KEEL Coordination of Dominant Cyber Offensive Engagement

Compsim White Paper

Executive Summary

Provide a mechanism such that autonomous software robots can pursue adaptive strategies in order to achieve goals given to them. The robotic software agents can adaptively generate fully autonomous agents, or can adaptively generate semi-autonomous groups, each with their own policies and behaviors. Mechanisms (policies) for defining the adaptive behavior will be developed by human commanders using a "dynamic graphical language" specifically created for defining dynamic, adaptive behaviors. Provide a solution that is cost effective to manage and deploy across any platform and any architecture.

Innovative Claims

Compsim has invented (patented) Knowledge Enhanced Electronic Logic (KEEL) Technology to model and execute human-like behavior such that human-like reasoning can be deployed in software applications and devices. Software agents that can "reason" can react to dynamically changing environments, such as counter measures taken by targeted devices. These software agents can deploy the most effective means to avoid detection and respond to any actions taken against them.

Reasoning is different from sequential (left brain) "rule processing" IF | THEN | ELSE logic that has been used in computers since they were invented. Reasoning (right brain) processing is a parallel process that interprets the importance of information and balances alternatives. KEEL Technology implements this interpretive reasoning capability and greatly extends systems that only execute the scripted segments.

An integrated solution would utilize KEEL Technology to interpret the agent's situation and determine which (and how much) scripted functions to perform. KEEL provides the way to create an adaptive control system.

Technical Approach

There will be a number of techniques that can be deployed to Deceive, Deny, Disrupt, Degrade, Destroy (D5). With KEEL, one models how the agent determines which techniques are most appropriate; and, incorporating human-like behavior models (like frustration), the software agent will adjust the tactics and pursue alternative techniques. When integrated in a multi-agent scenario, the agents can collectively determine tactics.

During the course of operation, the agents will look for vulnerabilities in target systems by probing and observing. Interpretation of these vulnerabilities will benefit from KEEL's interpretive capabilities. Using KEEL-based "judgment", the agent will probe the target systems and interpret the response of the target system. When an attack is appropriate, judgment (encoded in KEEL) will determine which approach(s) is/are most appropriate, taking into account the agent's capabilities and the commanding strategy (stealth or direct). There may be times when it is better to hide and wait for a better opportunity. KEEL can model and execute these behaviors using Time Utility Functions (TUFs) where there is an optimal instant to perform tasks. There may be times when some software agents should be "given up" to redirect defensive actions. Individual agents can be distributed to come alive at later (optimal) times. The policies of the agents can also define when they need advice from the outside.

Sometimes the role of the agents may be focused on deception. They could be deployed to force the opposition to use alternative resources, corrupt or drain financial resources, force the opposition to expend resources to respond to a threat that doesn't exist.

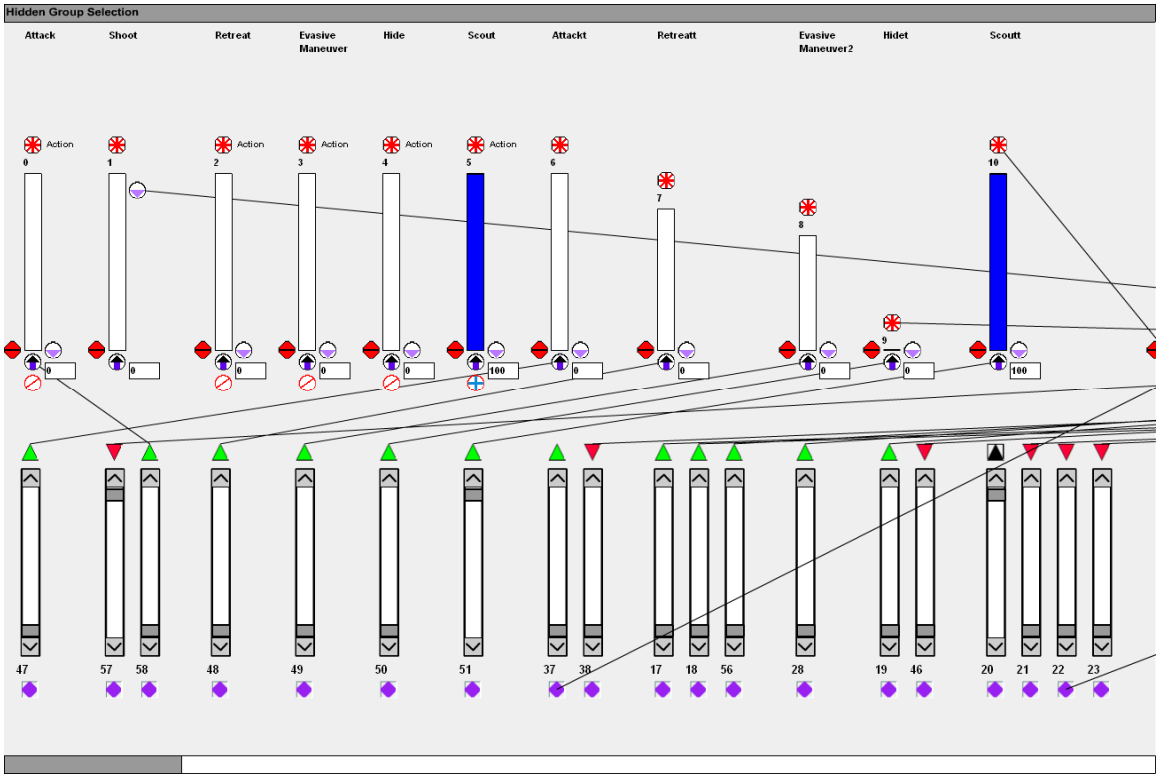
Tactics will include integrated command and control decisions linked to operational impact. This is the domain of KEEL Technology. The KEEL "dynamic graphical language" allows complex, non-linear behaviors to be created with relative ease. Domain

experts can create and test the models without requiring support from mathematicians or software engineers. This allows individuals trained in strategy development and tactics to create the models. The models can also be easily modified and extended (without starting over each time).

KEEL Technology is platform and architecture independent. Small memory footprint KEEL "Engines" are created using the KEEL "dynamic graphical language" (DGL). The KEEL engines are translated to the source code language of choice (C, C++, Java, Flash, Octave (MATLAB), Python, Visual Basic…) for integration into any IDE that is used to create the software agents that will be deployed. Because the KEEL engines can be deployed in multiple languages, they can be easily tested in simulations before they are deployed (even if the simulation environments differ from the deployment architectures). In a simulation (or emulation) environment, the KEEL "engines" can publish how they view the world so the designers can "watch them interpret information and make control decisions". This is provided with the "animation" capability of KEEL "tools". Simulated agents can expose their reasoning models in dynamic environments. In this case, KEEL can be used to model strategies and tactics of any policy; not just those associated with software agents.

A strategy similar to one used for Unmanned Aerial Vehicles (UAV) might be used as a starting point. The agent would transition through different modes depending on the situation it finds itself: Scout for target, hide from detection, evade threats, retreat when appropriate, or attack. Attack decisions would determine how, how often, how much, and exactly when.

The following image is a rendering of the KEEL DGL for the UAV supervisory control. To the uninitiated, this may appear complex, but the concepts of the graphical language can be taught in about 4 hours. One can start creating complex models in minutes, not hours, weeks, or years.

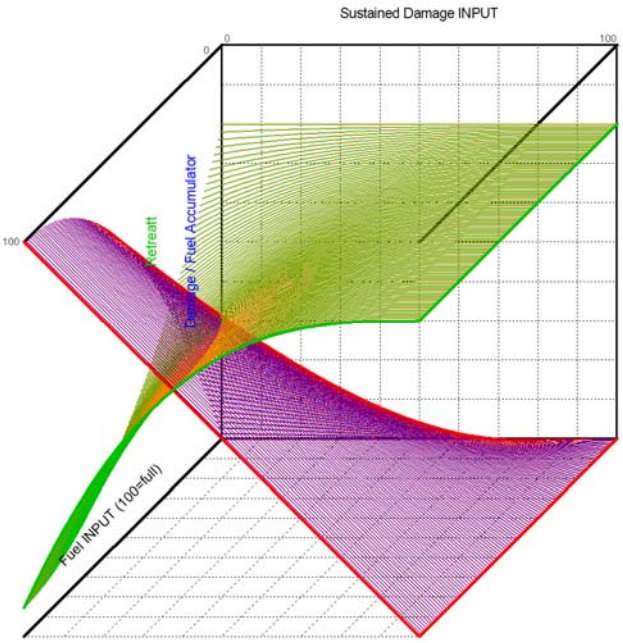


An interactive rendering can be viewed by clicking on the image:

http://www.compsim.com/demos/d23/showUAV.htm

Figure 1

The individual responsible for the strategy *thinks in terms of the importance of information and how information items are functionally related in order to determine a course of action*. They think in curves. Using the KEEL DGL, models are developed. 3D graphs are used to allow the policy maker to visualize how the system will react in dynamic situations. The graph to the right shows how a decision to



retreat will be determined while balancing fuel and damage against a target of identified value, risk of exposure,….

Using these techniques, strategies for attacking target systems can be developed and tested. Once the strategic models are created, they can be delivered to the integration team for integration and test.

Mathematical models that control complex, non-linear systems are very hard to develop with conventional tools. The mechanics of creating the formulas are completely hidden when using KEEL Technology, yet the result equates to a formula. It is 100% auditable, explainable (and extensible). This makes it easy to create complex strategies.

Technical summary/References and Proposed Deliverables

Conventional scripted approaches to agent management lead to static monolithic solutions that are costly to develop and maintain and easily detected. With KEEL Technology, one can easily develop dynamic, adaptable agents that can adapt to defensive responses and countermeasures. Because the adaptable policies can be created in advance, the agents can hide and deploy themselves in a more invasive manner.

KEEL Technology is only available from Compsim.

Compsim LLC is a technology company providing next generation cognitive technology for application in military, medical, transportation, industrial automation, governmental / business, financial, utilities, and electronic gaming markets. Compsim licenses its KEEL® technology for use in embedded devices, software applications and for the Internet. The website is: http://www.compsim.com.

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