Frontier: Towards Onboard Intelligence For Next Generation Space Assets; **P.E. Clark, CUA; M.L. Rilee, Rilee Systems Technologies; S.A. Curtis, Tetrobotics**

We are working toward development of Frontier, a highly adaptable, stably reconfigurable, web–accessible intelligent decision engine that will be capable of optimizing the design and simulating the operation of, and ultimately operating complex systems, ranging from instruments to multi-platform distributed assets, in response to evolving needs and environments. The most innovative aspect of Frontier is what makes it truly unique, capable of absorbing and utilizing lessons learned and thus evolving from a tool to a tool user: an adaptable framework consisting of a decision engine with evolving intelligence based on a genetic algorithm–driven evolving neural interface with an evolving synthetic neural system consisting of neural basis functions for the human (to the Stakeholder GUI) and tool (to the modeling support environment) interfaces and a specially designed stability algorithm to balance rule– and choice–driven inputs originating from either side facilitate the design evaluation and selection process. The adaptable framework will be increasingly capable of dynamic reconfiguration of parameters and rules associated with tools and resources, as well as selection of tools most optimally matched to stakeholder needs through pattern recognition in response to 'lessons learned'. Frontier is built on an open source, web services oriented environment. Through web–based interfaces, it will support distributed, multi–user, concurrent access to resources and tools, including the human and tool interfaces, modeling and development services, databases, simulation, scenario development, analysis, and evaluation.

In our NASA Edison SmartSat proposal, we apply Frontier in the demonstration of autonomous close proximity operations critical for deep space operation, including knowledge and control of orientation and position to support formation flying, close approach, stationkeeping, changing orbital parameters, and active/passive object interactions, with progressively greater onboard intelligence drive by Frontier intelligent decision engine (IDE). Morehead State University provides the 3 3U standard cubesat buses with 1) IDE based on GSFC patented Synthetic Neural System Nervous Net Attitude Control and Neural Net Target Discrimination, Tracking, and Prediction leveraged from previously supported developments in support of NASA ST-8 choice driven system for an autonomous navigation demonstration, and DARPA System F6 intelligent decision engine; 2) Morehead State University 60GHz RF System with omni-antennas for distance and direction determination, inter-spacecraft communication, and atmospheric sounding (science mode); 3) Honeywell Dependable Multiprocessor (DM), with GPS determination capability leveraged from NASA ST-8 and the DOD SMDC TechSat; 4) In-Space primary propulsion utilizing Busek resistojet thrusters leveraged from developments in support of the Air Force NanoSat Program and demonstrating sufficient Delta-V and ISP to support our proximity operations.

SmartSat has three levels of autonomy, from lowest level health & safety and control software baseline flight software (BFS) mainly on the standard C&DH platform, and two higher levels associated with the Synthetic Neural System Neural Basis Functions running as a DM application and consisting of low-level controllers to drive spacecraft behaviors through command sequences and high-level controllers to deal with more complex or symbolic tasks, for example, selecting between safing alternatives or collision avoidance trajectories.