Advanced Message Routing for Scalable Distributed Simulations

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On large Linux clusters, scalability is the ability of the program to utilize additional processors in a way that provides a near-linear increase in computational capacity for each node employed. Without scalability, the cluster may cease to be useful after adding a very small number of nodes. The Joint Forces Command (JFCOM) Experimentation Directorate (J9) has recently been engaged in Joint Urban Operations (JUO) experiments and Counter Mortar analyses. These both required scalable codes to simulate over a million SAF clutter entities. The JSAF application suite, utilizing the redesigned RTI-s communications system, provides the ability to run distributed simulations with sites located across the United States, from Norfolk, Virginia to Maui, Hawaii. Interest-aware routers are essential for scalable communications in the large, distributed environments, and the RTI-s framework, currently in use by JFCOM, provides such routers connected in a basic tree topology. This approach is successful for small to medium sized simulations, but faces a number of constraining limitations precluding very large simulations.

To resolve these issues, this work described herein extends the RTI-s software router infrastructure to accommodate more sophisticated, general router topologies, including both the existing tree framework and a new generalization of the fully connected mesh topologies. The latter were first used in the SF Express ModSAF simulations of 100K fully interacting vehicles. The new software router objects incorporate an augmented set of the scalable features of the SF Express design, while optionally using low-level RTI-s objects to perform actual site-to-site communications. The limitations of the original mesh router formalism have been eliminated, allowing fully dynamic operations. The mesh topology capabilities allow aggregate bandwidth and site-to-site latencies to match actual network performance. The heavy resource load at the root node can now be distributed across routers at the participating sites. Most significantly, realizable point-to-point bandwidths remain stable as the underlying problem size increases.

Keywords: Linux, cluster, scalable, JSAF, routers, Communications.

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