

Viewing the Center of Gravity through the Prism of Effects-Based Operations

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Editor's Note: This article was written in June 2005 and came to Military Review in the fall of the same year. In February of 2006, U.S. Joint Forces Command published the Commander's Handbook for an Effects-Based Approach to Joint Operations. Readers may notice some similarity between the figures in this article and some of the figures in the Commander's Handbook. The similarity is coincidental.

IN THE MAY-JUNE 2002 issue of *Foreign Affairs*, Defense Secretary Donald Rumsfeld described his strategy for transforming the U.S. military. Part of that strategy is to “change not only the capabilities at our disposal, but also how we think about war.”¹ Fundamentally, joint doctrine describes how the armed forces think about war, and under the Secretary's vision that thinking process is changing to meet the challenges posed by global terrorist organizations and potential nation-state adversaries. As part of this transformation, the old battle-proven objectives-based methods used to plan, execute, and assess operations are evolving into methods based on effects. But how radical should this evolution be? How will the traditional hierarchical focus on a center of gravity evolve into a focus on the connections among actions, effects, and objectives in pursuit of a desired end-state?

In recent years, effects-based planning and assessment has moved from doctrinal debate into operational implementation by the U.S. military. Although strategies to implement Effects-Based Operations (EBO) vary among the combatant commands and services, each faces the difficult task of planning and assessing operations. The Joint Warfighting Center, Joint Doctrine Series: *Pamphlet 7, Operational Implications of Effects-Based Operations*, provides valuable insight for implementing EBO.² The pamphlet defines the concept; discusses in detail an effects-based approach to planning, execution, and assessment; and reviews operational implications for doctrine, leadership, education, and training. What's missing, though, is any frame of reference showing how the objectives-based (in effect, center-of-gravity-based) planning concepts are folded into the EBO methodology.³ This essay therefore offers current planners a means for viewing centers of gravity through the prism of EBO.

Defining EBO

The definition of EBO has changed as the concept has developed, and for many, defining EBO has been like trying to hit a moving target. For the purposes of this paper, the definition in *Pamphlet 7* suffices: “Operations that are planned,

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executed, assessed, and adapted based on a holistic understanding of the operational environment in order to influence or change system behavior or capabilities using the integrated application of selected instruments of power to achieve directed policy aims.⁷⁴

EBO Today

With the publication of *Pamphlet 7* in 2004, the effects-based methodology has fully evolved from a linear strategy-to-task approach into a system-of-systems baseline to develop relationships (or linkages) between effects, nodes, and actions. The three key EBO components (planning, execution, and assessment) are enabled by a collaborative information environment and operational net assessment, the latter intended to provide a holistic understanding of the environment through a system-of-systems analysis (figure 1). Within each of the interrelated Political, Military, Economic, Social, Infrastructure, and Information (PMESII) systems, “nodes” represent a functional component of the system (person, place, or thing) while “links” represent the relationships (behavioral, physical, or functional) between the nodes.⁵

In the effects-based planning method described in *Pamphlet 7*, an adversary system-of-systems analysis output determines the direct and indirect relationships between nodes across the PMESII that can be exploited by friendly actions. System-of-systems analysis results become the input for the development of a linkage between enemy nodes and friendly Effects, Nodes, Actions, and Resources (ENAR). Understanding these relationships allows commanders to choose from a set of ENAR options when developing and selecting courses of action. In figure 1, direct relationships exist between adjacent nodes A and B as well as between nodes B and C. Indirect relationships exist between nodes related via another node, in this case between nodes A and C. The ENAR construct also represents desired as well as undesired effects. In *Pamphlet 7*, desired

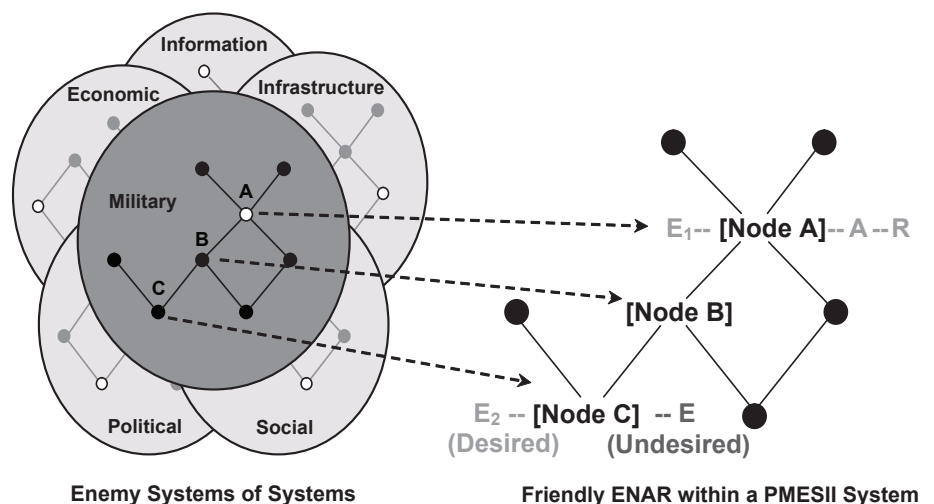
effects are those that support strategic objectives while undesired effects are those that can adversely affect strategic objectives. At node C we can see an undesired effect caused by an action at node A.

The intent of system-of-systems analysis is to treat each PMESII element as a system and the entire PMESII structure as a system of systems. The product sought is a nodal analysis that forms the basis for coupling nodes to effects, actions, and resources. Notably, as described in the pamphlet, this approach does not employ the traditional center-of-gravity analysis outlined in joint doctrine.

Does changing the way the Department of Defense (DOD) thinks about war mean that the seemingly timeless concept of center of gravity has run its course? Or does such a change merely require us to adapt the concept to handle the complexities of warfare today?

Centers of Gravity through an EBO Prism

The authors of *Pamphlet 7* identify the need to redefine center of gravity in broader terms if EBO is officially adopted. One approach to a broader definition is provided by Joseph L. Strange and Richard Iron, who see centers of gravity as “dynamic and powerful physical and moral agents of action or influence with certain qualities and capabilities.”⁷⁶ In the system-of-systems methodology, Strange and Iron’s definition can be applied to nodes with



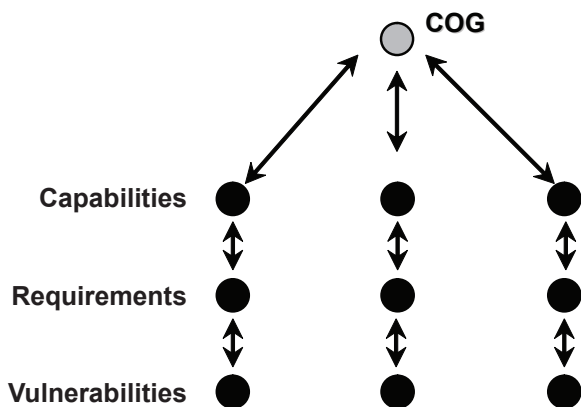
Legend: ENAR, Effects, Nodes, Actions, and Resources; PMESII, Political, Military, Economic, Social, Infrastructure, and Information; JWC, Joint Warfighting Center.

Figure 1. Systems-of-systems model (2004 JWC Pam 7).

influence over other nodes in the system. The level of influence of a node would be driven by the “qualities and capabilities” of that node. Further, Antulio J. Echevarria II argues that center of gravity could be redefined to mean “focal point.”⁷ This definition also lends itself to the idea of a systems approach.

Strictly speaking, the system-of-systems approach in *Pamphlet 7* does not need the idea of center of gravity to be effective. Therefore, another option is to adopt the network-based method and eliminate center of gravity altogether from joint doctrine. However, as a practical matter it is unlikely that planning staffs around the world would embrace a new methodology that does not address center of gravity, at least not in the short term. The issue then becomes, “What additional advantages does a systems approach offer, and what is the best way to view the concept of center of gravity in this new network construct?”

Based on Strange’s 1996 definition of center of gravity, the current center-of-gravity methodology is hierarchically structured.⁸ Capabilities, requirements, and vulnerabilities are arranged in a tree structure with nodes branching out from a center of gravity (figure 2). This approach is very effective at capturing the direct relationships between vulnerabilities and a center of gravity. It is not effective, however, at capturing the indirect relationships between two or more requirements of a given center of gravity or between multiple centers. The tree structure cannot account for the complexity added by indirect relationships. A network approach (figure 3), however, is flexible enough to “map causal



Legend: COG, center of gravity.

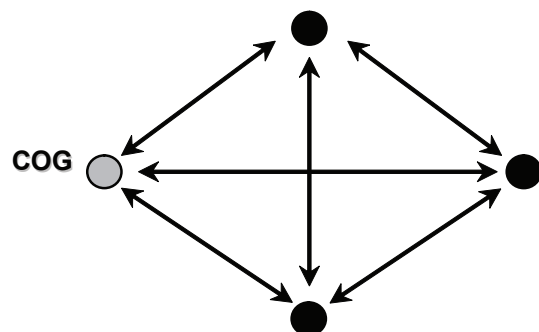
Figure 2. COG structure.

relationships between components of the system,” as Darrall Henderson demonstrates.⁹ In a network structure, capabilities, requirements, and other qualities contribute to the influence of each node, and the node with the greatest influence becomes the center of gravity. Visualizing the relationships between components of an adversary network is one significant advantage of a system-of-systems approach.

Fortunately, envisioning an adversary as networked rather than hierarchical does not mean we lose the fidelity available in the current center-of-gravity methodology. Referring again to figures 2 and 3, the hierarchical linkages in the current center-of-gravity model can be retained in the system-of-systems model while the indirect relationships can now be represented. In addition to retaining the information available through current center-of-gravity analysis, a system-of-systems approach can produce a descriptive model of the relationships between the components of the six PMESII systems—relationships not captured by current center-of-gravity modeling methods. Changing the way DOD thinks about war will not necessarily require us to conclude that Carl von Clausewitz was wrong. However, adapting the center-of-gravity concept to account for the complexities of warfare today is necessary, and a system-of-systems approach allows for this.

Adapting to the Complexity

To further adapt the center of gravity to the system-of-systems network approach presented in



Capabilities, requirements, and other qualities define the influence of each node. The node with the greatest influence is the COG. Each node and link is potentially vulnerable.

Figure 3. Network structure applied to a COG.

Pamphlet 7, we suggest adding the idea of “maximum influence node” within a network. A maximum influence node is consistent with Strange and Iron’s broader definition of a center of gravity.¹⁰ In effect, this addition extends *Pamphlet 7*’s definition of a node as “a person, place, or thing” to include an “event.” For example, in Iran, Hashemi Rafsanjani, Doshan Tapeh Air Base, nuclear weapons, and Ramadan—an event—are all potential nodes.

Robert S. Renfro and Richard F. Deckro suggest that a maximum influence node has two key characteristics: first, the node with the maximum influence is a pressure point; and second, the best way to influence (or act on) this pressure point may not be through a direct attack, but rather through other nodes within the system.¹¹ Since influence and power are synonymous, the node with maximum influence within a given system is the most powerful node. This idea is also consistent with Echevarria’s “focal point” definition.¹² Identified through systems analysis, the node with the maximum influence is also the center of gravity of a PMESII element.

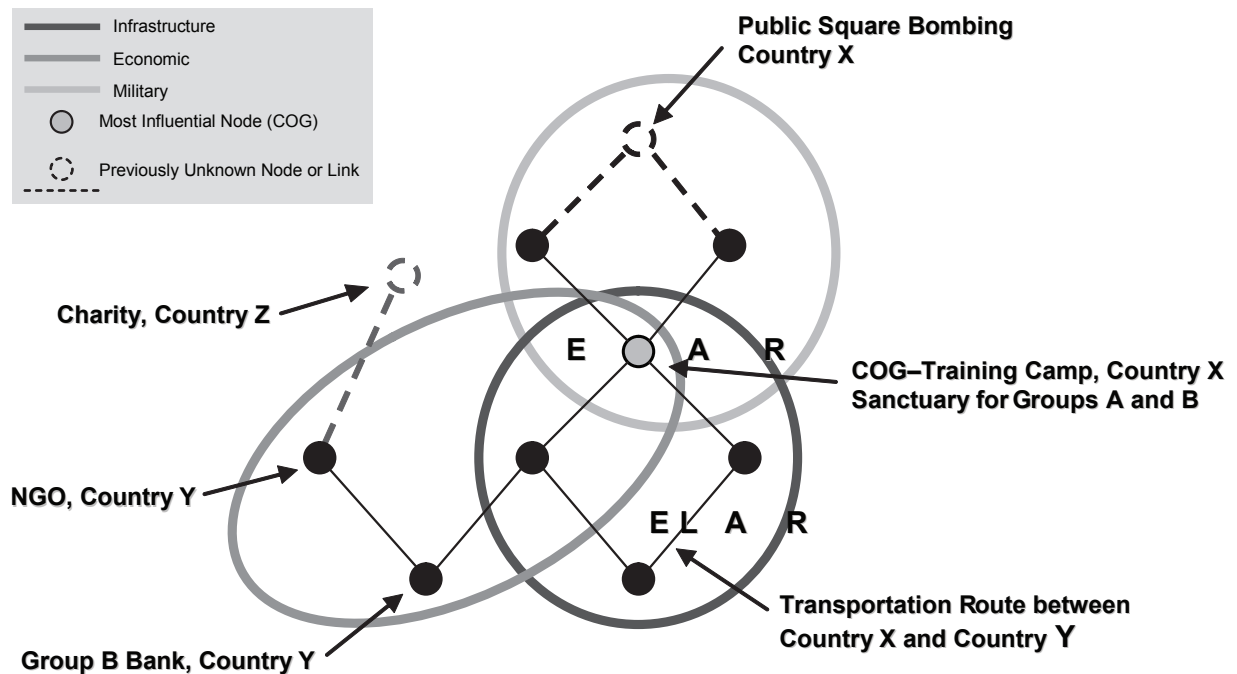
A maximum of six nodes—one center for each system—could represent the centers of gravity of the PMESII construct. On the other hand, if the most influential node in the political system is also the

most influential node in the social system, then these two PMESII systems will share the same center of gravity. In either case, the construct gives us insight into the relationships between system components.

Returning to the system of systems, figure 1 illustrates the meshing of centers of gravity into an effects-based methodology for a PMESII network. For simplicity, the network structure is limited. In figure 1, the filled-in (black) nodes represent the most influential nodes in the network and are the centers of gravity. With centers of gravity included, the development of a linkage between ENAR still follows directly from the system-of-system results, as *Pamphlet 7* describes.

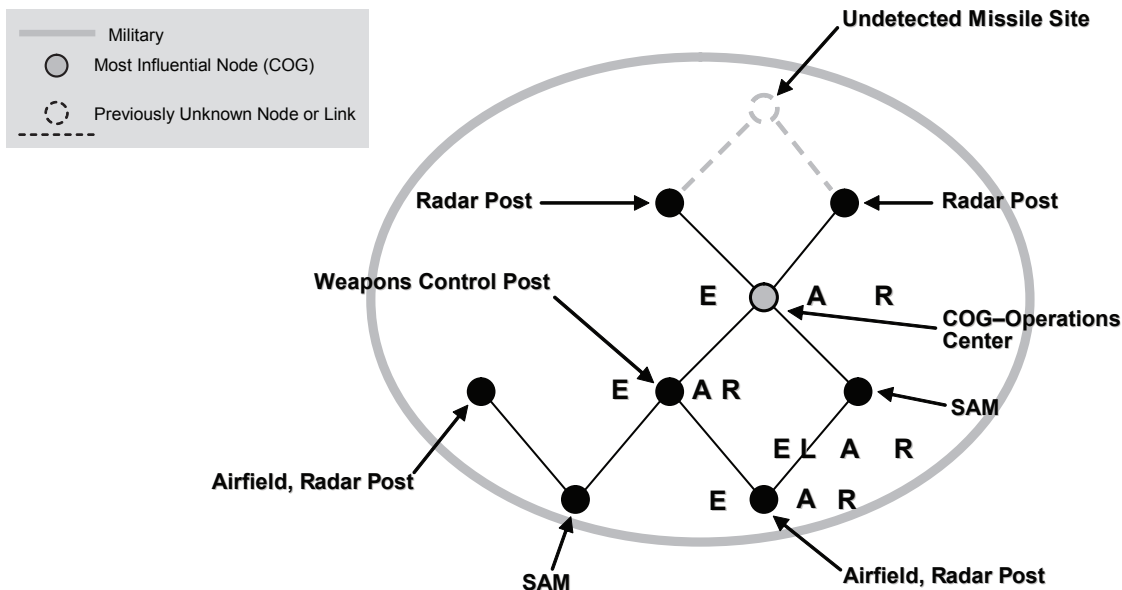
Considering ENAR is similar to listing capabilities, requirements, and vulnerabilities in order to develop courses of action, but because using ENAR allows for a broader understanding of the adversary, it gives the commander more options to employ as he seeks to achieve his desired outcome.

Recognizing that a link may be a more lucrative (or vulnerable) target than a node in terms of influence on the overall system, we add the link into the construct, so that effects, nodes, actions, resources becomes Effects, Links, Nodes, Actions, and Resources (ELNAR). Figure 4 combines the center of gravity and the linkage between ELNAR.



Legend: COG, center of gravity; NGO, nongovernmental organization.

Figure 4. Regional terrorist group example.



Legend: COG, center of gravity; SAM, surface-to-air missile site.

Figure 5. Air defense system example.

Figure 4 shows three systems (military, infrastructure, and economic) of a simplified PMESII network with the most influential node (or center of gravity) in each system being the same node (the filled-in circle). Effects, actions, and resources are linked to one node and one link. Secondary or indirect effects (dotted line and circle), both desired and undesired, are shown manifesting themselves through previously unknown nodes and linkages.

To illustrate in a more concrete manner, we will use two notional examples, one of a regional terrorist group (figure 4) and the other of a more conventional air defense system (figure 5). Our notional terrorist group, group A, has a presence in countries Orange and Black. Group B is a local ally in country Black, where it receives support from a nongovernmental organization and provides support to group A in the form of funding and fighters.

The maximum influence node, or center of gravity, is a training camp where both notional groups have sanctuary and reside. That is, the military, economic, and infrastructure elements of each group overlap at this node. Two of the notional desired effects are to disrupt the operation of group A and to kill or capture members of groups A and B. To that end effects, actions, and resources are matched to the center of gravity and to a transportation link between countries Orange and Black. In other

words, we attack group A directly at the center of gravity and indirectly through the maritime transportation link. In this case, friendly actions have a desired effect of discovering a charity acting as a funding source, and the undesired effect of a public square bombing by a previously unknown cell or individual. While especially appropriate for acting against a terrorist organization, this system-of-systems methodology also applies in our more conventional example of an air defense system.

The network structure for a very simple air defense system is shown in figure 5. Note that only one PMESII system is represented in this case: the military. Additionally, our notional desired effect is air superiority in one cycle of darkness. For simplicity, we only show the air defense portion of the network (we do not show other potential elements such as connections to other adversary military forces). The air defense network consists of radar posts, airfields, surface-to-air missile sites, a weapons control post, and an operations center. The center of gravity (or most influential node) in our example is the operations center. Actions and resources are matched with the desired effect at the center of gravity and other nodes and links within the network. A secondary effect of these actions is the detection of a previously unknown missile site.

From these two examples, we see that the maximum influence node concept can incorporate the idea of a center of gravity. However, our examples are only intended to illustrate the feasibility of establishing a node of maximum influence as a center of gravity. An important caution is necessary at this point: in this new scheme, centers of gravity are a product of system-of-systems analysis, not the other way around; therefore, the EBO methodology does not permit a cookie cutter approach. Additionally, centers of gravity produced through a disciplined system-of-systems process may not be what some planners would consider traditional centers of gravity. For example, leadership is more often than not a default center of gravity. However, Russ Marion and Mary Uhl-Bien, through a network analysis of Al-Qaeda, have demonstrated that the direct influence of the core leadership over the network may be limited; thus, Al-Qaeda's leadership is not the organization's center of gravity.¹³ Finally, there are some important limitations to planning with the system-of-systems network.

Limitations

One practical limitation of the system-of-systems approach in *Pamphlet 7* involves the size of the PMESII network itself. As we have seen with the previous examples, although the system-of-systems analysis was significantly simplified, the PMESII network still seems relatively complex. An actual PMESII network, depending on how they are constructed, could have hundreds of nodes for each PMESII element. In a quest to gain "total battlespace awareness," a planning staff could induce self-paralysis by having too many nodes to consider.

Another problem will be the availability of data to populate the network. If intelligence cannot sufficiently describe the nodes and links within a PMESII element, the network may not permit identification

of a center of gravity. Part of 21st-century operational art will involve deciding how many nodes and how much information is enough to conduct planning. Still, even in the absence of definitive information, the system-of-systems approach can supply a descriptive model of the adversary and an improved understanding of the relationships between components of the adversary system, neither of which are attainable using the old center-of-gravity-focused, objectives-based approach.

Slowing Down the Prism

Changing the way the military thinks about war means modifying the center-of-gravity concept to account for the complexities of warfare today. One method of accomplishing this adaptation is to mesh centers of gravity with the system-of-systems methodology by employing the concept of a maximum influence node. Doing so will enable planners to see centers of gravity through an EBO prism, which will provide a bridge during the transformation from the hierarchical strategy-to-task approach of the cold war to the network-structured practice of effects-based operations in the 21st century. **MR**

NOTES

1. Donald H. Rumsfeld, "Transforming the Military," *Foreign Affairs* 81, 3 (May-June 2002): 20-32.
2. *Joint Warfighting Center, Joint Doctrine Series: Pamphlet 7, Operational Implications of Effects-Based Operations*, U.S. Joint Forces Command, 17 November 2004.
3. Objectives-based planning concepts are addressed principally in Joint Pub 3.0, *Doctrine for Joint Operations*, and Joint Pub 5-00.1, *Doctrine for Campaign Planning*.
4. *Pamphlet 7*, 2.
5. *Ibid*, 10.
6. Joseph L. Strange and Richard Iron, "Center of Gravity, What Clausewitz Really Meant," *Joint Force Quarterly* 35 (April 2005): 20-27.
7. Antulio J. Echevarria II, "Center of Gravity, Recommendations for Joint Doctrine," *Joint Force Quarterly* 35 (April 2005): 10-17.
8. Joseph L. Strange, *Centers of Gravity & Critical Vulnerabilities: Building on the Clausewitzian Foundation So That We Can All Speak the Same Language*, Perspectives on Warfighting Series, 4, 2d ed. (Quantico, VA: Marine Corps Association, 1996).
9. Darrall Henderson, "Modeling a Strategy for the War on Terrorism," unpublished paper, U.S. Army War College, Carlisle Barracks, PA, 2002, 6-9.
10. Strange and Iron.
11. Robert S. Renfro and Richard F. Deckro, "A Flow Model Social Network Analysis of the Iranian Government," *Military Operations Research*, 8, 1 (2003): 5-15.
12. Echevarria.
13. Russ Marion and Mary Uhl-Bien, "Complexity Theory and Al-Qaeda: Examining Complex Leadership," presented at Managing the Complex IV: A Conference on Complex Systems and the Management of Organizations, Fort Meyers, FL, December 2002, 20.