Cellular approach to Multi-Domain Battle-space management

The role of cognitive models in joint and coalition forces' success

Eldad M. Shamash, PhD[1]

As the battlespace becomes more complex, the adversary is less visible, less organized and acts in several domains, The current methods of battlespace management - division to Areas of Responsibility (AOR) and management of each function in a different layer - are no longer appropriate. especially when the operation takes place in multiple domains, and the optimal solution is to be given from a variety of functions and from units from various origins and organizations. Add to this the adversaries strive to deny our superiorities, and we get a call to develop a new, integrated practices to maintaining our effectivity above the hybrid threats we face. This conceptual article will propose a new approach to manage battlespace and the mutual cognition of the units in the battle group. Based on theories from teams' effectiveness, especially the Task-oriented Shared Mental Model (TMS - Transactive Memory System); the mission-oriented Command and Control approach, together with an independent proposition of battlespace division, this article will argue that originally dividing the theater into cells, will improve common language between all of the participants in the operation, from all echelons, focus on specified tactical goals, based on shared understanding of the operational end state, integration of capabilities and independent coordination between battlegroup members. This is a modification and elaboration of the 'Convergence' approach (TRADOC, 2017) to cope with the challenges of battlegroups and coalitions fighting the Multi-Domain Operations.

The Challenge

Changes in the battle spaces and the adversary's deployment and methods of action, especially its irregular organization and preference for closed terrains, might lead us to conclude that the next conflicts will probably occur in several locations simultaneously, each location with a unique characteristic, and any battle decision will need to be gained in a very short time (many clashes and skirmishes, less organized whole unit battle). This scenario requires an adaptation of direct forces and their headquarters force generation and fighting methods. It seems likely that the most important change is the shift from formations to a flock of many small multipotent units, to remain agile against a constantly changing and unpredictable adversary. The adversary uses several technologies and actions to deny our technological and doctrinal superiority that was once our main advantage over potential adversaries.

TRADOC (2017) defines Multi-Domain Battle as taking place on and in the land, air, sea, space, and cyberspace, simultaneously. Recently, the term changed to Multi-Domain Operations, to enhance that "It is more inclusive of the type of competition that is now underway … Winning battle sounds more tactical. It is not necessarily winning the strateqgic competition" (Townsend, 2018). These types of multiple attributes of the problem resemble a number of

[1] Defence analyst & C2 expert. Corresponding author. Reply to eldadsh.academy@gmail.com

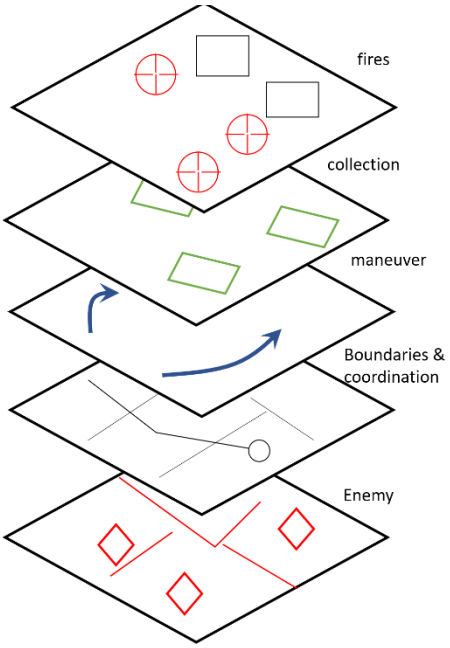
definitions of "Task complexity". Wood (1986) suggest three dimensions of task complexity: component complexity, which describes the amount of information to process needed to complete the task; coordinative complexity, that consist of the number of coordination actions needed between the participants and the need for continuity; and dynamic complexity, that emphasize the ratio of environment's transition and amplitude of changes. Campbell (1988) adds the amount of information available, the requirement to choose from several courses of actions, or otherwise to develop one; the assumption that there might be no agreement on the outcome, and the possibilities of contradicting requirements between actors. Haerem, Pentland & Miller (2015) leverage Campbell's definition. They argue that when a task is performed by a network of actors, former practices might not be adequate, and there for the need to adapt practices prior to mutual action is essential. In the early years of the 21st century, several armies dealt with this problem, trying to define the complexity and how to simplify it, e.g. 5C's suggested by the UK (Contested, Congested, Cluttered, Connected, Constrained. DCDC 2010), or VUCA environment (Volatile, Uncertain, Complex, Ambiguous. Kail, 2010) both call the commander or the manager "to make a clear choice in messy situations"

Current methods – the problem

The common method of preparing the battlefield is basically a division of each Area of Responsibility (AOR) into smaller portions for the sub-units. This division is usually made by straight lines, driven by the mission or the desired end-state, sometimes follows terrain outlines. Then, coordination lines and phase lines, again usually straight ones, drawn across the AOR to provide some coordination between headquarters and the executing forces.

According to this method, the superiority of own forces over the estimated enemy or adversary unit, varies between one phase to the other. The terrain and enemy deployment layers are followed by layers for each of the supporting functions: collection and reconnaissance, fires, sustainment etc. Fighting this battle, face own troops with different types of adversaries at one terrain portion, requires them switching from one type of battle form to another rapidly. When units from different origins fight in a battle group, differences in Tactics, Techniques, and Procedures (TTPs) and Rules of Engagement (ROEs) and different attitude to each domain and layer, might cause conflicts, and so hinders the battle group from accomplish its tasks and missions properly and by the time constraints, without external

Drawing 1 – Multilayer management



intervention for coordination and prioritization. The responsibility for coordination and prioritization between all of these functions and layers lies on the Chief-of-staff. Running estimates are required to gain Common Operational Picture continuously (COP), make sense of the situation and achieve shared Situation Awareness (SA), to make decisions and give orders. The environment changes rapidly, and so coordination measures are set and re-set to settle conflicts between requirements and tasks of different warfighting functions, usually by dividing the AOR again or by setting more coordination lines. Commonly seen, with all these coordination lines, the COP resembles a spaghetti bowl. This problem requires a new approach to simplify the picture, and by so shared Situation Awareness and independent coordination.

Striving for a new solution

lynch & Fish (2018) focus on size. They suggest transforming to small units swarming the battlefield, to cope with the challenges. "swarming is about changing military behavior, not technology. It is easier, cheaper, and faster to adapt small-unit tactics, or swarming rules, than it is to adapt technology" They also claim that swarming leverages professionalism. Goldfein (2017) suggests technology. He calls to re-utilize current technology and to develop new, to rethink training and capabilities, all to integrate and evaluate information from a variety of sources, to apply better SA and rapid Decision Making (DM). We argue that the solution shouldn't be technological or organizational. It should better be a socio-technical method. TRADOC (2017) suggest a convergence of capabilities across domains, functions and environments, in time and space to create physical, virtual and cognitive windows of advantages, as the solution to the complexity of the problem and for enabling maneuver. We will take this call one step further by proposing a method to prepare the units and a method to rearrange the Multi-Domain battle space and direct the units. This will allow better coordination when facing a constantly changing problem.

Shared mental models

Mental Models are the mechanisms whereby humans generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions of future system states (Rouse & Morris, 1986). When the mission described similarly, and the methods of actions are agreed between actors, we say that the model is "Shared". Going up to the team level, we see the team as an entity. It has "mind" and metal models of its own, that represent the way team members perceive the team’s mission and process and describe reciprocity in the team (Klimoski & Mohammed, 1994). This team construct emerges through shared work, develops through the endurance of the shared work, and the gain of shared experiences together. It might also predict the quality of outcome (Mohammed et al., 2010). It might look very beneficial to have team mental models, but when

time-to-act is short and the familiarity among team members is low, something else is needed. Task-related mental models are more focused on the actions team members do to accomplish their mission. One of these models is Transactive Memory System (Wegner, 1991; Lewis, 2003; Lewis & Herndon, 2011; Marques et al., 2013). This expertise-based task-related mental model, discerned from the differentiated structure of members' knowledge between domains (specialization), members' beliefs about the reliability of other members' knowledge (information credibility), and effective, orchestrated knowledge processing (coordination). When well performed, all team members know where all the knowledge is held and how to retrieve it for their needs ("Decentralized model". Van Knippenberg & Ginkel, 2014), and new knowledge created throughout the interaction between members ("Integrated model". Lewis, 2005; Gupta & Hollingshead, 2010). TMS is well fitted for teams whose members never worked together before. Vashdi, Bamberger & Erez (2013) suggest that TMS works well for operation-room teams when the personalization is fluid, but the requirement for coordination is high, using verbal and non-verbal gestures. Shamash (2017) found that TMS benefit municipalities' crisis management teams in the first hours of event management. Both researches emphasize the importance of role performance over the role holder. This might support the requirements of battle groups that change structure and allocation during battle management, especially when facing quick changing challenges, such as the challenges that arise in the multi-domain operations. Shared cognitive mode between battle group members will ensure unity of purpose and will allow the better coordination between members based on the mutual knowledge of the different specialties.

The headquarters as an additional unit in the battle group

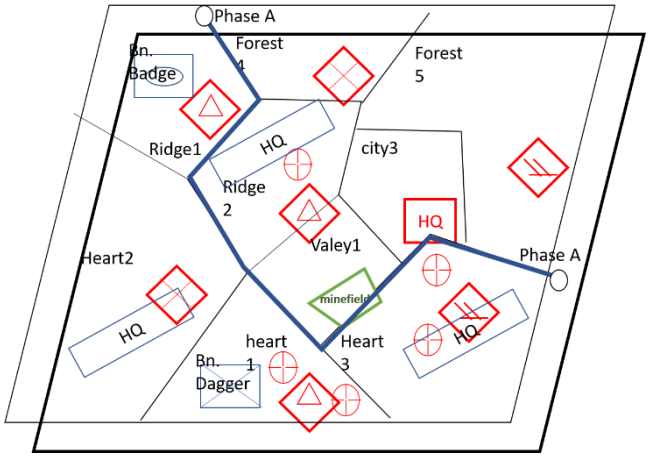
Headquarters and the staff, more than its essential role of planning and managing the battle, has some capabilities that enable it to act in the battle group. Staff members might compose an action team, designated to cope with a specific problem. Allocation of resources to such team might benefit the sub-units by collection and analysis, by fires, allocating protection and by directing sustainment efforts and harnessing information and capabilities from higher echelons and sibling units. These action teams will usually act ahead of lines of the sub-units, to ease the stress on the close battle, and to prepare the deep area to become the next close battle area.

Cellular approach to Multi-domain Battle space management – Tying all together (the concept proposition)

The need to reveal the enemy, to cope with several types of adversaries, transit rapidly from one method to another, and concentrate and coordinate multiple functions to overcome the enemy, requires a new approach. To harmonize the benefits of small units, the headquarters' advantages, and the shared mental models, to gain Shared SA and overcome any enemy, over

and above the idea of convergence, our proposition is to begin by re-arranging the battlespace to allow better coordination. We proprosit transiting to a "Cellular Approach" of battle management, i.e. to divide the theater to small portions – "Cells", or something like "Beehive" – to allow tactical focus under strategic guidance, driven by adversaries' types and deployment. This will allow facing one adversary type and unit at a time, with a concentration of all efforts on the relevant and dominant fighting function in this domain – kinetic, non-kinetic or cyber. i.e. to provide an integrated response to the hybrid multi-facial threat.

Drawing 2 – Cellular approach to battlespace Mamagement



Dividing the theater beforehand to many "Cells", each with a unique identification name, will contribute to efficiency by allocation of the correct resources needed for the dominant fighting function to cope with the enemy or type of dominant operation in the cell; will contribute to effectiveness by defining the tactical mission under operational and strategic end state, and support its understanding to all of the actors in theater; will support emergence of TMS between all of allies in the same cell, due to shared SA in cell and so - understanding of the mission in a specific cell or over a specific enemy type and size; this will result in a better harmonization and self-coordinated action of all of the functions acting in one cell. Mutually knowing What has to be done? What is the cooperative method of execution? As our Task forces and coalitions are built from a variety of capabilities, there sure is a high level of specialization. TMS will allow both decentralized ("everybody knows who knows what and how to get it") and integrated ("new knowledge emerges from the interaction") benefits based on information credibility and independent coordination.

Using the cell's boundaries as an infrastructure to allocate space and domains to units and to define coordination lines, will result in less congested and clearer OP, not crossing sub-units AORs; will allow the headquarters to act with fires for the sub-units, between their cells without fear of fratricide. Each cell might also function as a decision-junction. Advancement from one cell to another, will not necessarily be in straight lines, as planned, but rather by the continuity

of success to the adjacent cell and maintaining a high tempo of operations, adaptability of DM and agility of forces facing an unpredictable adversary.

This proposition also answers the call for "Edge C2" (NATO 2014), as it provides all the battle group members, according to the main mission in the cell and based on a shared plan, free and shared access to all of the available information, unconstrained collaboration, and distribution of decision rights. More than that, this method will support mutual learning and real-time during-battle improvement of actions and collaboration, between different domains, units and even autonomous systems. The Battlegroup will mature from one battle to another as the collaboration develops, despite the need to transit to another dominant domain or fighting function in the next cell's mission. It will also enhance reliance on performance (the outcome from each battlegroup member) over the performer (the unit, as the battle group composition might change)

Our method propose an overarching method and process, over organization and technology, and as such is better adequate for the complexity of the multi-domain battlefield, and the ever-changing composition and organization of the battle groups.

References

Campbel D. J. (1988) Task Complexity: A Review and Analysis. *The Academy of Management Review, 13*(1), 40-52.

DCDC (2010) Future Character of Conflict. *Ministry of Defence, UK*

Goldfein, D. (2017) Enhancing Multi-Domain Command and Control… Tying it all together, *CSAF focus area No. 3*

Gupta, N., & Hollingshead, A. B. (2010). Differentiated versus integrated transactive memory effectiveness: It depends on the task. *Group Dynamics-Theory Research and Practice, 14*(4), 384-398.

Haerem T., Pentland, B. D. & Miller, K. D. (2015) Task Complexity: extending a core concept. *Academy of management review*, 40(3), 446-460

Kail, E.G. (2010) Leading in a VUCA environment, HBR (http://blogs.hbr.org/2010/11/leading-in-a-vuca-environment.html retrieved January 3, 2011)

Klimoski, R. & Mohammed S. (1994). Team mental model: Construct or metaphor? *Journal of Management, 20*(2), 403.

Lewis, K. (2003). Measuring transactive memory systems in the field: Scale development and validation. *Journal of Applied Psychology, 88*(4), 587.

Lewis K., Herndon B., (2011) Transactive Memory Systems: Current Issues and Future Research Directions. *organization Science* 22(5):1254-1265

Lynch, J & Fish, L (2018) Soldier Swarm: New Ground combat tactics for the era of Multi-Domain Battlefield. *Modern warfare institute. April 5th, 2018.* https://mwi.usma.edu/soldier-swarm-new-ground-combat-tactics-era-multi-domain-battle/?utm_source=RC+Defense+Morning+Recon&utm_campaign=e20aee7d8a-EMAIL_CAMPAIGN_2018_04_05&utm_medium=email&utm_term=0_694f73a8dc-e20aee7d8a-85535181. Retrieved: May 1st, 2018:

Marques-Quinteiro, P., Curral, L., Passos, A. M., & Lewis, K. (2013) And now what do we do? The role of transactive memory systems and task coordination in action teams. *Group Dynamics: Theory, Research, and Practice*, *17*(3), 194.

Mohammed, S., Ferzandi, L., & Hamilton, K. (2010) Metaphor no more: A 15-year review of the team mental model construct. *Journal of Management, 36*(4), 876-910.

NATO (2014) Command and Control (C2) Agility. STO technical report TR-SAS-085

Rouse W. B. & Morris N. M. (1986) On Looking Into the Black Box: Prospects and Limits in the Search for Mental Models, *Psychological Bulletin*, 100(3) 349 - 363.

Shamash, E. M. (2017) The Effect of Physical Dispersion on the Quality of the Operational Picture in Crisis Management Teams: The Role of Shared Mental Models in Municipalities' Crisis Management teams. (in Hebrew). *Doctoral Thesis submitted for Haifa University*

TRADOC (2017) Multi-Domain Battle: Evolution of combined arms for the 21st century 2025-2040. Ver.1 December 2017

Townsend, S. J. (2018) Multi-domain battle gets new operational name. AUSA, May 22nd, 2018. https://www.ausa.org/news/multi-domain-battle-gets-new-operational-name. retrieved June 1st, 2018

van Knippenberg, D., De Dreu, C. K. W., & Homan, A. C. (2004). Workgroup diversity and group performance: An integrative model and research agenda. *Journal of Applied Psychology, 89*(6), 1008-1022

Vashdi, D. R., Bamberger, P. A., & Erez, M. (2013). Can surgical teams ever learn? the role of coordination, complexity, and transitivity in action team learning. *Academy of Management Journal*, 56(4), 945-971.

Wegner, D. M., Erber, R., & Raymond, P. (1991). Transactive memory in close relationships. *Journal of Personality and Social Psychology, 61*(6), 923

Wood, R. E. (1986) Task Complexity: Definition and Construct. *Organizational Behavior and Human Decision Process* 37, 60-82