ITEA Technology Review Conference 2011
19-21 July 2011
Annapolis, MD

Unmanned and Autonomous Systems: Considerations and Issues for Future Operations and Test

Autonomous and Cognitive Systems Session

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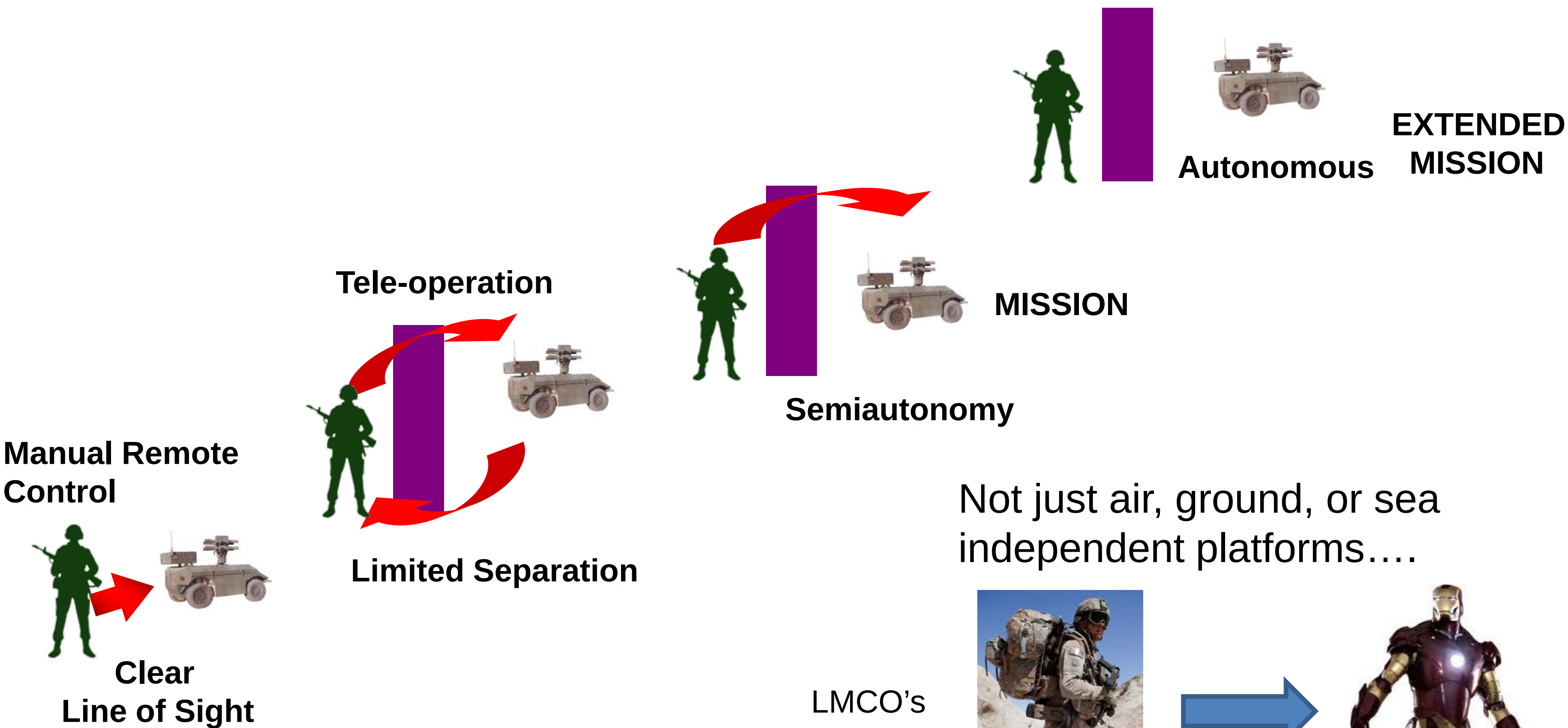
AI's Axioms

- As systems achieve intelligent autonomy, things usually seem to go wrong
  - HAL, Terminator, "VIKI" (Virtual Interactive Kinetic Intelligence)
- Bad often is developed with the good
  - Star Trek: Data and Lore
- The more a system achieves intelligent autonomy, the more it looks human
  - Terminator, Data, Sonny

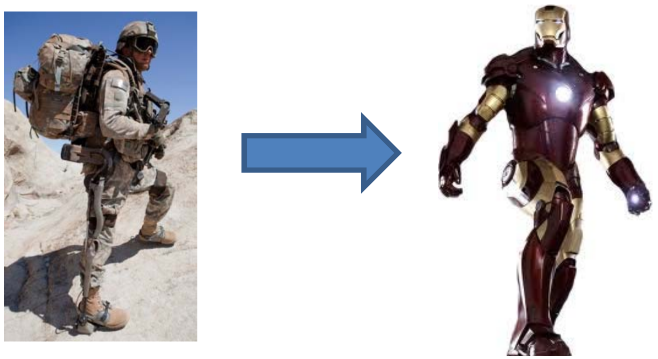
Reference: Hollywood

Evolution of UASs



Not just air, ground, or sea independent platforms….

LMCO's Human Universal Load Carrier (HULC)



If We Meet Expectations

- Warfighters are kept out of harm's way
- Unemotional warriors
- Sophisticated sensing beyond human Warfighter's capability
- No fatigue – 24 hr/day readiness
- Logistics impact reduced for food, water, and medical support; but increased for power and equipment resupply (especially if "throwaway")
- Cultural military shift
- Legal issues?

Legal Issues

- Deviant behavior
  - Learned by UASs – e.g., child's attack on UAS changes perception of child from non-combatant to combatant
  - Generated by human controllers
    - Used for criminal behavior (war crimes, stealing, etc.) or to exploit other humans (intruding on one's privacy)
- If a UAS commits a crime, is it the fault of the:
  - Commander
  - UAS
  - Human controller
  - Manufacturer of system
  - Manufacturer of software

Note: Responsibility may vary with autonomy

Need for Man-in-the-Loop

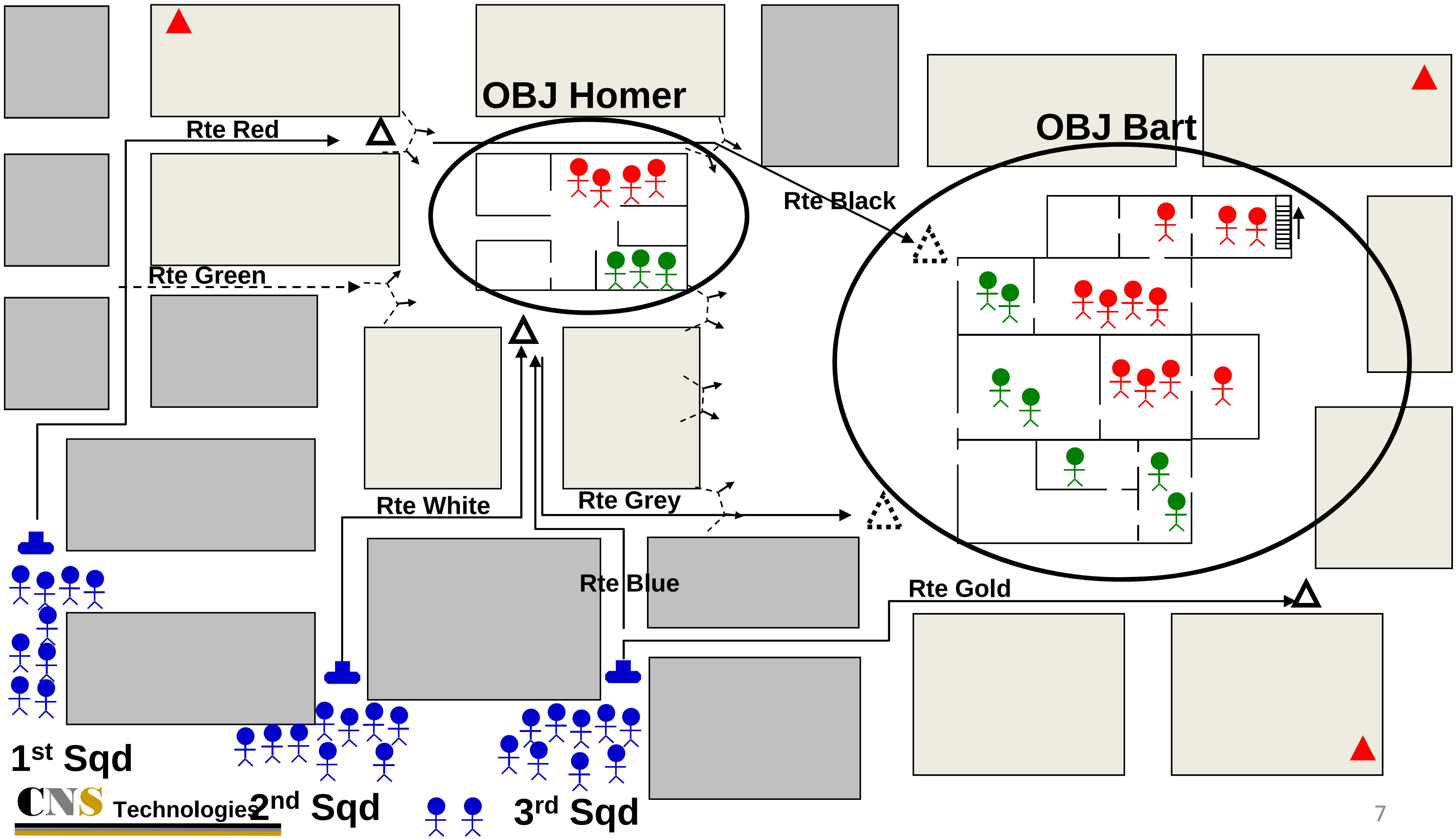
Feedback from Warfighters

- *Not just "man-in-the-loop" for lethal UAS*
- *All Warfighters will have "positive control" over lethal UAS*
  - *No lethal UAS will make a decision to fire without approval from a Warfighter*

May be feasible for engagements which have sufficient reaction time (e.g., determining to fire weapon on Predator UAV)

May not be feasible for engagements with short reaction times (e.g., lethal UGV and four dismounted Warfighter enter a room with armed insurgents)

Example of Autonomous Systems in Small Unit Urban Operations



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Use of Autonomous Systems in Small Units -- Considerations

- Use in critical tasks (e.g., team clearing a room) is directly related to Warfighter trust in the system
  - May be a finite decision rather than a gradual increase
- Use will depend on fidelity of UAS capabilities
  - Cheaper, throwaway UAS used for detecting human in a room
  - More expensive UAS used for identification of a human
- Use in mission will depend on demands on an operator
  - Higher the demands, the less use in missions that require a Warfighter's attention – e.g., less use in offensive operations than in defensive operations
- Use should not detract from operator's personal situational awareness

Threat Use?

- High tech adversaries
  - Will probably mirror our use
- Low tech adversaries
  - Ubiquitous use of UASs in commerce and entertainment translates to ease of access by low-tech adversaries
  - Will most likely use an "improvised" UAS (IUAS)
- Big problems
  - High tech or low tech adversaries with little consideration for human life may use "rogue" UASs (or IUASs) which violate all three of Asimov's laws
  - Enemy's use of cyber warfare to gain control of friendly UAS

Testing Challenges

- Predicting behavior of a learning, intelligent system
  - Especially, attempting to test for potential deviant behavior
  - Enough to assist with determining legal responsibility
- Challenges from very large number of varied UAS developers (many, varied, small acquisition programs)
  - Developing a limited number of methodologies and tools which have broad applicability for testing autonomy
    - Extreme analogous example is the modeling of human behavior
  - Testing vulnerabilities to cyber warfare – extremely difficult with large variations in software development
- Developing threat systems, especially Improvised UAS (IUAS)
- Accurately assessing Warfighter confidence/trust in systems – especially for small units in high intensity combat operations
  - And assessing the benefits of UAS in terms of MOEs
- Instrumentation for micro-UAS, which have little-to-no SWAP

Candidate Taxonomy for T&E

(1 of 3)

Autonomous behavior includes:

- Perception -- ability to sense/observe surroundings -- relating sensed features to real world
- Planning -- includes both path planning and mission planning
  - Deliberate or reactive path planning includes the development of a movement trajectory from current position to next position(s)
  - Mission planning provides the best course of military action, given METT-TC information
- Navigation -- having situational awareness, knowing current location and desired location(s); map and find a way through immediate surroundings, detecting nearby hazards to mobility
- Behavior and Skills -- the combination of artificial intelligence with inputs from perception, planning, and navigation to support cooperative behavior and develop motor commands
- UAS-Human, UAS-UAS, and UAS-C4ISR System Interactions -- ability to interact with humans (human controllers (including operators and commanders) and other humans (friendly military, enemy, and non-combatants)), UASs, and C4ISR systems
  - Includes teamwork (ability to organize teams and allocate tasks); the ability to communicate with others; and the ability to understand "commander's intent"
- Learning and Adaptation -- the ability to enhance or modify its artificial intelligence as well as its behaviors

Candidate Taxonomy for T&E

(2 of 3)

Supporting functions include:

- Mobility -- ability of a UAS to traverse through space, air, land (natural and manmade terrain), and water (on and under) environments
  - Includes combinations of those environments (e.g., systems that operate in littoral regions; systems that operate on the ground but also fly to traverse obstacles or large distances)
- Communications --ability to convey and receive concepts with voice, communications systems including military/non-military communications links, non-verbal communications (e.g., hand-and-arm signals, gestures), and graphical user interfaces
- Power and Energy -- includes power sources (e.g., rechargeable and nonrechargeable batteries, fuel cells, engines) and energy management
- Health Maintenance -- ability to make the UAS more robust and to provide maintenance capabilities for self-monitoring, diagnostics, and recovering from component failures
- Safety -- ability of UASs (especially those with lethal mission packages) to operate safely in an operational environment
  - Includes mid-air and undersea collisions (especially between UAS and manned air/sea platforms), control of air-to-ground crashes, damage to military and civilian ground personnel and property by large UGVs

Candidate Taxonomy for T&E

(3 of 3)

Mission packages include:

- Modular physical components (e.g., lethal weapon, non-lethal weapon, surveillance system) that are attached to a common UAS platform to provide it a unique capability
- Modular software components augmenting a common UAS platform
    - For example, to interact with higher echelon "leader" UASs, lower echelon leaders, "follower" UASs, or even one-of-a-kind task (e.g., UAS sensor) UASs

Questions?

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