A Brief Concepts of UAS Operation: a Fictitious Scenario for Research Purposes

Henry Hexmoor, SIUC

January 2010

Disclaimer

All information in this document is based on knowledge and inspiration from publicly available sources. No UAS specialists were consulted.

Battlefield

Imagine a largely landlocked square mile urban battlefield theater B in the blue region and two interested forces that are adversaries, dubbed blue and red. There is a shared body of water between blue and red forces. B continually produces 10 terrestrial, stationary (e.g., IED) or mobile (e.g., vehicles) targets for ISR interest and 5 pop-up (e.g., individuals) targets for strike interests.

UAxVs

Blue has a number of networked long duration UAVs-- 20 for ISR and 10 that are weaponized for strike. UAVs have high degrees of autonomy with preloaded missions. Each ISR UAV possesses a focal sensing zone around it and a slightly larger peripheral sensing zone. ISR UAVs can tag targets indefinitely. A strike UAV has a single kill effectiveness zone around it and once it uses its ordinance it must be retired (e.g., a bee stinger).

Commander

There is a single commander that can remote sense the battlefield, assign and updates target qualities (i.e., priorities) with separate ranges for ISR and strike via a satellite link.

Red has 10 networked ISR UAVs that track blue UAVs and may interfere with blue forces but their true intent is unknown. An ISR target expires after three visits and a strike target expires after one. A red UAV can also be selected for strike. For an extreme simplicity, assume that there is no electronic interception, jamming, or interference.

Objective

The objective is to implement a testbed for the blue commander to service the most targets in the shortest amount of time.

Social Networks

Blue and red UAV groups each form a social network where nodes with strong ties can share tasks. Ties are strengthened by frequency of interaction and delegation. Nodes gain social power among their peers proportional to the number of their accomplished tasks. With more power,

UAVs gain the right of swarm leadership for navigation purposes. Nodes with the least power atrophy and retire.

Expected Emergent Phenomena and Conversion into Control Parameters

1. Several physical swarming and crowding phenomena are expected. A benign one is due to collision avoidance. A second one is red spectator crowding effect where red forces are attracted to ISR targets that are geographically recurring as well as around any strike target. This is undesirable as it interferes with blue forces.

2. *Externalities* are indirect gains and losses in task completion due to activities of others. Our testbed should report crowding by red forces and negative externalities by revealing target locations due to blue UAV activities.

3. Social networks

Control charts (McCulloh, et. al., 2008) will monitor SNA metrics such as closeness, centrality, and density. These will help the commander to understand the nature of UAV organization.

4. Autonomy

Commander needs to mediate selectable autonomy for each and groups of UAS (Hexmoor, 2003).

References

H. Hexmoor and B. McLaughlan, 2007. Computationally Adjustable Autonomy, Journal of Scalable Computing: Practive and Experience, Volume 8, Number 1, Pages 41-48, SWPS.

McCulloh, Ian & Webb, M & Carley, Kathleen & Horn, D. B. (2008). Change Detection in Social Networks. *U.S. Army Research Institute for the Behavioral and Social Sciences, Technical Report No. 1235. Arlington, VA.*