STIR (subarea 5.3.4): Moving Target Defense in Military Organization with Connected Dominating Set as Command Units

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Military units, which are equipped with wireless communication devices, could form an ad hoc network when they roam in a remote battlefield. In formal terms, an ad hoc network is represented by a unit disk graph $G(t) = (V, E)$, where two nodes (soldiers, tanks, or drones) in V are connected via an edge in E if their geographical distance is within a given transmission range. Since the military units can change locations, $G(t)$ changes over time t. In our proposal, we advocate the use of *connected dominating set* (CDS) as a way to conduct efficient communications among the military units. A CDS is a subset of connected nodes in a given connected network where every node is either in the subset or a neighbor of a node in the subset. Nodes in CDS can be regarded as commanders who bear important responsibilities and are usually the targets of attackers.

CDS has many advantages as a military organization: (1) CDS forms a small group of commanders who are self-connected; (2) CDS can be constructed quickly both locally and hierarchically without global information, like geographical location information; (3) CDS as a unit can efficiently broadcast information to minimize redundancy (without involving non-commanders as relay nodes in a broadcasting process).

In this proposal, we aim to conduct our research on protecting CDS from attack through *moving target defense* (MTD) theory. The principle of MTD is to present attackers with a system whose attack surface keeps changing. We propose several techniques to follow the principle. We start with two basic approaches without considering mobility: (1) resorting to a mix of random and shortest-path routing to protect source (i.e. commander) location and (2) changing the role of commanders through CDS rotation. Then, we focus on how node mobility itself can protect CDS from attacks when it meets a certain threshold to cross both temporal and spatial spaces without resorting to either (1) or (2).

Intellectual Merits. By using random nodes as intermediate nodes, we can protect source location; we will design secure routing protocols that can explicitly control the system's robustness against attacks and the system's performance, efficiency, and/or usability. By rotating the role of commanders, we can significantly reduce the possibility that a node is always a commander. Thus, by the time the attacker figures out which nodes are local commanders, the current roles of nodes in the system may have already changed. This scheme provides essential protections for local commanders. By investigating the node mobility, which is natural in real scenarios, we will draw important insights on how node mobility will help preserve location security for CDS nodes.

Broader Impact. CDS can benefit military operations in many ways. In a military organization, the CDS can be regarded as a set of local commanders in control of their units. Our proposed research will investigate important and meaningful techniques to protect CDS nodes. We envision that the insights and results from this research will establish important guidelines for designing secure military operation systems. The proposed techniques will also contribute to current MTD theory.