

Yakov Ben-Haim, Decapitation paradox with unity of command: An info-gap analysis, *Military Operations Research Journal*, to appear.

Abstract We study decapitation in a hierarchical network with unity of command. Decapitation means removing a node and the sub-network below that node. Unity of command means that each node receives a command from only one other node. We focus on the question of vulnerability to decapitation: given two different networks, which network is more vulnerable to decapitation? Vulnerability to decapitation can be assessed by counting the number (or fraction) of lost nodes resulting from a specific decapitation. Two propositions prove, however, that the result is paradoxical: A different answer is obtained if one selects the decapitated node by counting i rows from the top of each network, or i rows from the bottom. Alternatively, one can assess the average loss based on the probabilities for decapitation of the different nodes. However, the probability distribution may be uncertain, in which case the assessment of vulnerability is also uncertain. In that case one can assess vulnerability to decapitation by evaluating the robustness to uncertainty in the probability distribution, while satisfying a performance requirement on the average loss. This analysis is based on info-gap decision theory. We discuss several examples, including choosing the number of brigades in a brigade combat team.

Keywords Hierarchical command, unity of command, decapitation of hierarchy, info-gap, uncertain vulnerability.