Abstract

Many current military visions convincingly suggest that net-centric technology can provide unprecedented levels of performance, robustness, and efficiency. In these visions, the strategic command of information and decision-making renders obsolete the brute-force approach of overwhelming an enemy with vast resources, with information and decisions playing a paramount role. Unfortunately, despite many declarations, this vision has not been fully realized. The technical obstacles to implementing this vision are many and include: lack of a comprehensive theory for decentralized information aggregation and *strategic* decision-making in large-scale networks where information is incomplete, asymmetric, and the source and reliability of available information is not clear; the problem of *data deluge*; our current inability to map local structure to global function in complex information and decision networks and systems, and our lack of rigorous understanding of collective phenomena and systemic risk in complex networks. We currently do not know how to monitor and measure systemic risk, the phenomena according to which small idiosyncratic shocks can combine to have aggregate effects and cascades. To this end, this comprehensive proposal outlines a rigorous basic research plan that leverages PI's track record in developing advanced mathematical tools, new theories and methods to tackle the above challenges. Our proposed effort is organized along three major thrusts that are distinct yet interrelated: 1) An axiomatic theory of information aggregation and strategic coordination in networks 2) Development of algebraic-topological tools and methods for large-scale network analysis beyond graph-theoretic methods; 3) A theory of cascades and systemic risk in large-scale social and engineered networks. The proposed work will build upon PI's more than decade long work with DoD as the lead PI of 2 and co-PI of 5 Multi Investigator University Research Initiatives (MURIs) and basic research grants from ARO, ONR, AFOSR and DARPA.