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GLOBAL STRIKE 2035:

CONSIDERATIONS FOR ENABLING

EFFECTIVE COMMAND AND CONTROL

by

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DISCLAIMER

Biography

Lt Col John K. Lussier is a senior pilot with over 1,500 hours in the HH-60G PAVE HAWK. He has held numerous operational and staff assignments, most recently as Commander of the 563rd Operations Support Squadron at Davis-Monthan Air Force Base, AZ. He holds Master's degrees from the National Defense University in Joint Campaign Planning and from the George Washington University in both Administrative Sciences and Mechanical Engineering. He is also a graduate of the Joint Advanced Warfighting School.

Abstract

By the year 2035, the Department of Defense will see the maturation and integration of a unique family-of-systems that will facilitate innovative, new capabilities to enable the Global Strike mission. For the purposes of this paper, Global Strike is defined as the ability to strike any target, anywhere, in any domain, on demand, in order to achieve strategic objectives. Key to success of the capability will be the command and control architecture that must fuse information from multiple, distributed sources to achieve global awareness and understanding and then translate that understanding into action. This paper explores some of the overarching command and control attributes required to achieve successful Global Strike operations in 2035. Using historical lessons from the command and control of nuclear forces and time sensitive targeting as a foundation, the paper draws several implications and makes recommendations to enable an effective Global Strike command and control architecture for the operational environment of 2035. Focused on the areas of organizational design, leadership and enabling technologies, the study also identifies key attributes required for Global Strike command and control structures. These include the importance of enabling speed of command and control processes to assure timeliness of response, resilience of command and control capability in a potentially degraded operational environment and the ability to gain and maintain global awareness and translate that awareness to understanding in order to support a compressed targeting cycle on a global scale.

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Introduction

"Wisdom is the principal thing; therefore, get wisdom: and with all thy getting get understanding."—Proverbs 4:7 (KJV)

In preparation for his 2011 Senate testimony, the incoming Secretary of Defense Leon Panetta expressed support for the ongoing development of a family of combat air systems that would enable the US to strike any target, anywhere, enhancing the US response against time-sensitive targets in distant, hard-to-reach places.[1] Broadly grouped under the moniker Global Strike,[2] this family-of-systems capability should mature by 2035 leading to the realization of an operational tempo and reach as never before achieved using air and space power. Enabled by a highly responsive and resilient command and control system able to provide rapid understanding for decision makers on a global scale, successful execution of Global Strike missions requires unifying a number of disparate systems in an overarching operational architecture. This requires the ability to synthesize "(1) information from many sources, including new sources, (2) a wide variety of expertise and perspectives (to understand, filter, and integrate the available information and knowledge), and (3) synchronized effects over multiple domains."[3] Taking into consideration the nature of potential target sets and technological advances by 2035, this study asks what will be the overarching command and control attributes to achieve successful Global Strike operations in 2035?

The challenges this command and control structure must overcome are not necessarily new, but they are different than the present. The focus of command and control in this paper centers on the timeless requirement of developing the capacity of understanding the environment and then having both an organization and requisite technologies designed and integrated to coherently translate that understanding into action. Reconciling the benefits and risks of enabling technologies, building resilient organizations designed to function seamlessly while under threat and having the right leadership that is able to orchestrate the actions of numerous individuals and create conditions for rapid innovation will all be elements of the equation that enable the Global Strike capability in 2035. These three elements define a useful framework for thinking about how the command and control architecture facilitates the process of translation.

In order to understand these desired command and control attributes, this paper first looks forward to the future world and some of the projected challenges that await US military forces. It then looks backward to explore the command and control lessons for nuclear forces and operations against theater time-sensitive targets that may be useful for the 2035 environment. Using observations from both of these cases as a baseline, it concludes with several implications and accompanying recommendations in the areas of organizational design, leadership and enabling technologies to enable an effective command and control architecture to overcome the challenges presented in conducting Global Strike in 2035. While not a definitive look at the full range of command and control issues that must ultimately be addressed, these implications are intended to provide a point of departure to spur further discussion. To understand the requirements for Global Strike command and control in 2035, one must first understand the challenges intrinsic to the character of the future operational environment.

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

[1] US Senate, "Advance Policy Questions for the Honorable Leon Panetta," 65.

[2] Although there is not a fully agreed upon DOD definition for Global Strike, for the purposes of this paper, Global Strike is the ability to strike any target, anywhere, in any domain, on demand, in order to achieve strategic objectives. For an additional insight on the challenges of formulating an agreed upon definition, see US GAO, *Military Transformation: DOD Needs to Strengthen Implementation of Its Global Strike Concept*, 12, 14.

[3] Alberts and Hayes, *Power to the Edge*, 74.

Command and Control Challenges in 2035

As already discussed, the purpose of a command and control network is to be able to translate situational understanding into action. From an organizational perspective, moving from awareness to understanding is the ability to monitor an environment of interest to gain awareness and then feeding that awareness through an ongoing analysis and assessment to develop understanding, a concept coined by John Boyd as "appreciation."[1] As laid out in his OODA loop model (observe—orient—decide—act), moving from awareness to understanding is "access[ing] the right information at the right time, and avoid[ing] information overload."[2] According to Boyd, the focal point, the *schwerpunkt*, resides within the orientation portion of the OODA loop as it shaped how individuals interacted with their environment and significantly influenced each of the other three elements of the OODA loop.[3] The ability to gain understanding in a timely manner thus becomes a critical goal for command and control processes so that leadership is able to make better predictions as to adversary actions, increasing time of response and available courses of action that may be pursued.

By 2035, continued globalization and the proliferation of high technology to multiple different actors will serve to make developing appreciation very difficult. Operationally, these challenges mirror, but will be exponentially greater than, those identified by the contemporary concept of hybrid warfare where, "new actors,…includ[ing] insurgent groups operating across international boundaries...global terrorist networks...gangs in Latin America and elsewhere…[and] 'micro-actors with massive impact,'…[combine] with new technology and new or transfigured ways of war, but the old threats also remain and have to be dealt with at the same time and in the same space."[4] Within this context, three factors greatly complicate Global Strike missions in 2035: the complexity of executing the full Global Strike cycle at global distances, the potential diversity of adversaries and their ability to blend into increasingly urban environments and the increased potential of adversaries with the capability to degrade systems critical for execution.

Although great strides have been made since the end of the Cold War to execute missions on a global scale, the Global Strike mission of 2035 must significantly improve upon this foundation. The command and control architecture must integrate multiple systems and sensors operating across multiple domains at an operations tempo where required response times continue to shrink. Moreover, robust networks must support synchronization of the actions of multiple entities operating in a distributed fashion that are critical to making Global Strike a reality.[5] Adding to the complexity, operations may be executed increasingly in environments where an adversary leverages anti-access/area-denial capabilities that seek to prevent US forces from entering the theater and curtailing freedom of action for any forces that make it to the area of interest.[6] Successfully facilitating operations within these types of denied environments are of particular concern for command and control.

In addition to operating at global distances, the wide-range of potential adversaries and targets is the second challenge. Global Strike assets may be tasked to execute missions that range from nation states to individuals and may include any number of disparate fixed and mobile targets.[7] Increasingly, these types of targets will be located in urban environments or concealed to increase the challenge of determining their location. A majority of the targets for Global Strike missions in 2035 share many of the same attributes found in recent conflicts in Iraq and Afghanistan, time-sensitive targets that are "of such high priority to friendly forces that the joint force commander designates [them] as requiring immediate response because [they] pose (or will soon pose) a danger to friendly forces, or [they are] highly lucrative, fleeting target[s] of opportunity."[8] While targets within this class may be either fixed or mobile, the more challenging of the two are targets on the move or targets that have only a fleeting opportunity for an attack when a window of opportunity opens for mission execution.[9]

The final factor that complicates the Global Strike mission of 2035 involves the increased threat to communications, computer systems and raw data vital to enabling command and control. Although this threat is not new, it is different in 2035. The proliferation of technologies, previously reserved for nation states, to non-nation state entities and individuals increase the likelihood of these assets being threatened in 2035. Cyber-savvy adversaries are likely to have capacity to degrade or deny the cyber environment to anyone who uses the cyber infrastructure as a backbone.[10] In addition, space-based assets have an increasing potential to be denied or degraded by nation-states, a strategic vulnerability that experts have known about for years and will remain so into the future.[11] For command and control systems that rely on computer networks as the backbone to enable distributed operations and utilize space-based assets to achieve global reach, the potential for degradation must be expected and overcome to create a reliable Global Strike capability.

It is the combination of these factors that increases the likelihood that command and control systems can, and will, be disrupted without considerable defensive effort. Resiliency in both technological systems and processes will be required to prevail and will form the foundation of future command and control system designs. Beginning with the next section, key aspects of the Nuclear Command and Control System (NCCS) that have a proven track record shed light on validated designs that may help to enhance resiliency in 2035's command and control systems.

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[1] Boyd, "Organic Design for Command and Control," Slides 34 & 37.

[2] North and Forsythe, “A Process Decomposition Approach,” 3.
[3] Boyd, “Organic Design for Command and Control,” Slide 16.
[4] Kilcullen, The Accidental Guerilla, 6.
[5] National Research Council, *US Conventional Prompt Global Strike*, 64-65.
[6] Krepinevich, Watts and Work, “Meeting the Anti-Access and Area Denial Challenge,” ii.
[7] Watts, The Case for Long-Range Strike, 27.
[8] Joint Publication 3-60: Joint Targeting, Appendix A, 1a.
[9] Watts, The Case for Long Range Strike, 27.
[10] Sheldon, “Deciphering Cyberpower,” 106.
[11] Carnegie Panel Staff, Challenges for U.S. National Security, 93.

Enabling Flexible Nuclear Response

The de facto command and control system for contemporary Global Strike missions is supported through by the infrastructure developed to enable the NCCS. While there have been incremental changes and evolutions to the NCCS infrastructure, the command and control architecture for nuclear forces "still largely bears a shape that stems from its Cold War origins,"[1] allowing its historical development to be a basis for forecasting some of the attributes of an effective Global Strike command and control system in the future. The key functions enabled by the NCCS include an effective warning and intelligence system that synthesizes and integrates information from multiple agencies in order to provide situational awareness and understanding, an organizational design that assures timely decision capability and response and resilient command and control systems that enables operations in a wartime environment.[2] A more in depth examination of each of these functions offers insight into command and control in a set-piece, opposed, fixed-target environment.

The first critical factor that enabled the NCCS throughout the Cold War was the robust warning and intelligence apparatus optimized to create timely decision making situational awareness and understanding for leadership. A major goal of the warning and intelligence systems was the capability to monitor a known adversary for indications of a nuclear attack and then assess, analyze and predict the outcome from the attack quickly enough to allow the National Command Authority to direct a response.[3] Early warning capability was queued to watch for the distinct signature from a nuclear missile launch taken from known missile characteristics.[4] The entire process was facilitated through multiple interlinked sensors that included overhead satellites, ground-based radars and communications intelligence systems whose information was "transmitted to 'fusion centers,' where it [was] processed, synthesized, filtered and distributed to political and military command centers for action."[5] The situational understanding for decision makers resulting from these processes evolved to be largely focused on defining and refining the fixed target packages against a known near-peer adversary.

Situational understanding was only useful to leadership if it enabled timely action—to decide on a response and then communicate this decision to nuclear units before the first strike arrived. For a complex task such as a nuclear response, the behavior of hundreds of individuals had to be coordinated to act in concert to create the desired organizational behavior as a whole. These desired actions were codified in standard operating procedures within the organization that eventually became the organization's routine reactions, or norms, to a specific situation.[6] As routines evolved in response to modern threats, the nuclear organization became a "tightly coupled and highly interdependent"[7] entity that would respond to the smallest stimulus originating from attack indicators. Codified in the Single Integrated Operating Plan (SIOP), vertical integration of the nation's entire nuclear complex ensured a credible response in the event of attack from a known near peer adversary.[8] With the highly interdependent nature of the organization and the large number of individuals that had to be coordinated for response, the SIOP "had to be simple, relatively rigid, and preplanned in exquisite detail."[9] The challenges of keeping the SIOP current drove a large portion of the nuclear organization to be optimized to support its target allocation strategy, and had an adverse impact on any organizational flexibility. At its most basic level, the organization existed to respond in a pre-determined fashion, and its design ensured that if a crisis moved toward a decision to launch, that decision would be carried out reliably and without fail.[10]

The final critical factor in the design of the NCCS was the requirement of redundant systems to assure response. As the National Command Authority sought to expand its response options with nuclear forces and increase flexibility, individuals responsible for the nuclear mission had to solve the problem of creating a resilient NCCS that would endure following an attack from a near peer adversary. Solutions to achieve this extraordinary degree of resilience included redundant, fixed command and control nodes to complicate targeting, mobile command and control assets to enhance survivability and hardening of communications infrastructure against nuclear effects that would accompany a nuclear attack.[11] Figure 1 graphically depicts the redundant systems that comprised the NCCS circa 2001 (then known as the National Military Command and Control System (NMCS)).

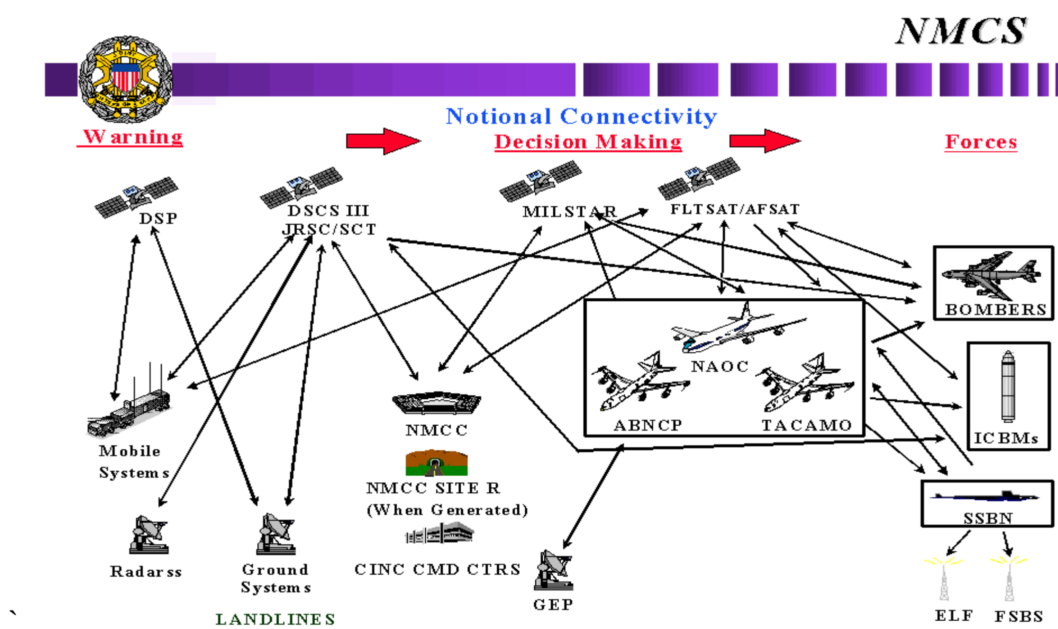

Figure 1: National Military Command System Connectivity to Forces[12]

If the CINC's ground command centers were disabled and unable to perform their command and control function during an attack, the command and control function could be shifted to an airborne command post. These aircraft had nuclear hardened communications suites and carried both battlestaff and communications personnel to enable a mobile command and control capability for nuclear forces.[13]

While the NCCS is highly adept for its designed purpose, conducting preplanned strikes against fixed targets with nuclear weapons, the model functions less well given the Global Strike target set of 2035. It is not optimized to synthesize the unique information requirements for missions against emergent targets that are unexpected, mobile and may be operating anywhere on the globe. In addition, the tight coupling and predetermined responses that occurs during a crisis impacts overall organizational flexibility. Given these limitations, the next section considers the development of command and control processes adjusted to handle the more diverse target set Global Strike must hold at risk in 2035.

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1 Critchlow, "Nuclear Command and Control," 2.
2 Yarynich, C3: Nuclear Command, Control Cooperation, 17.
3 Carnegie Panel Staff, Challenges for U.S. National Security, 94.
4 Ibid., 91.
5 Bracken, Command and Control of Nuclear Forces, 5.
6 Allison and Zelikow, *Essence of Decision*, 170.
7 Bracken, Command and Control of Nuclear Forces, 215.
8 Ibid., 6-7.
9 Buchan et al., Future Roles of U.S. Nuclear Forces, 10.
10 Allison and Zelikow, *Essence of Decision*, 145.
11 Carnegie Panel Staff, Challenges for U.S. National Security, 101.
12 Critchlow, "Nuclear Command and Control," 7.
13 Ibid., 4-5.

Enabling Theater Time-Sensitive Targeting

Much has been learned over the past decade about the command and control attributes required to conduct operations against time-sensitive targets effectively. Mobile and fleeting targets forced theater command and control organizations to place a premium on flexibility and adaptability and to develop processes and systems that increased speed of response. To develop the awareness needed to conduct these operations, the following three issues had to be resolved: "a) each command entity has a different perspective on any time-sensitive target, b) coordination among these command entities takes time and interferes with timely attack, c) the ability to mount timely attacks requires the persistent, often lavish allocation of both sensor assets and attack assets, as well as the proper use of the network to mitigate the first two issues."[1] In the command and control arena, both the focus provided by leadership, the Combined Forces Air Component Commander (CFACC), and the evolution of key organizational functions inside the Combined Air Operations Center (CAOC) successfully addressed these issues, resulting in significant gains in capabilities against time-sensitive targets.

First, the CFACC made prosecuting time-sensitive targets an organizational priority and emphasized innovation within CAOC processes, adapting existing organizational routines within the CAOC and applying them to the realities of this unique target set. To enable the capability, the CFACC developed processes designed to rapidly feed shooters a fused information solution that supported action against time-sensitive targets. The CFACC fostered unity of effort by defining how time-sensitive targets would be prosecuted and then decentralizing authority for execution against specific categories within the time-sensitive target set.[2] In addition, in the Iraqi theater of operations, the CFACC gained Joint Targeting Process Authority, allowing him to develop, select and prioritize targets within the theater of operations using the Joint Guidance, Apportionment and Targeting process.[3] When coupled with the decentralization of authority, the CFACC's control of the Joint Guidance, Apportionment and Targeting process greatly increased organizational flexibility and speed of response through controlling the allocation of both sensors and shooters against active time-sensitive targets.

In response to the CFACC's emphasis on the mission, the CAOC had to significantly adapt both the organization and existing processes to improve the coordination required to increase speed of response against time-sensitive targets. Overcoming existing organizational boundaries and inertia was crucial, especially in the face of new challenges that drove different timing and the formation of new relationships.[4] To adapt, a new organizational structure was required to allow the innovative capability to develop.[5] Within the CAOC, the CFACC provided the leadership cover and "put great care into development of his TCT cell for OIF" which was a cross functional cell focused on execution of the time-sensitive targeting mission.[6] Figure 2 depicts the makeup of the cell resident within the CAOC supporting time-sensitive targeting missions, circa 2003.

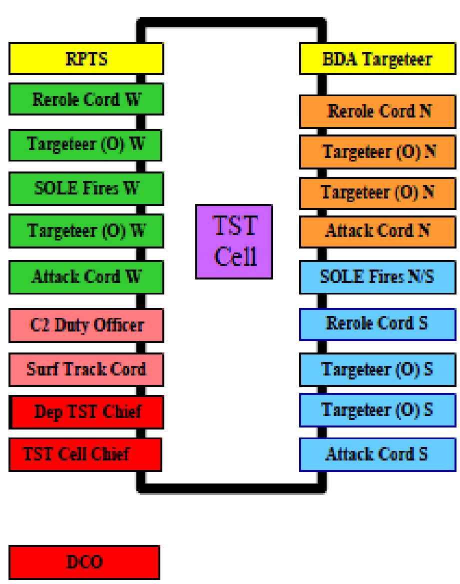

Figure 2: OIF CAOC Time-Sensitive Targeting Cell[7]

The key attributes of the cell was that it was made up of cross functional teams comprised of "intelligence personnel and rated operators working the F2T2 [find, fix, target, track], as well as special operations liaisons (SOLE) working friendly deconfliction issues...[organized] flat with each team working multiple targets in parallel, while the cell chief provided guidance and prioritized overall effort and resources."[8] With its ability to coordinate rapidly and allocate resources against ongoing time-sensitive targeting missions, the Time-Sensitive Targeting Cell was able to operate outside the normal ATO cycle, shrinking the time required from days to minutes.[9]

Concurrent with its organizational development, the Time-Sensitive Targeting Cell adapted existing processes to significantly improve capabilities against time-sensitive targets. Successful targeting required an enhanced ability to rapidly coordinate actions of numerous individuals to develop understanding among process participants. The Time-Sensitive Targeting Cell adopted network-enabled collaboration processes that greatly enhanced target development through the ability to rapidly fuse multiple types of intelligence together to gain understanding in a timely manner.[10] Enabled through the use of the windows-based Automated Deep Operations Coordination System (ADOCS) and one of its sub-modules known as the Joint Time-Sensitive Targets Manager (JTSTM),[11] "operators and analysts [could] access the same dynamic common operating picture…to provide users from across the room or around the world the ability to visualize, collaborate, access and fuse data for improved 'shared awareness,' [promoting] the commander's ability to anticipate and focus ISR assets to confirm activity and achieve effects."[12] As result, the Time-Sensitive Targeting Cell achieved "rapid parallel coordination on every facet of targeting including target validation and PID, friendly deconfliction, CDE, strike asset pairing and strike approval."[13]

With its access to process participants operating across the battlespace, the cell benefitted through better incorporation of human intelligence (HUMINT) information. Special operations forces (SOF) and other entities operating throughout the battlespace performed two crucial functions that greatly enhanced awareness and understanding. First, they added context to imagery and video produced by overhead assets that filled in the gaps during the fusion process for the most difficult targets.[14] Close-in collection, including delivery of various sensors aided developing these difficult targets and provided "essential data for increasing the accuracy and reliability of target identification."[15] Second, these forces performed a target queuing function for overhead assets and a subsequent terminal attack identification and control role in the final phases of mission execution.[16] The successful integration of these elements and the additional information they provided significantly increased its effectiveness.

At the theater level, command and control in its current form, enabled by the operational Time-Sensitive Targeting Cell embedded within the CAOC and led by the CFACC, has gained sufficient maturity to remain relevant for successful operations well into the future. However, for Global Strike missions in 2035, the lessons learned through theater level operations must be extrapolated to a global scale and must address the increased potential for a degraded operational environment.

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[1] Haffa and Welch, "Command and Control Arrangements", 2.
[2] Fyfe, "Evolution of Time Sensitive Targeting," 19.
[3] Kometer, Command in Air War, 140.

[4] Christensen, The Innovator's Dilemma, 175.
[5] Ibid., 176.
[6] Kometer, Command in Air War, 171.
[7] Fyfe, "Evolution of Time Sensitive Targeting," 21.
[8] Ibid., 20.
[9] Kometer, Command in Air War, 206.
[10] Fyfe, "Evolution of Time Sensitive Targeting," 15.
[11] This system has currently gained joint status and is known as JADOCs. Kometer, *Command in Air War*, 169, 171.
[12] Piccarillo and Brumbaugh, "Predictive Battlespace Awareness," 2.
[13] Fyfe, "Evolution of Time Sensitive Targeting," 35.
[14] Piccarillo and Brumbaugh, "Predictive Battlespace Awareness," 5.
[15] Defense Science Board Task Force, "Time Critical Conventional Strike," 54.
[16] Haffa and Welch, "Command and Control Arrangements", 5/Fyfe, "Evolution of Time Sensitive Targeting," 11.

Implications and Recommendations

Using concepts and ideas gained from both cases, several implications for the Air Force can be drawn, particularly in the areas of organizational structure, leadership and enabling technologies required for a command and control design to meet the 2035 challenge. This analysis begins by exploring the implications for leadership and organization of the future Global Strike command and control construct and then concludes with a look at some of the critical enabling technologies.

Leadership and Organizational Design

The first implication is that separate command and control processes, and perhaps separate staffs, are required for nuclear and conventional and conventional Global Strike. By 2035, Global Strike missions will need to be split from the strategic nuclear response architecture to have both the advocacy and focus on the innovation required for what should be a revolutionary capability. Mature organizations, such as those that make up the NCCS, have a bureaucratic tendency to emphasize that which is most ingrained in the dominant organizational culture, resulting in potential neglect of what is truly required to achieve success in a new area that is a significant departure from established norms.[1] For any organization that must learn to operate in new ways in support of innovative capabilities, leadership must ensure the "organization gets the required resources and is free to create processes and values that are appropriate to the new challenge."[2]

To address this implication, the Department of Defense should establish a standing Joint Force Strike Component Commander (JFSCC), separate and distinct from the nuclear mission, who is tasked with the requirement of enabling all the unique facets of Global Strike missions. Currently, USSTRATCOM has established a Joint Functional Component Commander for

Global Strike (JFCC-GS) which is a step in the right direction. However, JFCC-GS is dual-hatted, maintaining both the nuclear and conventional Global Strike capabilities.[3] Despite near-term budgetary constraints, a JFSCC whose sole focus is on the conventional Global Strike mission is likely required to make the capability a reality.

Common to both the NCCS and the time-sensitive targeting command and control architecture, achieving the requisite unity of effort among the numerous individuals focused on developing situational understanding within a global area of responsibility is a critical enabler of the mission that will require a clear commander's intent to drive organizational behavior.[4] As was evidenced in the targeting of theater time-sensitive targets, the JFSCC must develop a continuous Joint Guidance, Apportionment and Targeting process within the organization to prioritize targets that are of strategic importance. In addition, the JFSCC must coordinate operations across COCOM boundaries without a deliberate plan, as was the case with the SIOP, due to the fleeting nature of future Global Strike target sets. Building and maintaining relationships with COCOM commanders and their staffs will enable operations requiring rapid execution when a window of opportunity for attack opens.

In order to successfully exploit windows of opportunity against fleeting targets, the JFSCC requires a standing Joint Strike Fusion Center (JSFC) focused on the global environment similar to the theater Time-Sensitive Targeting Cell. The requirement for gaining awareness and then translating that awareness to understanding, "orienting" the organization on a global scale, will be the critical element for enabling future Global Strike missions. The JSFC must be capable of rapidly narrowing its focus against the prioritized Global Strike target set. As with theater time-sensitive targets, the JSFC will be the single central hub for synthesizing information from numerous sources often distributed throughout multiple organizations and then developing fused solutions to support action in a significantly compressed targeting cycle. To be successful, the JSFC must lead coordination and collaboration processes among numerous individuals and have the in-house expertise to integrate the results into usable products.[5] As was the case with enabling the theater time-sensitive targeting capability, integrating HUMINT is essential, especially in the crucial queuing function to the right place and at the right time when windows of opportunity open. As a result, the JSFC must build and maintain relationships with SOF and other interagency partners required to leverage HUMINT since it is often only resident and accessible within separate organizational networks and databases.[6]

The second implication for the organizational design stems from the requirement to operate globally. To facilitate potential rapid execution of Global Strike operations across COCOM boundaries, building and maintaining relationships with key COCOM leadership and staff personnel is essential. COCOM leadership requires a mechanism to gain the awareness and understanding resident within the JSFC when a window of opportunity opens for the execution of a Global Strike mission.

To address this implication, the JFSC must create small liaison cells, or circles,[7] distributed within organizations desired locations throughout the world. Comprised of two to three individuals, these cells will maintain full connectivity to the JSFC to both share and contribute to their awareness and understanding of the current situation. Enabled through the projected gains in computational power by 2035, these cells are essentially mini-JSFCs that provide awareness into potential Global Strike operations within each geographic COCOM. As a standing presence, they will be critical to building relationships within the COCOMs that will be essential to building support for strategic Global Strike operations.[8] As a complementary benefit, these cells provide the standing JSFC with a conduit, a “directed telescope” capability, to share relevant information tailored for Global Strike target sets resident within COCOM systems.[9]

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[1] Allison and Zelikow, *Essence of Decision*, 180.
[2] Christensen, The Innovator’s Dilemma, 177.
[3] USSTRATCOM, “Joint Functional Component Command for Global Strike (JFCC-GS),” http://www.stratcom.mil/factsheets/JFCC_-_Global_Strike/.
[4] Alberts, Gartska and Stein, Network Centric Warfare, 160-161.
[5] Elder, “Global and Theater Operations Integration,” 53.
[6] The ability to leverage pre-existing networks is one solution for a centralized organization to gain flexibility through decentralization of processes. Brafman and Beckstrom, *The Starfish and the Spider*, 96-98.
[7] Although this paper uses the terminology of cells, the functions of these cells will be remarkably similar to virtual circles enabled by modern networks linked through the Internet. Ibid., 88-91.
[8] Ibid., 90-91.
[9] Van Creveld, *Command in War*, 75, 272.

Critical Enabling Technologies

While the technological requirements for enabling the entire Global Strike cycle from a command and control perspective is extensive, creating resilience may be the most essential element for success in the 2035 environment. The command and control architecture will depend on reliable networks to support its ever-increasing distributed processes. Unfettered communications is essential to gain and maintain global awareness and understanding in a timely manner. As long as networks are not degraded and remain intact, this capability should see dramatic growth and improvement as computational power continues its growth exponentially.[1] Consistent investments in JADOC-like programs capable of leveraging new computational power will result in significant gains to collaborative capacity and speed of processes sufficient to support global operations.

However, if an adversary is able to degrade established networks, backup methods must also be readily deployable to the required collaborative capability necessary for enabling Global Strike. The recommended technological solution that shows the most promise for this implication is the use of advanced wireless mesh network (WMN) technologies that already are employed to support emergency and disaster response operations.[2] Figure 3 provides an overview of how the key components that enable WMNs, easy-to-install routers and clients, are linked to create a network leveraging existing infrastructure.[3]

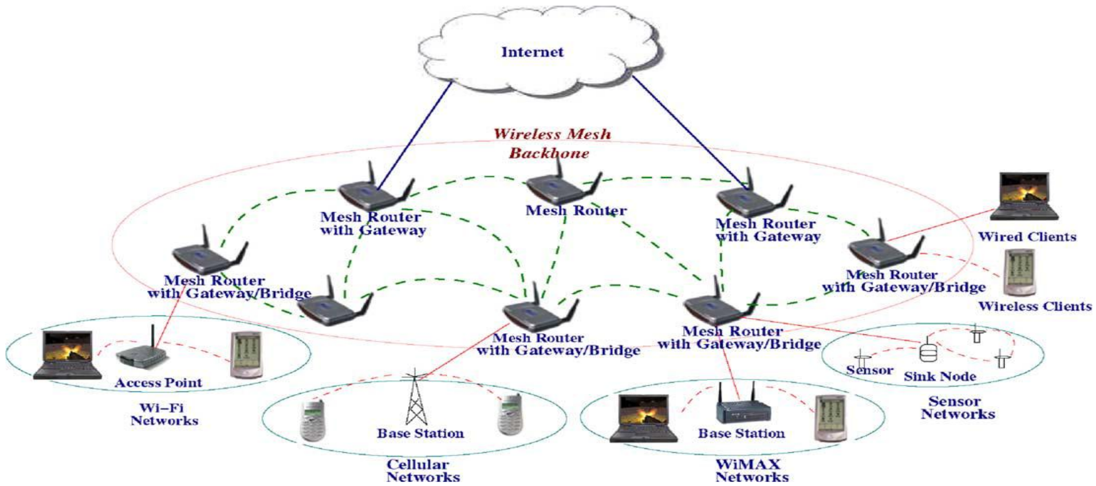

Figure 3: Infrastructure/Backbone for Wireless Mesh Networks[4]

These routers are designed with multiple interfaces able to leverage existing wireless infrastructure, enabling creation of adhoc networks with the ability to access to the internet.[5]

The clients, consisting of WMN-enabled laptops, cell phones, or PDAs, are not only able to access the network through the routers, but also have the capability to facilitate access to and through other clients, creating a self-forming and redundant network.[6] By 2035, as long as the devices can be delivered and installed and wireless infrastructure is available, WMNs should continue to see size reductions as a result of computational power increases allowing creation of adhoc networks anywhere in the world with micro- or mini-devices. As a dual use capability, WMN technology greatly aids the ability for "on target" queuing under the right circumstances.

In addition, the second recommendation that stems from resilience in 2035 will be enabling command and control when beyond line of sight communications are either degraded or completely unavailable for a long period of time. Applying the similar backup airborne command and control concept used by the NCCS, the JSFC will need to rapidly transition to a mobile command and control and fusion node during periods of degradation. The airborne platform requires the capability to interface with any adhoc ground WMNs formed to support a Global Strike response and act as a router with optional gateway capabilities. As envisioned by this study, this capability would alleviate reliance on space-based assets.[7] Upon reaching the area of interest and anchored in an orbit, this airborne platform would create linkages with sensor and shooter assets and standing theater command and control nodes to facilitate the targeting cycle.

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[1] Known as Moore's Law, this exponential growth has driven the computer industry since 1965 has seen computational power double every 18 months and is projected to continue for at least the next seven or eight years. Kaku, *Physics of the Future*, 20-23.

[2] Dilmaghani and Rao, "Hybrid Wireless Mesh Network," 55.

[3] Akyildiz, Wang and Wang, "Wireless Mesh Networks," 446-447.

[4] Ibid., 448.

[5] Ibid., 448.

[6] Ibid., 449.

[7] Medina and Hoffman, "The Airborne Internet," 349-351.

Conclusion

"It takes a network to defeat a network…A true network starts with robust communications connectivity, but also leverages physical and cultural proximity, shared purpose, established decision-making processes, personal relationships, and trust. Ultimately, a network is defined by how well it allows its members to see, decide, and effectively act."—General Stanley A. McChrystal[1]

While it takes a network to defeat a network, it also takes a network to leverage a network as evidenced in this study. The command and control of future Global Strike missions will center on building an effective organization that is able to fuse information from multiple, distributed sources to achieve global awareness and understanding and then translate that understanding into action, as directed by a single leader. What will be the overarching command and control attributes to achieve successful Global Strike operations in 2035? The key command and control attributes required to realize a true Global Strike capability are speed of command and control processes to assure timeliness of response, resilience of command and control capability in a potentially degraded operational environment and the ability to gain and maintain global awareness and translate that awareness to understanding in order to support a compressed targeting cycle on a global scale. While the year 2035 may seem a long way off, in reality, any desired operational capability necessary to enable future missions must begin now. Ultimate success or failure will be determined by how well the command and control—the leadership, the resultant organization and required technologies—is designed and integrated to support all the elements that will comprise the future Global Strike architecture.

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[1] McChrystal, "It Takes a Network," http://www.foreignpolicy.com/articles/2011/02/22/it_takes_a_network?page=0,2 (accessed 30 November 2011).

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