see Figure 2). The problem with all these disparate systems became evident in 1967.

During hostilities between Israel and Egypt in June 1967, the USS LIBERTY, a naval reconnaissance ship, was ordered by the JCS to move further away from the coastlines of the belligerents. Five high-priority WWMCCS messages to that effect were sent to the Liberty, but none arrived for more than 13 hours. By that time the ship had become the victim of an apparently mistaken attack by Israeli aircraft and patrol boats that killed 34 Americans [FAS, 2000][1].

On August 30, 1996, Lieutenant General Albert J. Edmonds, Director, Defense Information Systems Agency, officially deactivated the WWMCCS Inter-computer Network (WIN). One could thus argue that up until January 2006 we have been without a C2 Policy directive, for almost 10 years. Yet, by all accounts, we have been conducting C2 better today and over the past 10 years then ever before. Which begs the question: have we been doing better at C2 because we have no strong C2 Policy or in spite of that fact?

[1] Additional information on WWMCCS can be found at: http://www.fas.org/nuke/guide/usa/c3i/wwmccs.htm.

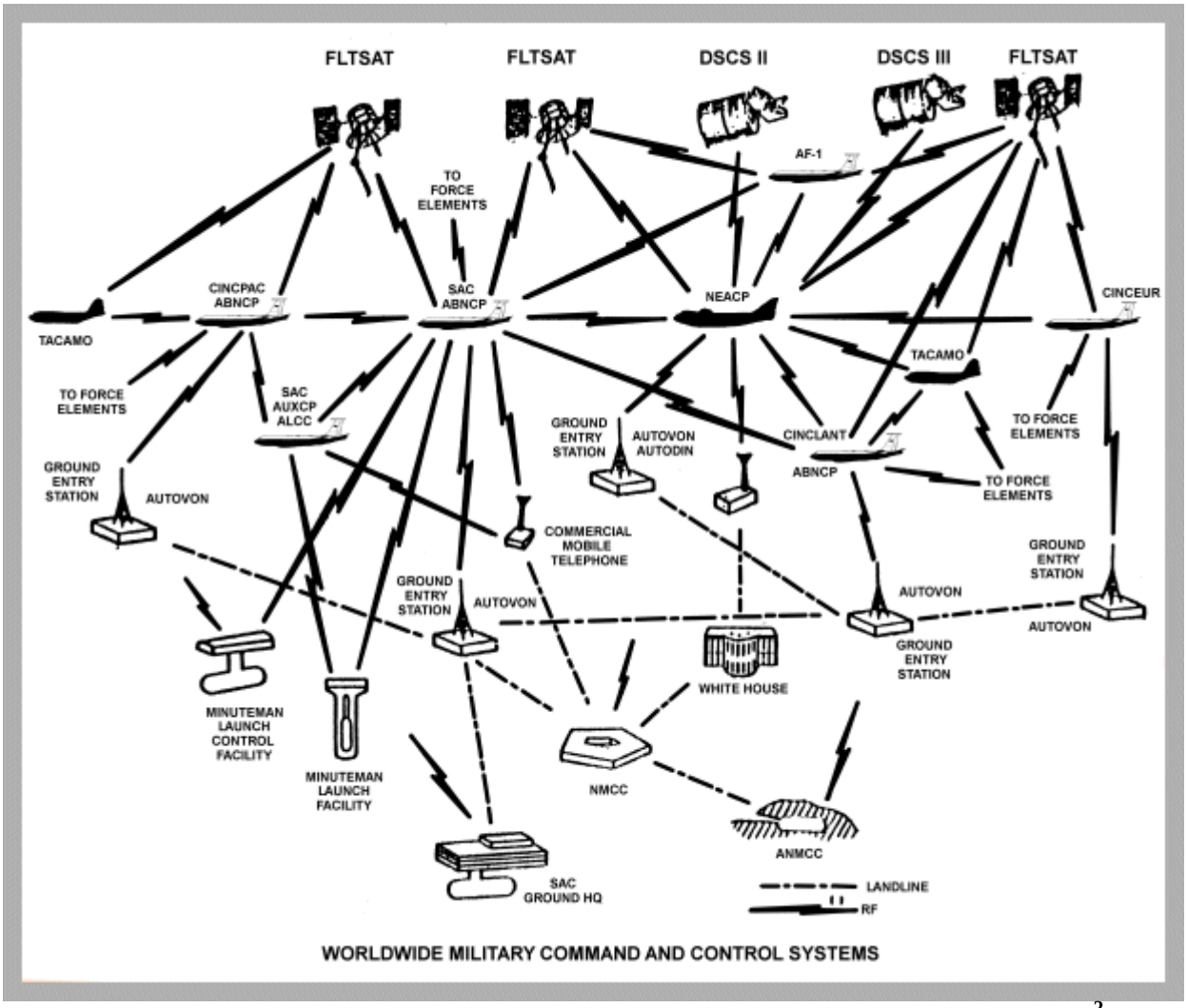

Figure 2. World-Wide Military Command and Control System (WWMCCS).[2]

When WWMCCS died in 1996, the Joint Staff declared the Global Command and Control System (GCCS) the joint command and control system of record. GCCS is an automated information system designed to support deliberate and crisis planning with the use of an integrated set of analytic tools and the flexible data transfer capabilities. GCCS became the single C4I system to support the warfighter from foxhole to command post. Again, multiple, different computer systems were used (See Figure 3) but this time, in an effort to standardize components, it was composed of Commercial-Off-The-Shelf (COTS) software instead of multiple, general purpose software systems. Most would argue that COTS is, by far, better, cheaper, faster than DoD / military specific development and COTS has, in fact, been touted and used within Government for may years. But is COTS really better or even a good idea?

> "Imagine this scenario: The joint forces commander has the opportunity to deliver a decisive blow against the enemy. The Air Operations Center, after careful planning, develops a massive 2,500 sortie air-tasking order. But there is a

[2] Figure 2 obtained from: http://www.fas.org/nuke/guide/usa/c3i/wwmccs.htm).

problem--the command and control system this commander relies upon to generate and distribute the air-tasking order will not function because a commercial-off-the-shelf software (COTS) license has expired, and the software is designed to time out under this condition. The commander has aircraft on the ground, crews ready, ordinance ready, and a chance to strike at the enemy's center of gravity but is unable to generate the command to execute the mission. The forces have been rendered ineffective because of a configuration control problem with a piece of supposedly foolproof COTS software. A nightmare? Impossible? It happened earlier this year [1996]. And we are thankful it happened during an exercise. In this case, we quickly isolated the problem and called the parent software company. In checking its files, they found that the person who wrote the software code no longer worked for them, and they had no access to the logic code he used. We were fortunate to locate him through the phone book, and he graciously told us the method he used to write the lockout code so we could correct it and continue our exercise. Imagine the consequences if this had occurred during an actual operation." *Lt. Gen. John S. Fairfield, HQ USAF Deputy Chief of Staff for Communications and Information, October 1996*

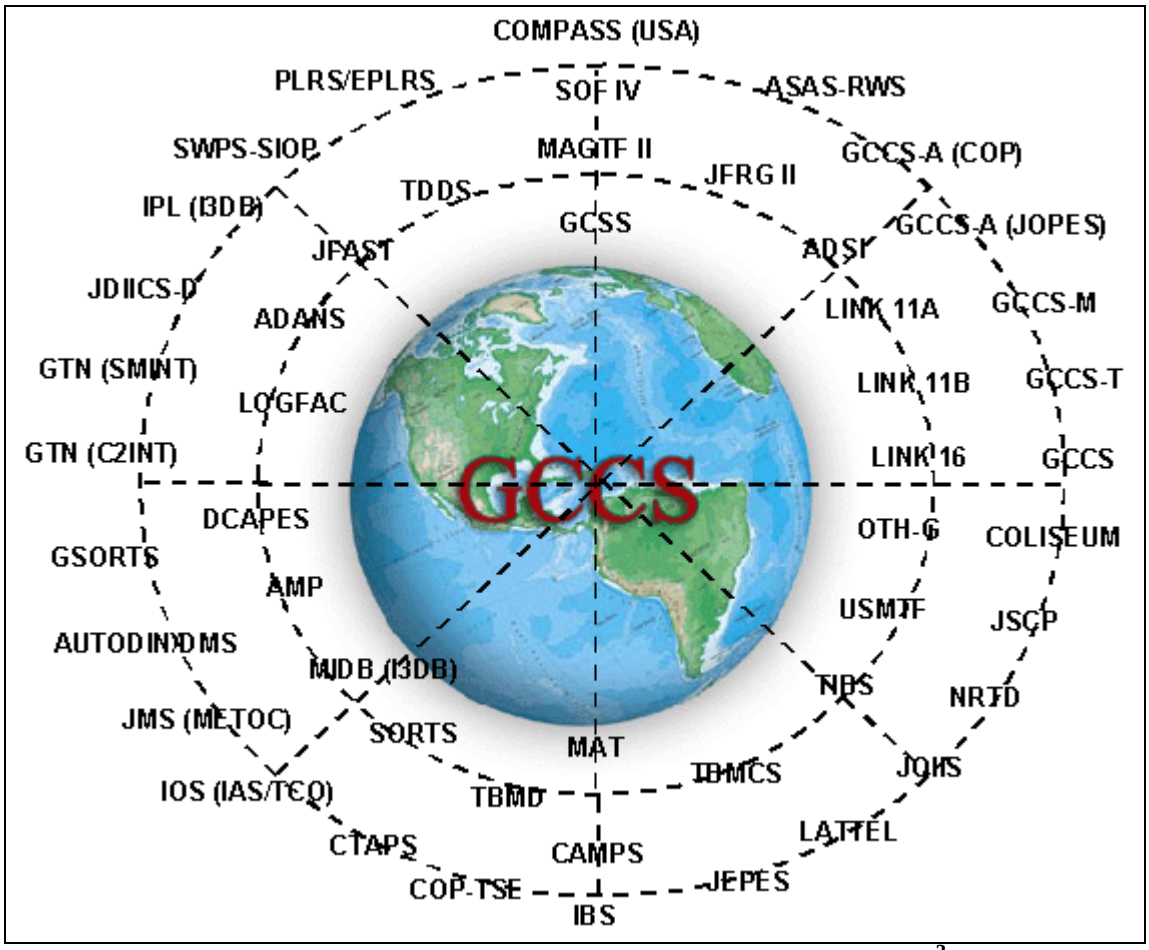

Figure 3. The Global Command and Control System.[3]

[3] Figure 3 obtained from: http://jitc.fhu.disa.mil/gccsiop/

COTS may, in fact, be the best alternative. But, if we intend to continue its use, it seems obvious that more stringent controls are required to prevent such occurrences in the future.

GCCS is a Common Operating Environment (COE), integration standard, and migration strategy that is supposed to eliminate the need for inflexible stovepipe command and control systems and expensive duplication. It is the migration of existing systems into a new COE connected across the Secret Internet Protocol Router Network (SIPRNET) and the integration of selected Command and Control systems into a comprehensive, interoperable family of systems.

The GCCS core consists of the basic functions required by the warfighter to plan, execute, and manage military operations. These functions are satisfied by selecting the applications from existing C2 systems that best meet the requirement. This ensures interoperability, minimizes training requirements and allows efficient use of limited defense resources. GCCS was identified by the Assistant Secretary of Defense for Command, Control, Communications and Intelligence (ASD(C3I) – today known as the ASD for Networks and Information Integration (ASD(NII))) as the C2 migration path to meet the goal of migrating the many Service systems into a collection of fewer, better integrated, interoperable systems.

Command and Control is implemented through a process that extends global influence over our national agencies, military forces, allies, and ultimately, over our adversaries. The process is extended through a system which provides National Command Authority (NCA) and subordinate leaders with a means to exercise their authority and direction. This process uses information to coordinate resources toward common mission objectives. It involves a continuous dynamic interaction between information, the organization, and a support system. Warfighting Commanders, Unified and Specified Commands, sub-unified commands, Commanders of Joint Task Forces (CJTFs), their respective Service components, and coalition forces all require the ability to respond rapidly and appropriately to contingencies.

The primary objective of GCCS is to have an architecture consisting of C2 forces and elements within a highly flexible system. It must be able to collect, process, disseminate, and protect information. It will support the NCA and subordinate elements in the generation and application of national power.

GCCS is an infosphere (information sphere) of software and hardware that links systems together during operations. An infosphere consists of distributed global networks, computer hardware and software, space-based C2 support, and other related support systems.

Planning support must be available on a "push" or "pull" basis as required by the CJTF. "Push" implies over-the-air updating initiated by the source and based on predetermined criteria. "Pull" implies the provision for the receipt of tailored information upon specific request. A standard interface to the theater/operational infosphere must be provided to all Command, Control, Communications, Computers and Intelligence (C4I) systems. It must permit access, in either the “push” or “pull” mode (or perhaps both), to multimedia information.

In sum, GCCS is a command and control system supporting the Joint Chiefs of Staff (JCS) and Combatant Commanders in managing military assets. GCCS supports six mission

areas (operations, mobilization, deployment, employment, sustainment, and intelligence) though eight functional areas [JITC, 2005][4]:

- Threat identification and assessment
- Strategy planning aid
- Course of action development
- Execution planning
- Implementation
- Monitoring
- Risk analysis
- Common tactical picture

But even GCCS is a dying Command & Control system. It will soon be replaced with the Joint Command & Control (JC2) system. JC2 is becoming DoD's principal command and control (C2) information technology. JC2 will enable decision superiority via advanced collaborative information sharing achieved through vertical and horizontal interoperability. As the Net-Centric migration path for the Global Command and Control System (GCCS) Family of Systems (FoS), JC2 will support force-level planning, execution, monitoring, and assessment of joint and multinational operations. JC2 will use Net-Centric Enterprise Services (NCES) Core Enterprise Services (CES) and will be able to exchange data across multiple security domains.

The JC2 mission space is defined as the C2 area encompassing the National Military Command System (NMCS) through unit-level commanders executing or supporting C2 functions as a resource to JTF or Service Components. Historically, warfighting C2 has been divided into three stratified levels: Strategic, Operational, and Tactical. However, in today's warfighting environment, these demarcation lines are no longer distinct. JC2 will eliminate these traditional vertical and horizontal C2 boundaries. JC2 customers will likely include National Political Leadership, the National Military Leadership, Joint Force Commanders (JFC), Combatant Commands, Component Commanders, NATO and Coalition partners.

JC2 functional capabilities are defined in eight joint Mission Capability Packages (MCPs). JC2 applications and functions will be based on Global Information Grid (GIG) Enterprise Services (GES) enabling shared access to Service/Agency/Joint-provided data sources. JC2 is a systems integrator, replacing the Global Command and Control System – both Joint (GCCS-J) and all Service variants as the DoD principal C2 capacity supporting the NMCS and JFC. JC2 integrates databases, servers, client workstations, local area networks, and computer software into an open, scaleable, network centric single architecture while maintaining conformance with the Net-Centric Operations Warfare Reference Model (NCOW-RM) as expressed in the three key DoD Net-Centric Strategies: Data, Information Assurance, and GES. [JITC, 2005][5]

The Joint Requirements Oversight Council (JROC) approved the JC2 Operational Requirements Document (ORD) on 22 August 2003. Using that ORD as a foundation, U.S. Joint Forces Command (USJFCOM) issued a draft Capability Development Document (CDD) for JC2

[4] For more information on the GCCS visit its homepage at http://jitc.fhu.disa.mil/gccsiop/.
[5] Ibid.

Increment 1 on 2 August 2004. ASD(NII) approved JC2 for entry into the Concept Refinement phase on 17 August 2004 and directed that ASD(NII) lead the JC2 Analysis of Alternatives (AoA) while DISA was designated as the lead DoD component for completing all other Concept Refinement phase requirements leading up to an anticipated Milestone A (MS-A) decision. Subsequently, in September 2005 DISA was designated lead component for the JC2 Capability development effort and began standing up the Joint Program Executive Office (JPEO) and Joint Program Management Office (JPMO). The Milestone A decision is targeted for second quarter FY06 [DISA, 2005][6].

It was mentioned above that JC2 applications and functions will be based on Global Information Grid (GIG) Enterprise Services. The GIG will be an integrated, scalable, fully distributed information processing and transport infrastructure based, to the maximum extent, practicable, on commercial information technologies and standards. The GIG is being planned to support the discovery and transfer of information in real time from any source to any destination, provide tailored information through intelligent pull, and will be self-configuring, robust, and secure. The GIG will integrate legacy Command, Control, Communications, Intelligence, Surveillance and Reconnaissance (C4ISR) systems as well as business applications and will permit the full exploitation of sensors, weapons and platform capabilities. Furthermore, the GIG is intended to support the integration of compatible C4ISR systems of allies and coalition partners. The GIG will provide the foundation for joint, combined, real-time net-centric warfighting capabilities. Notice that two huge systems (JC2 and the GIG) are being designed, built and implemented at the same time.

It is the authors' contention that the GIG is not the place for traditional Command and Control processes to reside and we could go on to say that the traditional approach to Command and Control dies when the switch to the GIG is complete - if it ever gets turned on. A report by the Congressional Budget Office [CBO, 2005] warns that securing the Defense Department's Global Information Grid will be difficult. Among some of the conclusions in the report:

- A National Security Agency (NSA) panel of industry experts concluded that "… a detailed architecture defining the GIG in the near term is nonexistent."
- Plans for developing an information assurance architecture for the grid is problematic, "… requiring managing vast amounts of information never attempted before and depending on technologies that do not exist and may not be feasible …."
- The survivability and robustness of the grid have not been addressed.
- "Risk is unbounded within the GIG vision …." [Brewin, 2005]

Also, just developing an information assurance architecture is so complex that the National Security Agency (NSA) has already completed a 2,000-page draft IA document for the GIG. At the 2005 International Command and Control Research and Technology Symposium (CCRTS), Jenifer Wierum presented a paper describing many of the difficulties associated with Information Assurance and Certification and Accreditation of the GIG and like constructs

[6] For more information on the JC2 see http://www.disa.mil/jc2/ or contact the DISA Public Affairs Officer at (703) 607-6900.

[Wierum, 2005]. Part of the problem is technical but a good portion is also administrative. The GIG supports many different Departments, Agencies and Communities of Interest (CoIs) many of which have their own, often conflicting and / or inconsistent, standards and requirements for IA. Currently, the Committee on National Security Systems (CNSS) has a standing IA Working Group to study the issues with respect to National Security Systems (NSS).

In addition, the tragedies that occurred on September 11, 2001, demonstrated that the Federal Executive Branch (FEB), all Departments and Agencies (D&A) not just DoD, did not have the ability to quickly access and share information, collaborate among senior leaders, and make informed decisions - another example of a lack of Command & Control. So shortly after 9/11 the Executive Office of the President (EOP) initiated the Continuity Communications Enterprise Architecture (CCEA) effort. It was intended to ensure execution of FEB Mission-Essential Functions (MEFs) under all circumstances – routine, day-to-day operations through all types and levels of natural disaster and human conflict. That work continues into 2006. In addition, the National Command Capability (NCC) effort is just starting up as a superset of CCEA with existing DoD systems expected to provide the "core" capability.

All of these systems and services take C2 well beyond the original concept of "commander's intent." Many refer to a C2 capability "… from the President to the Foxhole." While technology can certainly provide such a capability, it may be prudent to stop and ask ourselves if this is really a good thing. We have actually exercised similar capabilities several times in the past: Viet Nam and the USS Pueblo incident come to mind. Both of these, by many accounts, led to less than optimal results [Sharp, 1978], [Pueblo, 2005].

3.0 COMMAND AND COLLABORATE: An Alternative Approach

The shift from "Command and Control" to "Command and Collaborate" is an alternative approach that already exists and is being used in the field – in Baghdad by the U.S. Army's 1st Calvary. It is called the Command Post Of the Future (CPOF), a system currently deployed at division level, enabling division and brigade commanders to discuss and collaborate when processing information, to share ideas, and to attend virtual meetings without assembling at one place. Commanders attending the virtual meeting do not have to attend in the same facility, or even the same country, to discuss and draw on the same map. CPOF was developed from a technology demonstration by DARPA. The prototype was deployed with the 1st Cavalry division and is currently operating in Baghdad, connecting the division HQ and five brigades. DARPA is expanding the system with the introduction of advanced visualization tools such as multi-screen video wall, video and audio conferencing and online collaboration tools, allowing brigade commanders to communicate, collaborate and share information. The first unit scheduled to receive the enhanced CPOF is the 3rd US Infantry Division.[7]

CPOF enables forward command elements to operate C2 systems with reduced staff. In the distant future, advanced CPOF systems will eliminate parts of the brigade's Tactical Operations Centers (TOC), primarily the forward and assault TOC which could be transformed into virtual TOCs. COPF relies on wideband data-communications links currently available to

[7] http://www.defense-update.com/products/c/cpof.htm

the Army, via military and commercial satellite communications services. The commander's battleboard is interfaced to the system supporting all communication, collaboration, and information feeds he needs [CPOF, 2004].

Modern C4I systems are feeding huge amounts of information into the TOC where such information is processed, interpreted and displayed on maps and status reports. Such situational presentations are generated by computers, and displayed at the Command Posts (CP) on large screens or relayed to remote subscribers, via high speed networks. Unfortunately, such connectivity is not provided with existing tactical radios. Therefore, tactical commanders are usually disconnected from these vital information feeds when leaving the TOC to deploy in their command vehicles. This becomes most critical at brigade and division levels, where many different operations are executed simultaneously over a large area. To support commanders on the move and at forward deployments, modern command vehicles are being upgraded to field integrated data-communications and display systems, utilizing wireless data networks and mobile satellite terminals, which facilitate on-the-move communications, and enable the commander and part of his staff to continue to exercise effective command and control over the entire force under their command.

The system is maintained as "liquid information" in database format, which separates the data from the viewing space. This method enables faster visualization and optimal maintenance of large volumes of constantly changing information. The system gathers real-time and near-real-time feeds from multiple C2 applications. Constant monitoring of the battlefield is provided, by tracking the combat elements on maps or satellite photos and video feeds from battlefield sensors, following enemy forces through intelligence reports, ground observations, forward units or Unmanned Aerial Vehicles (UAVs). Commanders no longer have to call on the radio to check the status of each unit. CPOFs support commercial presentation style briefings, including maps, photos and video. The participants can respond by sketching out their comments on the shared "Battleboard" presented in each location and at the central Command Post's video wall. The Agile Commander program provided a scalable, reconfigurable operator environment which enabled commanders to access all command post information and functions anywhere, anytime, utilizing advanced MOSAIC (a Graphical User Interface, or GUI) and Global Mobile networking.

While this is certainly a step forward in the technology of information handling, analysis and traditional decision support, does it actually improve decision-making? Noted author and leading expert on intuition and decision-making, Gary Klein, casts doubt on the effectiveness of such systems to improve decision-making. "*Information technology can diminish the active stance found in intuitive decision makers and transform them into passive system operators. Information technology makes us afraid to use our intuition; it slows our rate of learning because we are too timid to explore new strategies.*" [Klein, 2003] Dr. Klein also identifies sources of uncertainty: "*The five sources of uncertainty are missing information, unreliable information, conflicting information, noisy information and confusing information.*" One might conclude that added information may actually increase uncertainty rather than alleviating it. More observations from Dr. Klein's work: [Klein, 2003]

- "*… information technologies are taking their toll. … decision aids and smart systems are reducing their operators to clerks…. Operators come to passively follow what the information technology recommends rather than relying on their intuition*."

- "*Information technology makes us less adaptive by pressuring us to follow the prescribed procedures*."

- "*Information technology … deprives us of the skills we will need once we leave the training environment*."

- "*Information technology can diminish the active stance found in intuitive decision makers and transform them into passive systems operators. (It) … makes us afraid to use our intuition....*"

And finally,

"*Studies have shown that as more and more information about any given situation is accumulated, the confidence in the accuracy of a diagnosis increases dramatically. But, as it turns out, the actual accuracy of the diagnoses does not change significantly. It remains pretty constant at about 30 percent*." [Gladwell, 2005]

Is it possible that we have taken Information Technology a bit too far?

4.0 COMMAND AND SELF-CONTROL: Another Alternative Approach

One could argue that anyone ordered to perform a mission by a higher authority must have their own authority over resources with which to carry out that mission effectively. The level of authority should be based on the role and allocated tasks of the person or persons working to carry out the mission. This level of authority could be thought of as "empowerment." The Merriam-Webster dictionary defines empowerment as "to give official authority or legal power to." So, the command structure remains in place. The difficulties with "Command and Self-Control" are that:

- the one delegating the authority must refrain from then directing the actions of subordinates (*self-control*), yet maintain some semblance of a command structure with them, and
- the subordinate must have the ability, or *self-control*, to work independently or with a team to achieve the mission goals.

The authors (and likely most other career officers) can look back on their military careers and find numerous instances when orders were given but the orders did not come with sufficient empowerment to achieve satisfactory results.

There is certainly a fine line between delegating authority and maintaining a controlling hierarchy. Probably the best way to balance this is to create ownership – by giving the subordinates as much control as possible over their destiny and thus empowering them. While 'empowerment' is not a new concept, it is a new way of thinking about the control aspects of C2. This means giving subordinates the necessary information, responsibility and concomitant authority to make decisions, thus allowing them self-control, and then holding them accountable for the results. And the problem is not unique to the military.

The sharing of information is critical to empowerment, bringing us back to the role that GCCS, JC2 and the GIG play as C2 systems. Ken Blanchard (of "One Minute Manager" fame) and his co-authors wrote a book on the three keys to empowerment [Blanchard, 1996] summarized as the ability to:

1. share information with everyone,
2. create autonomy through setting boundaries, and
3. replace hierarchy with self-directed teams.

In a military structure, this does not mean real-time transfer of all available data and information nor does it include handing over all responsibility from the commander to his or her subordinates. More research into accountability, authority and coordination (without losing control) is warranted. Suffice it to say; that we need to train / grow subordinates that can exercise autonomy, intuition and self-control under the guidance of enlightened leaders and that even with self-directed teams, some form of control is necessary.

GCCS, JC2 and the GIG are not unto themselves the answer to the sharing of information. It may still be revealed that they have become their own worst enemies. A draft 2,000-page document on the GIG's information assurance architecture should be a wake-up call. Being able to solve command and control problems through the progressive application of more and more technology is not the solution. Future solutions must, eventually, fall upon the critical role humans play in command. Because, when the COTS license expires or a GPS coordinate was entered incorrectly, or when the system fails for whatever reason, the human must be able to pick up where the computer left off.

5.0 C2 PROCESS CONCERNS

We have seen that traditionally, Command & Control (C2) is the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission – where "Command" is the legal authority exercised over subordinates by virtue of rank or assignment and "Control" is the process and system by which commanders plan and guide operations. While we can leave the discussion of the role of "command" to those more knowledgeable about exercising legal authority over subordinates, the role of "control" as a top-down-only effort is what should probably change in our current mindset of traditional values.

Future coalition Command & Control information systems will have to take into account interoperability issues so that information can be effectively shared and exploited within coalition operations. In this context, interactions between participants require mechanisms to facilitate the exchange of information and provide a shared understanding of the situation based upon common terminology, as a minimum. One solution to facilitate the communication between agents is to build a common ontology that represents a shared model of a domain [Boury-Brisset, 2000]. Unfortunately, significant time, money and manpower have been spent developing systems architectures, enterprise architectures and ontologies for their own sake seldom if ever lead to any fruitful outcome. Consequently, these approaches, while still valid and necessary, have become unwelcome, or at least viewed skeptically within DoD circles.

A common Command & Control schema, such as the one being developed as part of the Defense Advanced Research Projects Agency (DARPA) Joint Task Force-Advanced Technology Demonstration (JTF-ATD), would provide a substrate for numerous applications in planning, logistics, intelligence, and so on. With the proper underlying technology, it could support advanced knowledge-based applications as well as conventional databases and software systems. To construct this schema, small groups of experts in each of the key sub-areas collaborate to specify ontologies describing the essential concepts, their properties, and interrelationships.

6.0 SUMMARY

The basic underlying precept of Command and Control, "commander's intent," has not changed since Sun Tzu. Our implementation of this precept, however, has changed vastly with the advent of technology from couriers and carrier pigeons, to telegraph, telephone, radio, TV, the internet and beyond. The authors opine that perhaps the technologies have become the driver - forcing Command into a secondary role. We seriously need to re-think our requirements and desired outcome. Do we want Control? Do we really need this much control? Does the President or the operational commander really need to give real-time, tactical direction to subordinates halfway around the globe? Or, do we want Command; Leadership of the sort provided by all the great commanders of the past – Sun Tzu, Genghis Khan, Grant, Patton, McArthur, Spruance, Nimitz, King and many others. And, more importantly, which best serves our goals. It seems that our concepts of Command and Control are in need of serious re-evaluation if not overhaul.

We would like to conclude as we started this paper – with some words from Dr. Ross Pigeau and his colleague Carol McCann. Dr. Pigeau is Chief Scientist of the Defence & Civil Institute of Environmental Medicine in Toronto, Canada.

> *"In our view, the essence of control lies in structure and process, while the essence of command lies in creativity and will.*
>
> *"Most importantly, however, our definition of command captures the fundamental assumption … that humans bear the burden of command. So fundamental is this axiom that it seems to have suffered the fate of many axioms: its self-evident nature has concealed its significance.*

"Command and control are complementary. Command cannot be exercised without control, but control is meaningless without command. However, the two are not equal. Command creates and changes the structures and processes of control to suit the uncertain." [Pigeau, 2002]

7.0 FUTURE RESEARCH

There are a number of areas in which further study would be beneficial.

1. Massive quantities of ubiquitous information in the Service Oriented Architecture (SOA) so widely touted today may not be such a good investment.

2. This whole concept of C2 "… from the President to the Foxhole" bears considerable investigation. Some have argued that it is a capability that should be constructed such that it is available if necessary but, under ordinary circumstances, "… nobody will really use it anyway." First of all, military conflict is not, and never has been "ordinary circumstances." Second, if the capability exists, someone will exercise it at the worst possible time (Murphy's Law[8]) – witness Vietnam and the Pueblo incident cited earlier.

3. If Dr. Klein's work with intuitive decision making is an accurate representation of how military commanders actually function, perhaps we should re-focus our efforts toward supporting intuition rather than flooding commanders with information, no matter how accurate and relevant. Dr. Klein's view seems to be that they will make minimal use of it anyway. This area is probably the most deserving of additional attention.

Recently we seem to have been focused on large, prolific quantities of ubiquitous information made available to any and all combatants via a Service Oriented Architecture (SOA) residing within a Network-Centric environment supported by the GiG. Maybe it is time to refocus our attention to the actual functions of "Command" and "Control" and how they are implemented by good, successful leaders / decision-makers. Then perhaps we will be better able to see what technology is needed to support such a construct instead of proliferating technology for technology's sake.

[8] Murphy's Law: "If there's more than one way to do a job, and one of those ways will result in disaster, then somebody will do it that way." It is most commonly formulated as "Anything that can go wrong will go wrong." [Wikipedia]

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