

Chapter 6

Modeling C2 Networks as Dependencies: Understanding What the Real Issues Are

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ABSTRACT

This chapter describes an approach to modeling C2 and other types of networks as a series of nodes (people, groups, resources, locations, concepts, etc.). The nodes are linked by one or more weighted arcs describing the type and the strength of the dependency that one node has on another node. This model allows analysts to identify the most important nodes in a network in terms of their direct and indirect dependencies and to rank them accordingly. The same model also supports consequence analysis in which the direct, indirect, cascading, and cumulative effects of changes to node capabilities can be propagated across the networks. The chapter describes the basic modeling technique and two types of dependency propagation that it supports. These are illustrated with two examples involving the modeling and reasoning across insurgent networks and an Integrated Air Defense System. These show how aspects of the networks can be analyzed and targeted. Details are also provided on the mechanisms to link the analysis to a planning system through which plans can be developed to bring about desired effect(s) in the networks.

OVERVIEW OF MODELING C2 NETWORKS AS INTER- CONNECTED NETWORKS

The purpose of this section is to provide a short overview of previous approaches to modeling C2 networks and identify the strengths of the approach proposed here. Several modeling approaches have addressed the need to understand

how Command and Control (C2) and other types of networks are constructed and function. For the purpose of this chapter a network is defined as: “One or more nodes (people, organizations, resources, locations, concepts, etc.) that are linked by one or more weighted arcs describing the type and strength of the dependency that one node has on another node.”

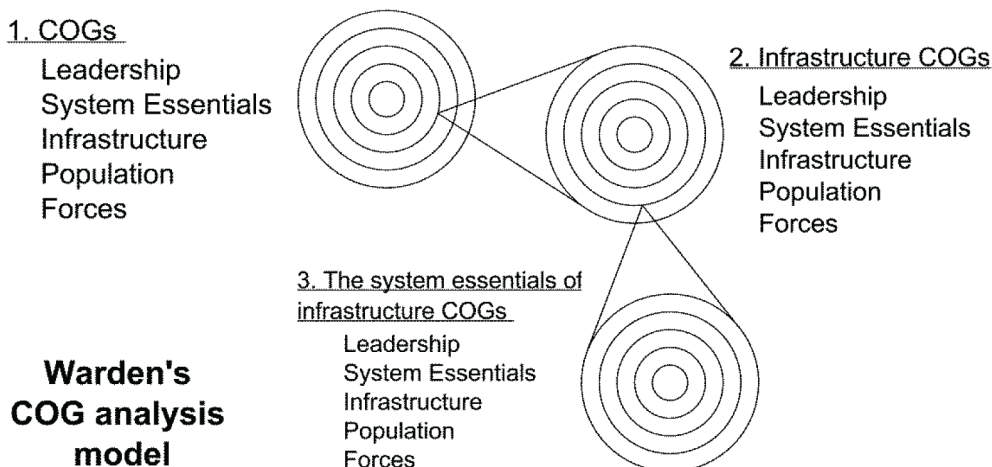
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This allows a wide variety of different C2 networks to be modeled and studied, depending on how its nodes are instantiated. For example, instantiating a network's nodes as C2 Centers, Air Operations Centers, Airfields and their associated personnel would create a partial model of an Integrated Air Defense System (IADS). Whereas instantiating the nodes with distribution centers, headquarters buildings, repair centers and repair and installations crews would create a partial model of the C2 network of the local electrical power (EP) company. The dependency based approaches described in the following sections can be applied to model a wide variety of different networks, but more importantly they show how these networks are not standalone but are actually inter-dependent. For example, EP repair crews are dependent on transport links to travel to work sites and the transport network is dependent on EP for its traffic control systems, sensors and for communication between the nodes in its own C2 network.

The dependency based approach to network modeling builds on previous approaches by firstly fusing them into a coherent model and secondly significantly increasing the range of reasoning capabilities they can support. The "Five Ring"

Model developed by Col. John Warden (1995) represents the networks as a common set of fractal models where each ring can be decomposed into a lower model that is structured in the same way. Figure 1 displays the Center of Gravity (COG) for a country. Infrastructure is a ring in a Country COG, and this can be decomposed into an Infrastructure COG with the same five elements. For example, if the infrastructure COG is a country's EP system then the Leadership is the people who control the generation and distribution decisions, the Forces are the people running and repairing the network, etc. The Five Ring model provides a way to structure and decompose networks but it does not provide measures of the relative importance of the COGs or the rings within a COG. For example, in the COG model, are the country's Leadership elements more important than the Infrastructure elements and how are they dependent on one another? In order to address these issues Major Jason Barlow (1993) developed his National Elements of Value (NEV) model which is shown in Figure 2. This uses a different set of categories to those used in the Five Ring model and introduces the concepts of relative importance and linkages. Figure 2 shows that the Leadership has greater importance than Transportation (given

Figure 1. John Warden's (1995) Ring model



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