SITIS Topic Details

Topic List

Proposals Accepted:

Program: SBIR

Topic Number: MDA11-031 (MDA)

Title: Improved Techniques for Optimistic Modeling

Research & Technical Areas: Information Systems

Topic Author: Alan Jacobs, Phone: (719) 244-2769, Fax: (719) 325-8265, Email: alan.jacobs@mda.mil

James Ceney, Phone: (719) 325-8261, Fax: (256) 955-2968, Email: james.ceney@mda.mil

Acquisition Program: Modeling and Simulation

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

Objective: To develop tools and techniques to improve development of optimistic models and simulations to: - Increase speed/throughput of coded development for optimistic models - Eliminate coding errors in optimistic models. - Improve detection and diagnosis of faults related to coding errors in optimistic models. - Increase potential to convert existing non-optimistic code, such as time-stepped models and tactical code, into optimistic models.

Description: The Missile Defense Agency has advocated the use of optimistic modeling techniques in its M&S architectures that model the complete Ballistic Missile Defense System, especially for the performance assessment mission with its need to use very-high fidelity models while maintaining reasonable run-times. Optimistic modeling is a methodology to allow a simulation to take full advantage of parallel processing by distributing models across all available processors and letting them run at maximum processing efficiency and concurrency, yet still maintaining causally correct ascending time order and preventing periods of coexisting alternate truth states. Models execute optimistically assuming that the processing of the next current event will not become invalid due to the arrival of an earlier event processed on another compute node. If an earlier event should arrive, rollback techniques are used to “undo” the modeling computations to the point of the divergence, and then continue to race forward. This allows for significantly reduced run-times or improved real-time responsiveness when running complex simulations. Unfortunately,

optimistic modeling caries the additional burden for developers to write code to implement rollbacks in addition to models they are developing. Writing rollback code is a relatively straight forward technique, but the errors that arise from mistakes are exceptionally difficult to diagnose. These errors often manifest themselves infrequently and are often subtle, revealing themselves in nearly correct behavior. If mistakes in writing rollback code can be prevented or detected early, then it will be far cheaper and faster to develop optimistic models. Furthermore, there is a strong desire to re-architect existing non-optimistic code into optimistic simulations. Techniques and tools that would allow the imbedding of existing time-stepped simulations and tactical code into optimistic simulations would greatly increase the adoption of optimistic modeling techniques throughout the MDA M&S community and greatly benefit the agency.

PHASE I: - Analyze the three different phases of simulation development (Design, Coding, and Maintenance) for both the development of new optimistic models and conversion of existing non-optimistic code. - Identify techniques that can be developed into tools to assist model implementers in reducing the effort during these development phases. - Determine which are more valuable to pursue based on return on investment for that technique. - Develop a detailed concept description and development plan for tools based on one or more of the identified valuable techniques.

PHASE II: - Develop the tools identified in phase 1 to an initial capability level. - Demonstrate that the developed tools improve development of optimistic simulations by applying them to test efforts in their respective phases. -- Design Phase: Support development software requirements for an MDA optimistic model, showing potential for increased thoroughness and detail of effort. -- Coding Phase: Support the coding of an MDA optimistic model, showing potential for increased speed and decreased errors in the effort. -- Maintenance Phase: Find, diagnose and repair problems in an existing MDA optimistic model, showing potential for increased speed and/or quality of effort.

PHASE III: - Use developed tools in support of MDA modeling and simulation efforts. - Make improvements to the tools based on return on investment value and feedback from users. COMMERCIALIZATION: Once baseline tools have been developed, these tools could be commercialized through the addition of user friendly GUIs, guides, and add on functionality. This could then translate into the growth of optimistic modeling in areas outside of MDA. Tools and techniques to improve development and maintenance of optimistic simulation models would benefit any organization that must develop very complex simulations that have rigid (executable at real-time) or practical (one or more runs executable in a fixed amount of time) run-time constraints. Applications other than the Missile Defense Agency include any arena in which detailed modeling of system-of-

systems is required. Military applications may include modeling of naval task forces, air-electronic campaigns, and networked autonomous systems. Civil applications may include detailed modeling of power grids, complex industrial processes, and component system level models of ships and aircraft. A large potential market exists for sales of developed tools and techniques to any organization/company that must develop such complex large-scale simulations.

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Keywords: Modeling, Simulation, Optimistic, Discrete Event, Time Stepped, Software Development

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