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Modeling C2 Agility to Meet the Demands of a Distributed Force

Topic Area:

Topic 1: Concepts, Theory, and Policy
Topic 5: Experimentation, Metrics, and Analysis
Topic 6: Modeling and Simulation

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Abstract

The advent of Counter Insurgency (COIN) doctrine emphasizes reliance on the tactics, techniques, and procedures (TTPs) of a distributed force. Such forces require innovative technologies, processes, and organizational structures to be both effective and agile. Understanding effectiveness and agility, and the relationship between them, can inform the maturation of Mission Command as an overall doctrine.

MITRE's Mission Command Modeling Methodology (MCM2) works with detailed process models. For example, a model previously developed for targeting, was designed specifically to analyze alternative configurations of a distributed force. MCM2 suggests configuration options based on the established North Atlantic Treaty Organization Network Enabled Capability Command and Control (NATO NEC C2) maturity model. In our research on C2 agility, the targeting process was used as a representative component of C2, and applied a variation of the NATO NEC C2 maturity model to understand process-related mission relationships.

This paper describes our approach to modeling the target development process, and alignment of the DoD targeting model with the attributes of the NATO NEC C2 maturity model. MCM2 measured force configuration changes along axes defined by the maturity model. The modeling results reveal changes in predicted C2 agility that stem from process variations.

1 Introduction

The MCM2 and C2 Maturity Model individually support the Capstone Concept for Joint Operations (CCJO) vision and this paper describes how they can be used together to understand how various force configurations and their TTPs lend themselves to force adaptability and their performance characteristics.

1.1 CCJO Vision

The future security environment, as described in the CCJO 2020,[1] is "likely to be more unpredictable, complex, and potentially dangerous than today." This calls for greater speed in planning and conduct of current TTPs, the ability to change TTPs quickly once a fight is underway, and increasing fiscal efficiency.

The CCJO describes "globally integrated operations" as the Joint Force concept to prepare for the future security environment. The key feature of such operations is the ability for a Joint Force to "quickly combine capabilities with itself and mission partners across domains, echelons, geographic boundaries, and organization affiliations. These networks of forces and partners will form, evolve, dissolve, and reform in different arrangements in time and space with significantly greater fluidity than today's Joint Force." Mission Command[2] is an appropriate doctrine in such highly uncertain and changing environments, which place a premium on lateral collaboration, partnering, and flexibility. This includes the ability to change relationships among force elements at all levels, even among combatant commands (CCMDs), depending on the needs of the mission and environment. This has two implications: (1) mutually supporting commands can help construct command relationships tailored to specific future threats, and (2) TTPs could be standardized across CCMDs to facilitate the shifting of forces.

1.2 Integrating Two Complementary Efforts

Mutually supporting commands and force shifting are essential to a capability to combine and recombine capabilities within Joint Forces and with mission partners. Process modeling and TTPs, which examines the results of different force configurations executing various functions, can create insight into the performance of flexible forces. This paper examines MITRE's MCM2, which compares the performance of various force configurations, and relates the resulting relationship structures to the NATO NEC C2 Maturity Model,[3] developed by the IDA. The combination yields improved understanding of some of the hypotheses underlying Mission Command as it relates to better performance in a more collaborative environment. In addition, some of the force configurations modeled examine sharing of resources, and thus inform force options that support fiscal constraint within the CCJO 2020 vision.

In addition to reviewing MCM2 models of various force configurations and examining the subsequent performance characteristics and relationship to the NATO NEC C2 Maturity Model, we consider the impact of shifting from one force configuration to another. This requires changes

[1] Capstone Concept for Joint Operations: Joint Force 2020, 10 Sept 2012,
[2] http://jfsc.libguides.com/missioncommand
[3] http://dodccrp.org/events/17th_iccrts_2012/post_conference/plenary/0619_1030_Waldo %20Freeman_Mission %20Command %20and %20C2 %20Agility.pdf

not only in human-to-human relationships and tasking, but frequently also in the supporting IT. We discuss the relationship with IT in the Future Directions section.

2 MITRE's Mission Command Modeling Methodology (MCM2)

MCM2 generates and measures a variety of force configurations and TTPs using modeling and simulation, and measures the resultant performance (agility) in context with the operational process. MCM2 is an iterative method that involves continual engagement with operators during modeling and analysis efforts. This yields benefits for all participants: the operators obtain a clearer definition of their processes, while analysts can gather more detailed information as areas of interest are identified. The methodology follows the steps depicted in Figure 2-1.

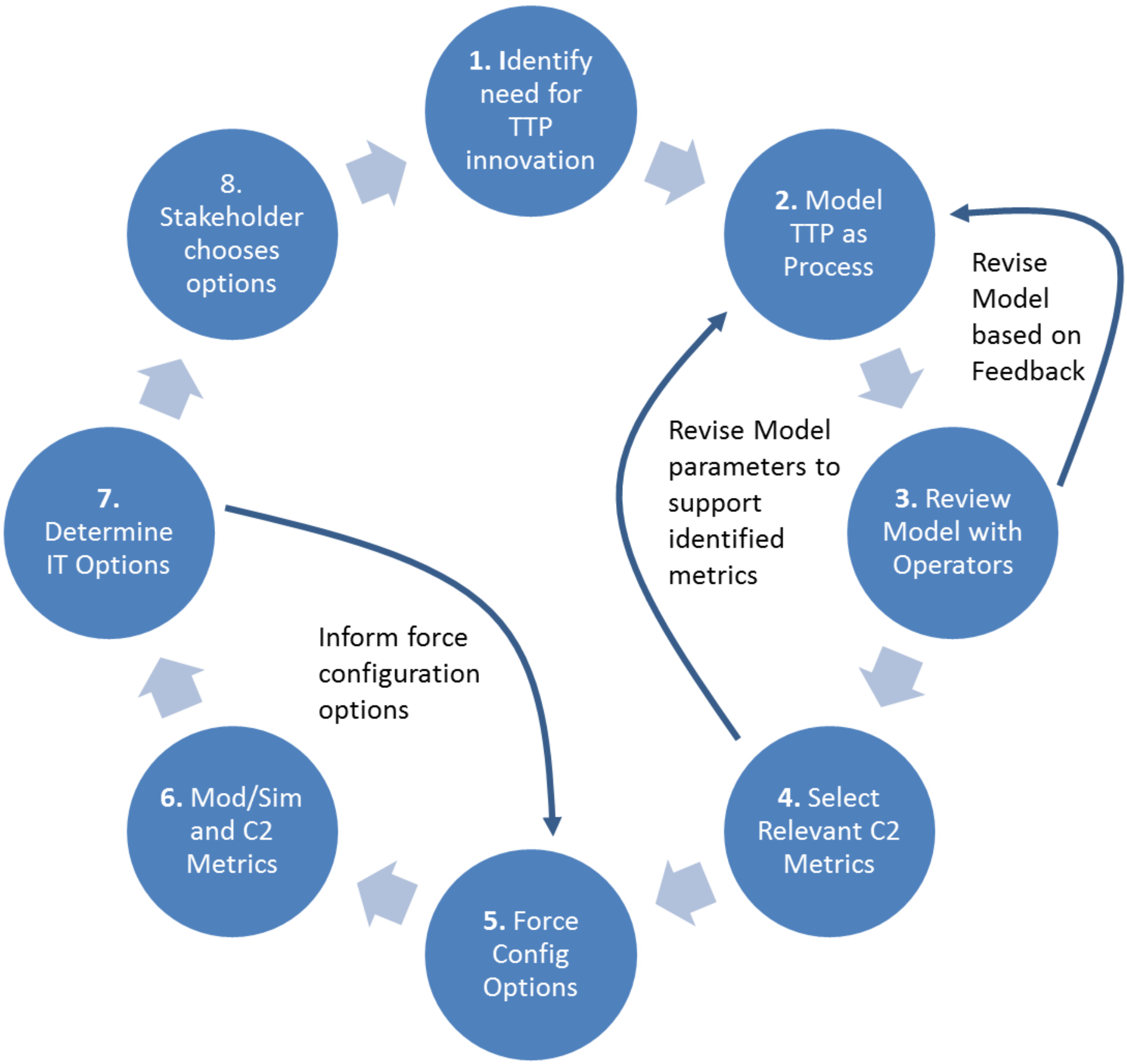

Figure 2-1: MCM2 Overview

- Step 1 - The process begins when a stakeholder identifies a need for new TTPs to meet challenges created by the adversary, environment, fiscal pressures, etc. The responsible stakeholder realizes s/he needs to consider innovating the TTP to meet the challenges of the adversary, environment, fiscal pressures, etc.
- Step 2 – Review documentation and identify the key attributes of the process relevant to the study. Focus on the decision points and information exchanges that are the key drivers for measuring the process. If possible, observe the TTPs being executed either in training, exercises, or actual operations. Create a business process model of the relevant TTPs and their relationships, focused on the activities actually performed by the operators. This gives the context to assess the maturity of any associated documentation and the value of the prescribed procedures to actual operations.
- Step 3 – Review the process model with the operators and decision makers to ensure it reflects reality. Return to step 2 to revise activities in the model to incorporate feedback from operators.
- Step 4 –Identify relevant C2 metrics for the operational process modeled. Understand the possible configuration changes as they relate to the metrics. Return to step 2 to refine/expand the parameters of activities in model for the analysis.
- Step 5 - Determine force configuration options. Based on the as-is model, consider and model options for alternative force configurations and processes, including the associated costs and the time needed to implement them.
- Step 6 –Perform modeling and simulation and determine the granularity of data necessary for the metrics identified. Gathering best estimations from operators is sufficient for preliminary analysis that will improve the model and reveal where additional detail is needed.
- Step 7 - Determine IT Options. For each credible force configuration option, consider IT options for adapting IT to meet the needs of each force configuration option. Each IT option has a cost and time to implement. Methods to achieve agile and adaptive IT capabilities.
- Step 8 – Decide which options to choose. Based on the challenges posed by the adversary, environment, and fiscal pressures, the stakeholder evaluates the various options, chooses a force configuration option and a related IT option and implements the new TTPs. Based on the performance of the modified TTPs in real conditions, the stakeholder may have to adjust the TTPs or replace them entirely.

2.1 MCM2 Background

United States European Command (USEUCOM) sponsored MITRE to perform studies of a core set of integrated processes centered on targeting. Over a 2–3 year timeframe during Austere Challenge 2009 (AC09) and AC 2010 (AC10), MITRE documented a detailed target development process and used MCM2 to develop associated models and simulations. Understanding the integration and interactions between ISR and air operations was a key aspect of this effort.

During AC09 MITRE's study centered on targeting operations and the use of new staff organization and coordination TTPs known as Boards, Bureaus, Centers, Cells and Working Groups (B2C2WG). MITRE created detailed diagrams of battle drill processes and other operational contexts. USEUCOM's fully engaged staff was able to achieve recognizable improvements and refine Concept of Operations (CONOPS) for future missions. In November 2009, USEUCOM asked MITRE process engineers to deploy to theater and lead the effort to generate the same artifacts for a newly formed International Security Assistance Force (ISAF) Joint Command (IJC)/NATO Joint Task Force (JTF) in Afghanistan.

The following spring AC10 expanded the support to produce an integrated process model that included the targeting process from the Air Tasking Order (ATO) cycle at the Air Force Air Operations Center (AOC). In response, MITRE developed an intuitive process model of the 72-Hour ATO target development cycle for the USEUCOM Staff elements (targeting and ISR). MITRE demonstrated the model to the IJC and adapted it significantly to reflect the IJC's specific instantiation of the integrated processes. The IJC used the model in its staff training and as a basis for launching further architecture studies for systems integration efforts.

Once Operation Odyssey Dawn (OOD) and Operation Unified Protector (OUP) began, USEUCOM called upon MITRE to conduct an operational review of the two operations, both of which included intense air targeting campaigns. MITRE expanded the AC10 targeting model to include the CCMD's target folder development processes. MITRE derived a rich set of lessons learned from the detailed process model created during the operation.

USAFRICOM, USEUCOM and the 603rd AOC found themselves being reduced of targeteers, in the middle of an operation (OUP) and having to rely on innovative work-arounds without the benefit of analysis and course of action development. That instigated the urgent need to provide a modeling and simulation capability recognized by the detailed process model, that captured all of the key organizational attributes that would reflect the process impacts of depending on remotely distributed expertise, and remote management of personnel assets, that previously had been local.

Because the structural changes to relocating critical personnel and their skill sets went un-studied/without analysis; the implications to targeting effectiveness were too complex to describe. By showing how these changes impact the process and delays of unsynchronized/ agreed to working impacts in advance, the impacts were unintuitive.

In response, USEUCOM asked MITRE to refine the OOD/OUP target folder development process into the DOD Targeting Model, modeled after the Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3370.01[4] to perform simulation and analysis. MITRE therefore adjusted the allocation of targeting staff resources in its simulation, transferring CCMD-assigned targeteers to Continental United States (CONUS) units. In this new configuration the targeteers could provide general support of all CCMDs, as well as surge capabilities to accommodate real-world operational needs in response to unanticipated events. This simulation gave the USEUCOM Targeting Chief the tools to understand the implications of different approaches to managing the targeting staff and the impact of personnel allocation on targeting operations. This, in turn, enabled development of detailed simulations that focused on the personnel support aspect of the overall operations. The ability to simulate this thread from each staff element's perspective illustrated how the transfer of collaborative and sequenced activities would occur. This experience demonstrated that the simulation of distinct focus issues in a process is valuable in

[4] Target Development Standards. Chairman Of the Joint Chief of Staff Instruction 15 September 2011

capturing the speed and accuracy of the process. Figure 2-2 illustrates the evolution of the targeting modeling efforts as each model was consumed by and informed the next.

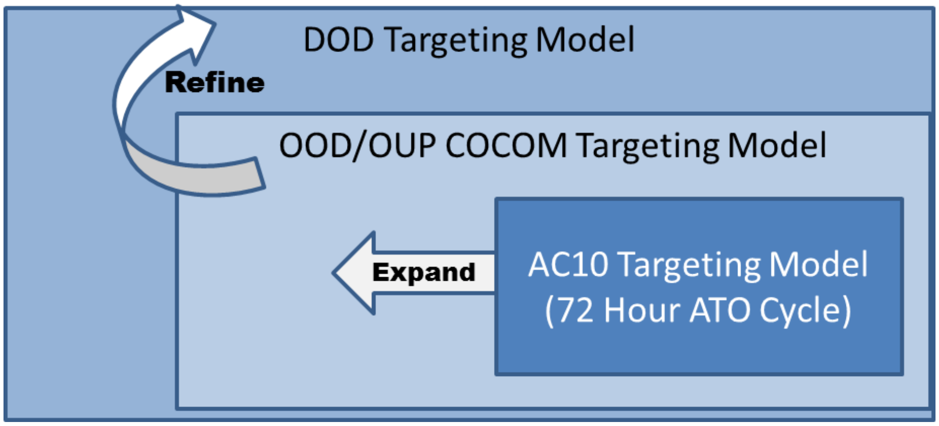

Figure 2-2: Evolution of the Targeting Model Efforts

2.2 IDA C2 Agility Maturity Model

In November 2011 Acquisition, Technology, and Logistics (AT&L) asked IDA to initiate a study on improving the state of the art of agile C2. AT&L also directed IDA to conduct an independent assessment of existing theoretical work and ongoing DoD-sponsored research to determine their demonstrable value in improving the future state of practice of agile C2 in US operational forces.

In response, IDA has developed a conceptual model for understanding C2 Agility in MC terms. The resulting C2 Maturity Model has the capability to address several key agility factors in analyzing C2 performance. As shown in Figure 2-3, the model is represented as a cube defined by three axes. “Patterns of interaction among entities” indicates the degree of self-synchronization between groups. “Allocation of decision rights to the collective” measures the extent to which organizations pass decision authority down to the lowest level possible. “Distribution of information among entities” reflects how freely information flows between groups and the accessibility of data. Together, the three axes determine the level of agility and encompass MC.

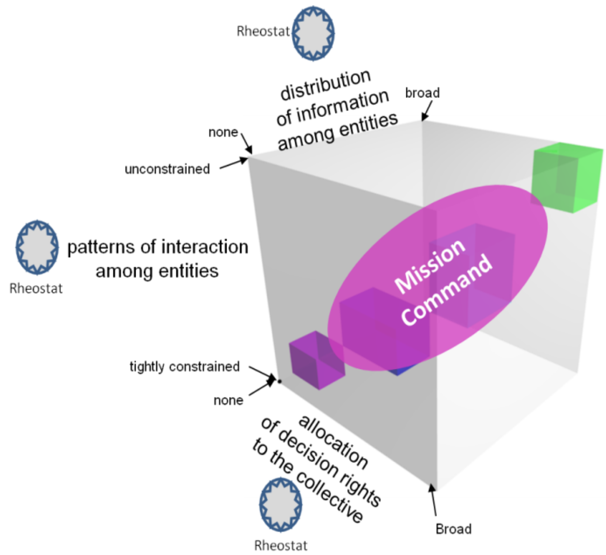

Figure 2-3: IDA C2 Maturity Model

The C2 Maturity Model helps to explore such questions as:

1. "How do I know where my organization is in the approach space?"
2. "Should something move, and in what direction?"
3. "What specifically must change if I turn each axis rheostat X notches?"

3 Measuring TTP Performance through Process Models

The DoD Targeting Model for a CCMD with an established Joint Task Force (JTF) captures targeting assets from internal and external targeteer assignment structures. Internal supporting personnel are assigned at the JTF Headquarters, and within the Joint Force Air Component Commander (JFACC) structure and the associated AOC. Distributed forces supporting targeting come from CCMD-supporting structures known as the Joint Reserve Intelligence Support Element (JRISE) and the Air Force Components supporting structure in the Air Force Targeting Center (AFTC). Modeling the various configurations of the distributed forces gives us the ability to measure the execution performance of the TTPs as well as map the configurations to the C2 Maturity model axes. Each configuration's results are mapped to a point in the cube. The relationship of the force configuration modeled and resulting vector is described below.

The CCMD establishes certain ***predetermined decision rights*** within the targeting domain to fully manage the priorities and target selection aspects and ensure the unit is effectively prosecuting appropriate targets in a fluid environment. The J2 and targeting leadership at the CCMD and the JTF together decide on the strategic- and tactical-level targeting requirements. These decision rights must be effectively focused. The agile implementation of the resulting target folder development is crucial to a robust identification of targets that meet the Commanders' needs. As the supporting targeteers and ISR collection planning staff become more distributed, decision makers need an effective way to display the current priorities and accommodate input from several external sites, as well as a means to dedicate the available personnel to "working up" the prospective target folders.

Organizations can establish several ***patterns to orchestrate*** their parallel support: designating which support units prepare the "point dropping" for complex targets, conduct the Collateral Damage Estimates (CDE), and perform the weaponeering. This division of responsibilities, delegated to lower leadership within the supporting elements/units, allows efficient allocation of personnel skills. These skills, in turn, require specialized training and certification from external training teams. Leadership must anticipate these training needs to prepare for crises, as routine training cycles cannot ensure availability of adequately trained personnel for unanticipated crisis operations.

Another foundation for agile targeting operations is the ***sharing of information***. This is difficult because of the security requirements that protect the exact priorities and targeting intent from reaching the enemy. Within these constraints however, sharing of information can be still be attained. Determining what to share (what risks are worth the benefits) is what needs to be determined.

3.1 Joint Research: Combining the Two Approaches.

The targeting process contains the essential components that can be visualized with the three axes of C2 Maturity Model. IDA collaborated with MITRE on a short (30-day) turn-around effort to demonstrate how MITRE's DoD Targeting Model could be illustrated within the C2 maturity model. This effort illustrated changes in the distributed force configuration and enabled us to observe, detect, and record positive and negative effects. To simulate the distributed force configuration in the targeting process.

The concept underlying the combined model is to capture the process components' ability to identify the force configurations for targeting process speed of execution. By varying realistic alternatives of classifying target folder attributes, among the several varying organizations that exist to perform specific portions of the process, meaningful insights can be made about personnel skill mixes and assignments, training levels of the different skill sets, and organizing structures that determine how and when to vary the process.

3.2 Initial MCM2 Application

Initial uses of MCM2 indicated that various configurations of tasking relationships could be mapped to the C2 Maturity Model to reveal changes in the three major axes defining agility. MITRE and IDA demonstrated the use of the DoD Targeting model aligned with IDA's paradigm of C2 agility to capture the factors central to depicting performance attributes of specific, measurable process workflows and illustrate agility in the overall process.

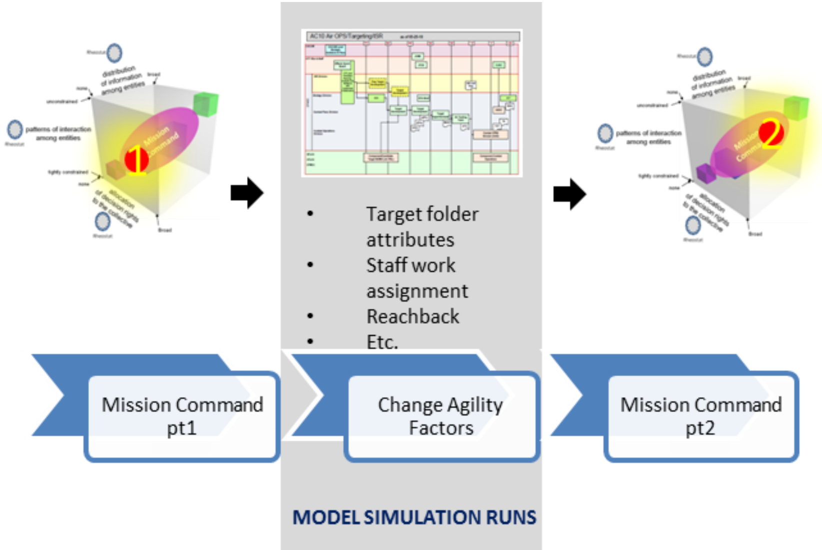

Figure 3-1: MITRE Processes Used to Measure Change within IDA C2 Maturity Model

3.3 Targeting Simulation

The timeliness data in the simulation initially developed for the USEUCOM targeting division was populated based on inputs from USEUCOM targeting chief. MITRE derived staffing levels from discussions with members of the various groups and determined the impacts of specific changes to targeting using Subject Matter Experts (SME) inputs on certain data elements within the process. These inputs were not validated or refined for accuracy. However, the simulation produced realistic behaviors (as confirmed by USEUCOM targeting chief) and expected impacts based on the directed changes to activities aligned to the C2 agility-axis as defined in the concept model by IDA.

MITRE modified the DOD Targeting model to align it to the agility factors described in the IDA model. The proof-of-principle demonstration focused on timeliness in developing target folders for the Joint Target List (JTL) – the bulk of the target development process – and staff resource utilization. The target development process includes vetting and validating targets, and then sending them to the Joint Targeting Control Board (JTCB) for approval. The measure of timeliness for targets to be placed on the JTL is one factor in targeting operational performance. In the example described in Section 3.4 we only measure agility changes in terms of timeliness and resource utilization. As the initial purpose of this simulation was to demonstrate the effect of adjusting personnel support across several collocated units of targeteers, these measures were the only ones that MITRE and IDA could address in the short turnaround timeline.

The simulation abstracted targets into categories to reflect a realistic and diverse spectrum of complexity in working the real range of targets. The three target categories were simple, medium, and hard. This characterization made it possible to assign different processing times to each target category throughout the simulation. Additionally, MITRE defined the pools of targeting staff resources by their geographic location, as identified by the existing organizations that provide targeting support. These organizations are the JTF Headquarter (HQ) targeting cell, the assigned AOC personnel dedicated to support the JFACC, Coalition targeting personnel, AFTC, and several locations of Reserve elements composing the JRISE, which are located in several different geographical, CONUS locations.

3.4 Target Development Process Simulation Results

MITRE made adjustments to the targeting process simulation to address the agility factors by parameterizing the model. During the study, process attributes were identified that could be modified to reflect changes in terms of the IDA's agility cube.

3.4.1 Adjustment for Patterns of Interaction

Currently in operations the Target Development data flow is federated across the globe through e-mails for staff assignments, which does not provide insight into development progress or workload to staff members. To adjust the *Patterns of Interaction* and *Information Sharing* rheostat MITRE varied the target development data flow in the simulation, allowing staff elements to be assigned either via push or pull. The push method reflects the current operations, the staff is assigned targets to develop through an email. This email method doesn't allow staff elements or leadership insight into the target development progress, because targets are not all equivalent in time and effort it is difficult to accurately estimate the proper distribution among the distributed staff elements. The alternative to the current approach is enabling a pull method which would store targets that need to be developed in a shared location allowing for targeteers in different locations to select a target when they are available.

Figure 3-2 identifies the notional position of the current targeting process within the cube, labeled as "S." The position labeled "2" denotes how the targeting process shifts within the cube based on the configuration change (push to pull method). Along with the shift within the cube the MCM2 provides measurements associated with the shift. For the targeting development process the timeframe for getting a target through development to approval (placed on the JTL) indicates mission readiness. The figure depicts the targeting development timeline changes at points "S" and "2."

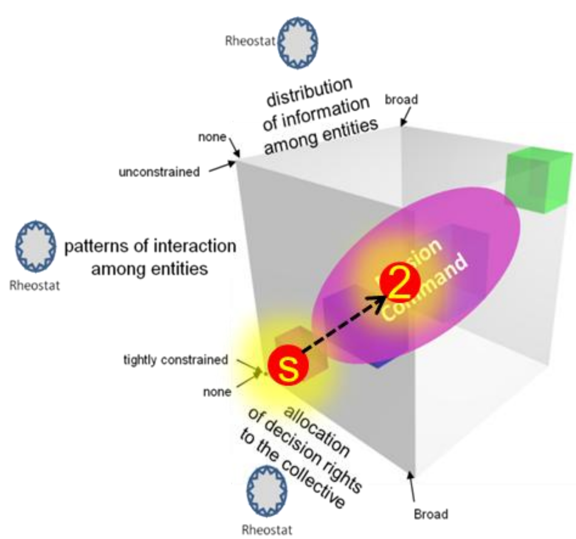

Figure 3-2: Patterns of Interaction and Information Sharing Rheostat Adjustments

As shown in Figure 3-3, the pull configuration reduces the target development timeline for all categories of targets. This equates to more targets being approved and ready sooner that can be acted upon in times of conflict.

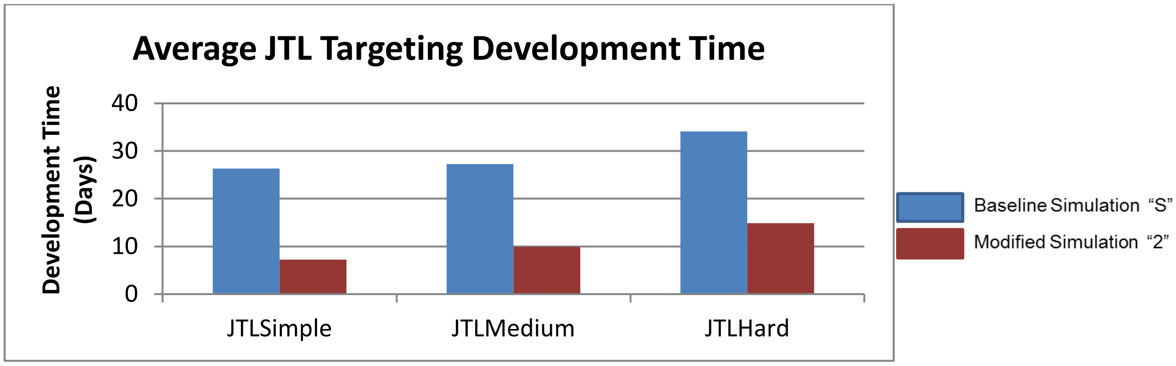

Figure 3-3: Average Target Development Timeline in Days

In addition to reducing the target development timeline the change in configuration allows more effective utilization of targeteer staff resources. Figure 3-4 shows that preventing the staff elements from self-tasking (position “S”) means that some groups of personnel are significantly under-utilized while others are over-utilized. However, when given visibility into the remaining target development workload (position “2”), the targeteers can more appropriately allocate tasks among the different staff elements during the development cycle. This results in a more evenly utilized workforce.

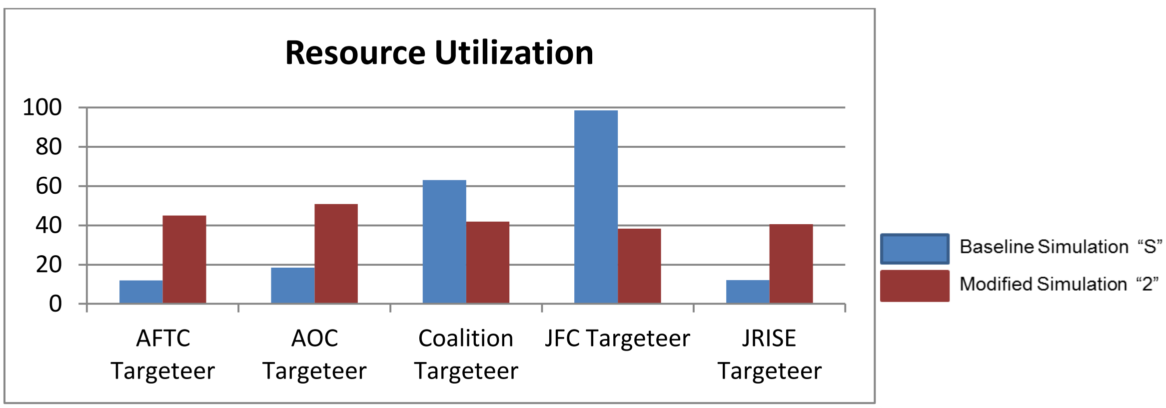

Figure 3-4: Targeteer Staff Percent Utilization

3.4.2 Adjustment for Delegation of Decision Rights

To address *Delegation of Decision Rights*, MITRE altered the Electronic Target Folders (ETF) vetting and validation processes. Currently, every target is subjected to Vetting and Validation Boards that traditionally occur every 12-24 hours. We modified the simulation to allow priority target folders to be vetted and validated upon completion versus still subjected to board schedules. This allows priority targets to be submitted to board members for approval prior to the next official board meeting.

Figure 3-5 identifies the notional position of the current vetting process within the cube, labeled “S.” The position labeled “1” denotes the shift within the cube based on changing the configuration to priority target vetting.

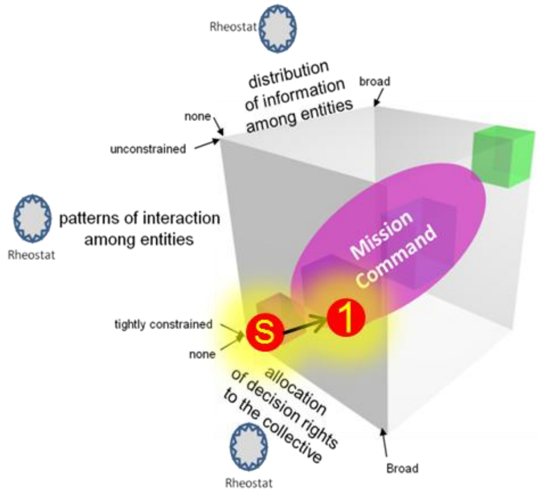

Figure 3-5: Delegation of Decision Rights Rheostat Adjustment

As shown in Figure 3-6, basing vetting on priority reduces the development timeline for high-priority targets. This equates to more priority targets being approved and ready sooner that can be acted upon in times of conflict. This movement along the *Delegation of Decision Rights* axis does not affect the targeteer staff resource utilization, as shown in Figure 3-7; targeteers at each location must develop the same number of targets even with priority targets moving to the front of their queue.

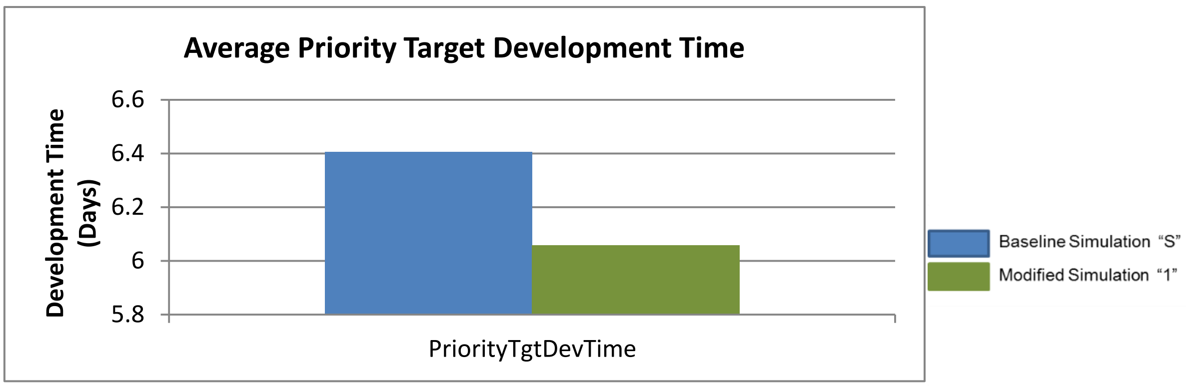

Figure 3-6: Priority Target Development Timeline in Days

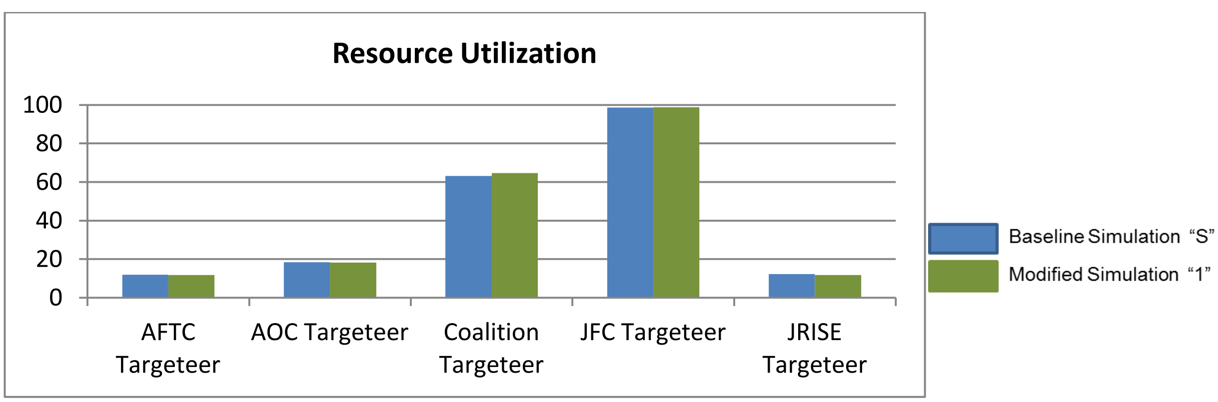

Figure 3-7: Targeteer Staff Percent Utilization

3.4.3 Adjustment of Multiple Parameters

Parameterizing the simulation permits design of experiments that use various combinations along the different agility axes. The ability to adjust the factors independently enables analysts to determine the effects of changes on the performance of the process for achieving various effects. The "N" position in Figure 3-8 depicts the new location of the targeting process within the cube after these modifications.

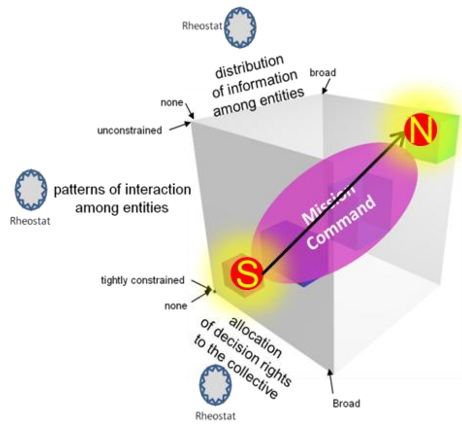

Figure 3-8: Targeting Process Locations for All Rheostat Adjustments

Modifying the targeting process to allow for self-tasking of targeteers (pull v. push) and enabling priority targets to move through vetting without being subjected to the normal timeline creates noticeable synergy. Figure 3-9 shows the reduction of the targeting development timelines between position "S" and "N".

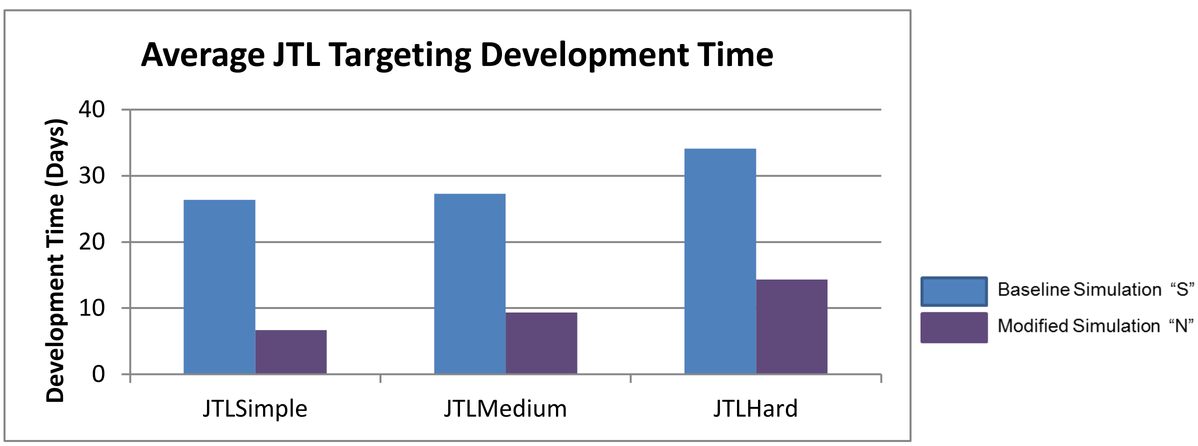

Figure 3-9: Average Target Development Timeline in Days

Making these modifications to the process in unison results not only in more effective use of targeteer staff resources but also a shorter timeline for developing priority targets, as seen in Figures 3-10 and 3-11.

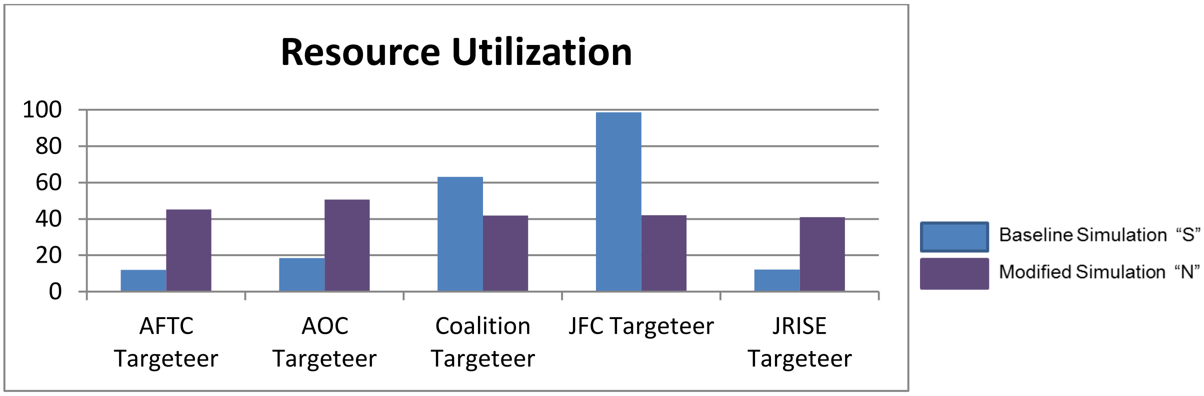

Figure 3-10: Targeteer Staff Percent Utilization

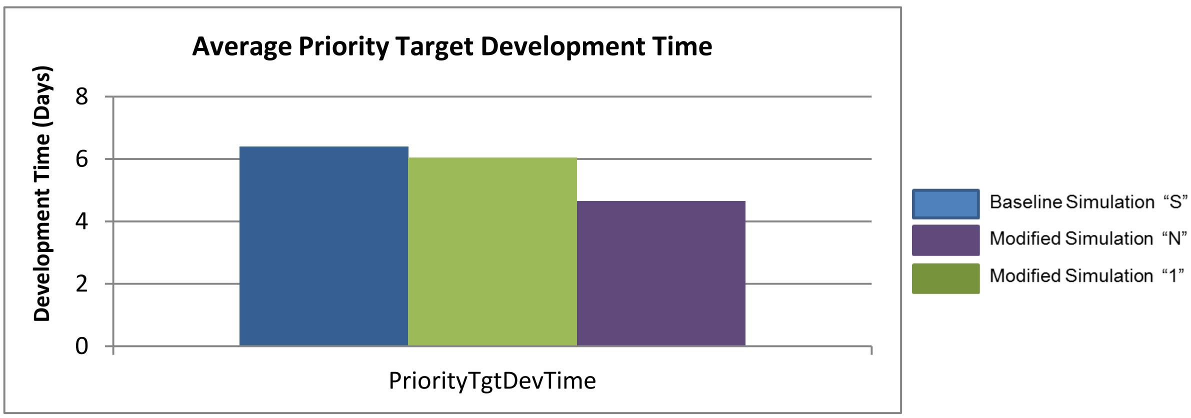

Figure 3-11: Average Priority Target Development Timeline in Days

These basic measures indicate how the DoD can use the model to simulate C2 agility factors. Further analysis of other types of factors would enable MITRE and IDA to redesign the model to accommodate new considerations. Ultimately, this would call for a thorough investigation of the factors that specifically comprise C2 agility. MITRE and IDA will present the results of their work to the Director for Command and Control within the Office of the Assistant Secretary of Defense for consideration in further research and analyses.

4 Future Directions

In the research described above, we examined independent configurations and their associated cube-vectors to explore the relationship among configurations, cube-vectors, and execution performance. The work shows promise to understand the impact of different types of force configurations. For future work, certainly applying MCM2 and the C2 Maturity Model to additional TTPs, such as Counterinsurgency (COIN) and Anti-Access/Area Denial (A2/AD) should be pursued, and will deepen our understanding. In addition, MITRE recommends the following significant future directions for this work:

1. Measure adaptability related to changing force configurations, including IT - the results above can inform decisions about desirable configurations from an execution performance perspective, but do not indicate the cost in time and resources to actually change from one configuration to another, which may be significant. The rate of change

from one configuration to another is a measure of adaptability, an important factor when the force must adjust its TTPs to counter a change in environment, adversary tactics, etc.

   a. A corollary research area is investigation of the relationship between adaptability of the force and adaptability of the associated IT capabilities. Initial discussions between MITRE and IDA indicate that relationships exist among IT capabilities developed in accordance with Multi-Party Engineering systems engineering methods,[5] and that mappings of IT configurations to the cube are analogous to the mappings of force configurations.

2. Relate execution performance of a TTP to overall mission effectiveness – the results above inform us as to which force configurations have better execution performance. There is a mapping to the C2 Maturity Model to begin investigating how the force configuration is considered with the Mission Command construct. However future work is required in order to gain a deeper understanding of how execution performance and rate of changing force configurations contribute to overall mission effectiveness. Refinement of the C2 Maturity Model and the addition of simulating the dynamics of the personnel and capabilities to adapt to the changes also need to be taken into account for a true mission effectiveness measure.
3. Explore the bounds of force distribution – expansion of this initial study should include more complex distribution of forces, including orchestration of relationships, and predetermined support relationships. For example, military Services are developing their own reachback capability, based on their unique capabilities. We need to understand these organizational designs so that the Services could better synchronize available resources in planning and conducting exercises, and operations.
4. Inform JIE and FMN efforts - The MCM2 effort described in this paper, in conjunction with the NATO NEC C2 Maturity Model, can inform Joint Information Environment (JIE) and Future Mission Network (FMN) instantiations over time. Although FMN initially focuses on the six critical human-human collaboration capabilities (e.g., email, chat, etc.), subsequent development of FMN guidelines will include authoritative data and services, processes, and force structures and configurations, such as described in the FMN Use Cases (e.g., Haiti Humanitarian Relief).
5. Integrate emerging cyber TTPs into force configurations and models - as U.S. forces must counter more technologically sophisticated threats and adversaries adopt more diffuse tactics to avoid direct military confrontation, understanding these factors becomes increasingly important. Introducing the effects of cyber and other nonlethal intelligence operations is key to the continued development of enhanced TTPs, and their corresponding models.
   a. A corollary research area is the incorporation of disruptive technologies such as cloud and mobile technologies. This begs the creation of new TTPs and models, but those models must also be grounded in current integrated operational processes that drive more effective, efficient, and affordable technology insertions and process improvements focused on understanding desired operational effects.

[5] ICCRTS 2012 paper "Supporting Agile C2 with an Agile and Adaptive IT Ecosystem", Reed, Benito, Collens, Stein: http://dodccrp.org/events/17th_iccrts_2012/post_conference/papers/044.pdf

5 Summary

Using MCM2 on the DoD Targeting Model proved the value of studying various options for applying distributed forces and the effect of each option on mission performance. The collaborative study described in this paper is the first step in using executable modeling of mission threads to enable U.S. forces to understand how innovations in their structures, IT, and process configurations affect their missions.