Design and Optimization of Agent-Based Emergency Supply Chains

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Networks provide the physical and information structure of systems for transporting all food, water, people, information and goods within our modern life. Emergency Management (EM) organizations need to have highly functioning logistics networks as key towards supporting and aiding affected populations in disasters or conflicts.

Optimization has made immense strides towards improving logistics costs and services. However, most optimization has been designed to operate in a centralized environment, while many systems actually operate in a decentralized way, with individuals making decisions that impact the entire system, especially in emergency management. EM operations can be linked with mobile computing, but new methods are needed to operate across the decentralized network.

We introduce research that explicitly integrates the decentralized decision-makers into the optimization of the entire supply chain by incorporating their behavior with mathematical models so as to improve the overall system outcomes. Specific research areas we study include:

1. The strategic design and management of a service network that will be operated by a set of decentralized agents, where agents may be high level entities such as governments, military branches, or non-governmental organizations (NGOs). Furthermore, we develop optimization techniques for making tactical level decisions in a network with decentralized agents as well as to design the mechanisms/incentives of the agents to achieve greater efficiency where the agents are assumed to be individual participants.

2. Control of information sharing as a mechanism to improve decentralized decisions. In this setting we assume that there is a centralized overseer who tries to maximize the performance of the overall system and that he influences the dynamic decisions of individual agents by controlling the information that is passed on to the agents on the overall system status, such as through mobile computing applications.

The methods we develop can be linked with mobile computing applications and sensing networks, as well as models of human behavior to improve robustness of the network. Our research can also include *evaluation and measurement* of the system through analytics, experiments, and analysis of secondary data, to understand characteristics leading to robust network, and how human interactions play a role in local optimization.

The result of this research will be innovative scientific technologies to incorporate *decentralized* agent decision making into network design and analysis, resulting in supply networks that can function in decentralized, disruptive environments. The advances will transform the performance not only of state and federal governments, but also private firms and non-governmental organizations (NGOs). To ensure relevance and impact, we have built connections with organizations including The American Red Cross, the Centers for Disease Control and Prevention, FEMA, USACE, The Home Depot, UNHCR, UN WFP, and others to solve supply chain problems form pre-event planning to post-event recovery.