

**The competitive advantages of a spatially centralized entity
versus a decentralized entity**

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Introduction

Today the US and other governments face a threat to security from terrorist networks. These terrorist networks are decentralized in both geographic and structural terms. Conversely the nation state is a centralized entity. In response to a terrorist attack the nation state will often send out forces to search and destroy the terrorist groups. When faced with a number of threats this can result in the nation state being 'overstretched' with the core of the state left vulnerable.

Literature Review

Since 9/11 much work has been done on the concept of the 'Global Terror Network'. However, the concept of a centralized nation state facing a decentralized, dispersed enemy is not an entirely new one. Arquilla and Ronfeldt (2000) proposed the idea that it takes a network to beat a network. They proposed that the US military needs to become more decentralized in terms of its command and control structures and create a network with other government departments in order to be more effective in their fight against a decentralized networked enemy.

The Social Network Analysis community has also researched the terrorist threat that faces today's nation state. Some leading research in this field has been by Carley (2001). Carley addresses the effects of disrupting a centralized hierarchy compared to a decentralized dispersed network. Her research showed how the different networks reform after the removal of a central node.

Contractor and Monge (2002) take a social network approach, which could be applied to a terrorist threat. They introduce the idea of a Multi Level Multi Theoretical network. The multi level aspect of this theory, address the complex systems idea of scale.

Whilst these works have provided useful insights for the military community when formulating counter terrorist strategy, they do not address the concept of a centralized entity defending itself against a decentralized entity in spatial terms.

The Model

We model a conflict situation between a centralized organization A, with a clearly defined "center of gravity" and a decentralized organization B, represented by a certain number of cells. Schematically, a "blob", and B represent A by a set of randomly

scattered spots. At every iteration of the game, a B-cell could appear at a random point of the space.

After the game is started when a B cell appears it aims to 'attack' A cells until it is destroyed or all A cells are destroyed. A responds to an attacking B cell by drawing 'power' resources from adjacent cells to the point where it is being attacked, and also by expanding outwards in all the other directions, trying to "go after" the other potential attackers.

The goal of the organization A is to preserve its centralized structure and to preserve its resources, by reacting coherently to the external attacks. The goal of the group B is to divide the group A or to significantly reduce its power by random attacks, which would imply that A has lost the struggle.

Such groups of elements may model a number of real-life situations, e.g. a conflict between a centralized state and a terrorist group, or a struggle of a complex organism against a virus, etc.

In our model, each element of both groups is characterized by its "power" (or survivability) and by the amount of "damage" that it can inflict on the element of the opposite group. Both power and the damage of a certain element are given by a certain numerical index. If an element of A "fights" a certain element of B, their "powers" decrease according to the damage that they inflict on each other. If the damage received by an element exceeds the power, the element is terminated.

We chose the elements of A to have a greater survivability (reflecting the greater resources of the centralized state) and to possess a smaller destructing power, while the B's have a greater destructive power (which reflects their "destructive advantages", e.g. by the ability to choose the time and the place of the attack - the element of surprise) and a smaller power.

To make the model more realistic, we have randomized the outcome of the combat between the elements. The damage inflicted by one element on the other can take any values between 0 and certain maximal values, which are the additional parameters of the model.

The complete set of the parameters is given by the number of the A and B elements, the initial powers of the B-elements and the A-elements and the maximal damage powers that the A and B elements are ascribed.

The main results of this investigation are as follows. In the figures the results are clustered using the K-Means Algorithm following 200 iterations of each of the set of parameters.

- In figure 1 it appears that there may be a 'bifurcation' of the potential state of A into a steady survival state or an alternate 'death' of A.

- In figures 2 & 3, is that the initial ‘power’ state of B is more important than its damage capability – this would appear to mean that B’s long term survival is more important than inflicting a high level of damage on A.
- When A disperses at a fast rate during the initial stages of the game and occupies all of the space it appears to defeat B in a shorter timescale – this may indicate the effectiveness of intelligence/reconnaissance and pre-emptive action.

Figure1

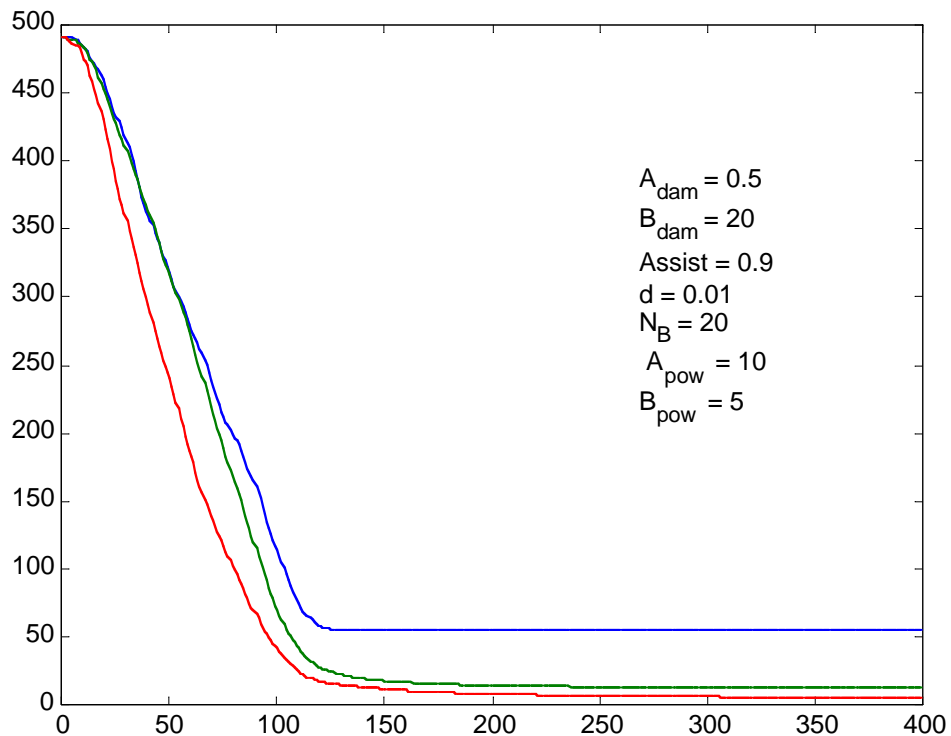
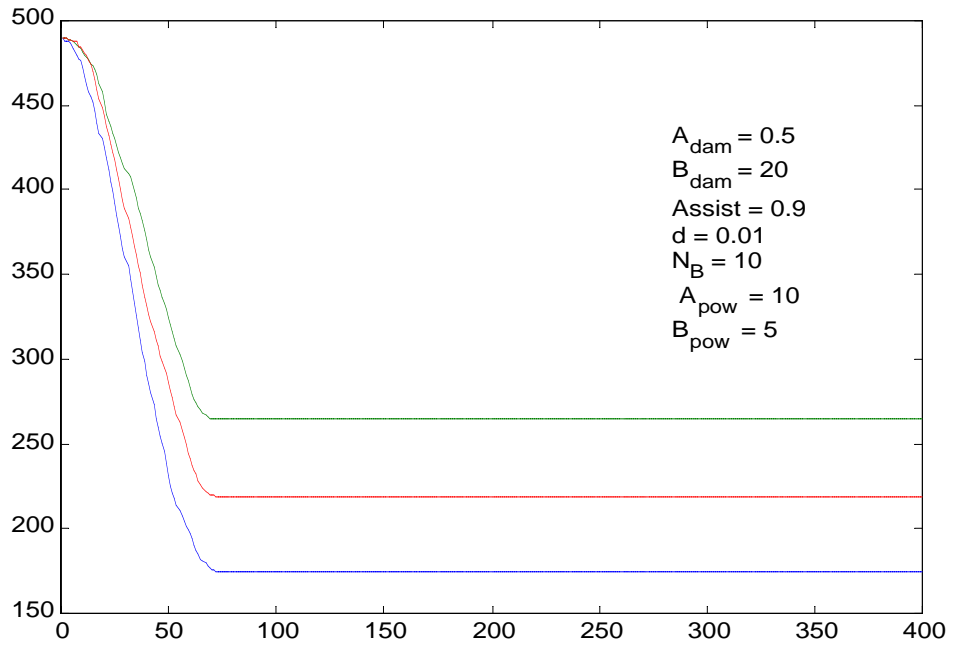
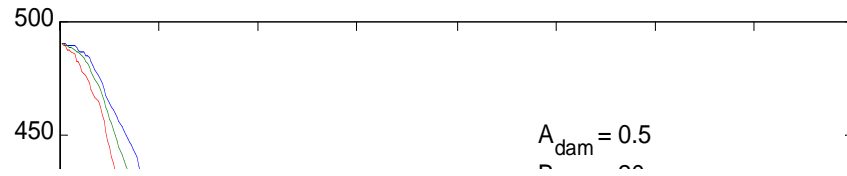


Figure 2

Figure 3



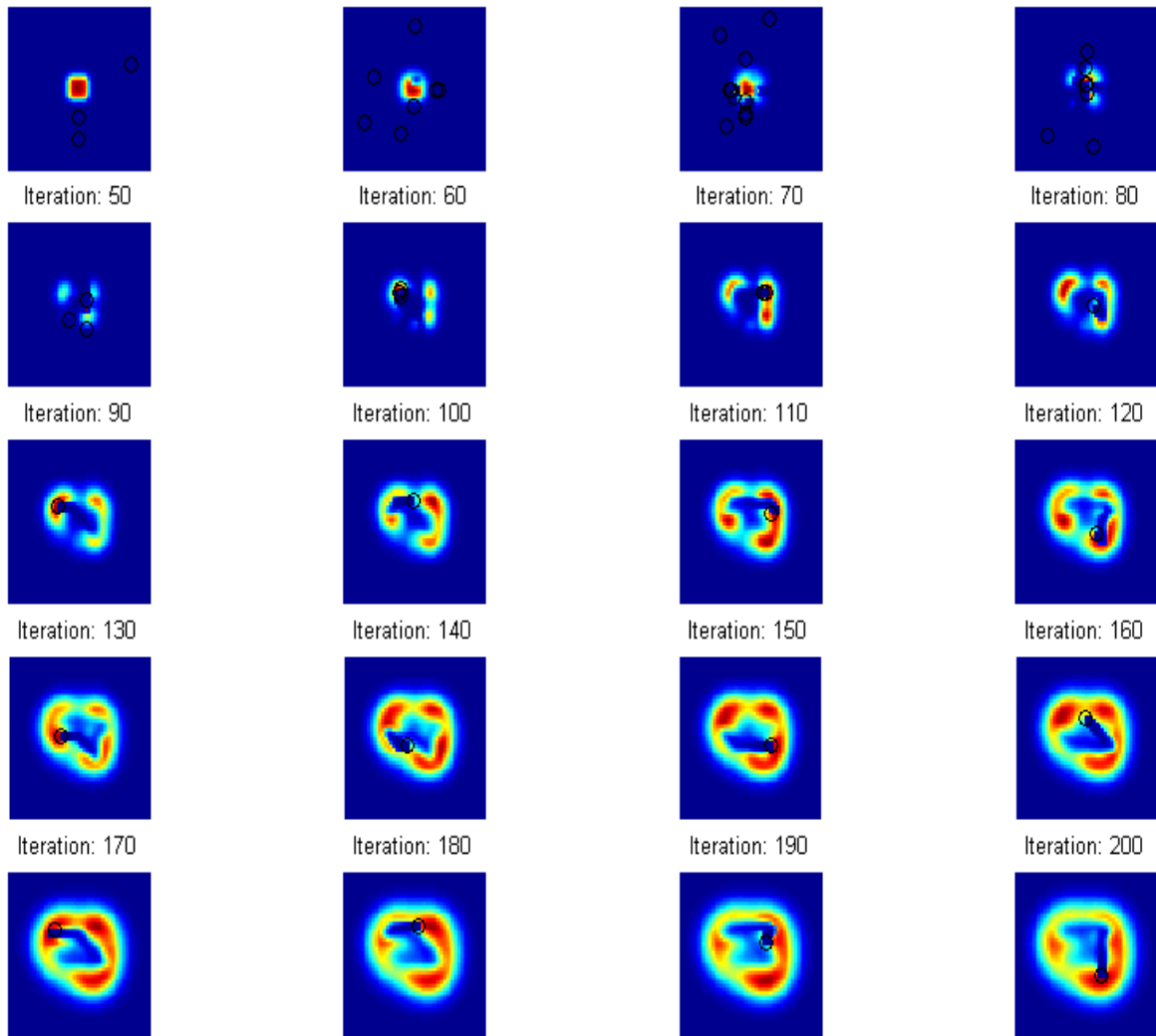


Figure 4

Figure 4 is illustrative of one iteration of the initial conditions indicated at figure 1.

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