Urban Battlespace Simulations Seek to Understand the City's Most Complex System – Its Population

By Gary Sivak and Dinah Luneke

The Principal Investigator for this project was Mr. Jim Blank, of the Joint Concept Development and Experimentation Directorate (J9) Joint Forces Command, Suffolk, Virginia. Utilization: DoD Dedicated HPC Project Investment (DHPI) award.

The urban environment is extremely complex and human-oriented. Cities represent the political, economic, social, and cultural centers of civilization. With business centers, manufacturing and storage facilities, and transportation networks, urban centers are essential to global and regional commerce.

For those conducting military operations, the urban landscape is also extremely dangerous. This environment, composed of diverse buildings and networked infrastructure – power grids, transportation, and sewage systems – offers multiple potential targets and complex maneuvering space for the enemy. The explosive growth of the world's major urban centers, the ongoing global war on terrorism, and enemy operations in city streets have made the urban battlespace decisive and virtually unavoidable.

Success or failure in achieving U.S. strategic and operational objectives will be determined by the U.S.'s ability to effectively conduct urban warfighting and the ability to gain support of the city's most complex system – its population.

During 2006, the U.S. Joint Forces Command (USJFCOM) executed Urban Resolve (UR) 2015, an experiment that focused on three specific joint concepts:

- Joint Urban Operations (JUO)
- Military Support for Stabilization, Security, Transition and Reconstruction Operations (SSTRO)
- Major Combat Operations (MCO)

Model of a simulated city with approximately 200,000 entities

This UR 2015 study included three different trials. The first was a baseline study that focused on the Iraq conflict in 2005, and the two others focused on the 2015 timeframe.

Input and Output Results

"What we have been able to do with the supercomputer at Wright-Patt is simply amazing," Mr. Blank said. "A previous paradigm was broken using batch-processing within the HPC community. We used it in real time with inputs and outputs coming directly from the supercomputer to our nodes at J9 and around the U.S., using the distributed architecture. We ran our HPC jobs simultaneously at Maui and the AFRL MSRC during the course of our experimentation, based upon the classification of the specific experiment we were performing."

The primary code that ran on the Glenn System was a government-owned Joint Semi-Automated Forces (JSAF) code primarily used for experimentation. JSAF is now used extensively throughout the DoD for training, testing, and acquisition.

The Enormity of Attributes

Before this J9 applied research project ran, fidelity within the simulation was sacrificed for scalability. For example, a human entity was depicted as walking about within a simulated environment. That particular entity has certain attributes associated to it with some entities needing more attributes than others. An example of such a simulation would include a multi-mission Navy ship that requires a number of different attributes that need to be assigned to it. This simulated ship would have many required attributes including the ship itself; the people located on it; the machinery aboard, such as radar or munitions systems, and the need to carry a large quantity of fuel. Naval aircraft carriers include airplanes on deck that would need an entire support structure to accurately represent such an enormous entity.

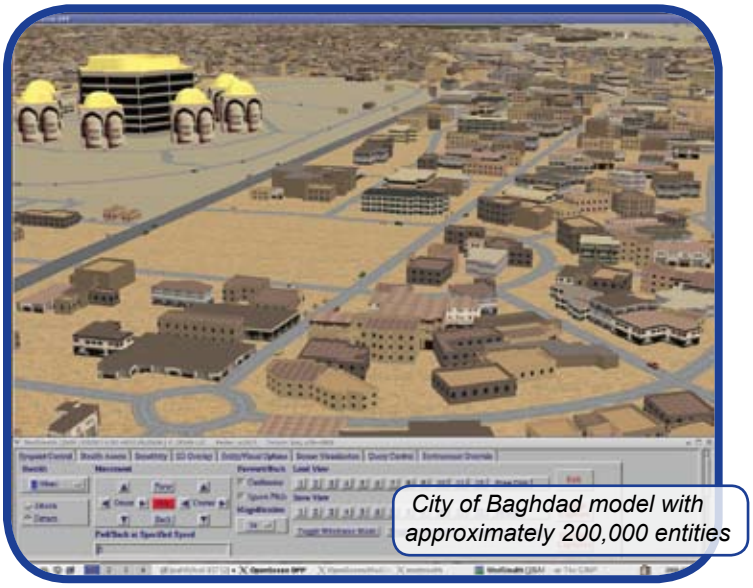
The J9 system projected noise, or variations, into the project. Culture Simulation is a capability that provides a population moving about in an urban environment. This includes people, buses, trucks, motorcycles, and any other vehicle that might be seen in an urban center. Each entity has its own set of objectives, such as going from point "A" to point "B" when they show up in the simulation. These are known as semi-smart entities that possess different capabilities, such as a UAV, soldiers, insurgents, and the Iraqi people.

Modeling the City of Baghdad

The essential premise of the J9 experiment included 8 to 10 experimental objectives that ranged anywhere from the evaluation of a C-4I system already in use to what the impacts of a population are during a conflict.

Human entity depicted as walking within a simulated environment

"Modeling a city can be even more complex," Mr. Blank said. "When a city environment is modeled, there can easily be more than a million entities needed to accurately model a city environment at high levels, which can cause a processing capabilities issue. What we have been able to do with the supercomputer there at Wright-Patt was demonstrate that fidelity and scalability are no longer a problem for us in that particular environment."



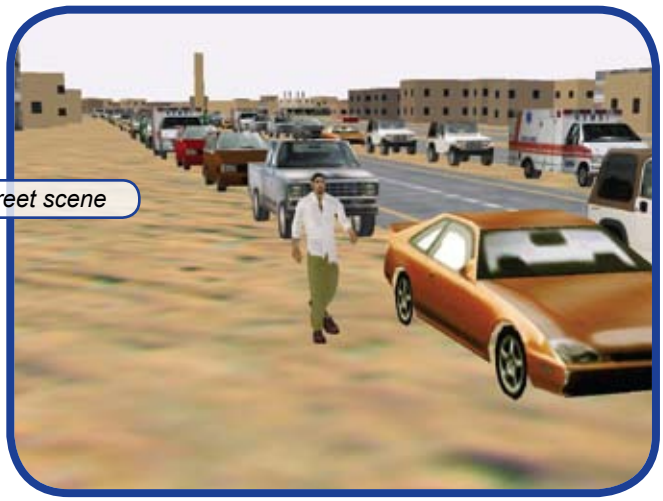
City of Baghdad model with approximately 200,000 entities

The Wright-Patt J9 project was able to run approximately two million entities at a high level of fidelity during the experiment. The work that took place at Wright-Patt has led directly to an increase in capability within the Modeling and Simulation (M&S) community, as well as the Experimentation community at J9.

During the actual J9 experiment, the city of Baghdad was modeled and included approximately 200,000 entities and a 99.9 percent availability rate on the M&S and Command, Control, Communications, Computers, and Intelligence (C-4I) architectures. To ensure there were no hardware or software issues during the actual experiment, a test was used for up to 2 million entities to stress the system.

"We weren't looking within the simulation or experiment at the entire city of Baghdad at any given time," Mr. Blank said. "We were looking at particular sections of the city where the experiment was focused. We didn't need to get to the 2 million entity level, but that will change as time goes by."

Snapshots of a street scene



Beneficial Outcomes

"The J9 experiment at Wright-Patt has driven a lot of further research being conducted by J9," Mr. Blank commented, "and has led to some operational support that we've provided as well. The beauty of that experiment, from a technical perspective, is that it led us to develop a real-world capability of supporting our forces in conflicts. One of the results of this experiment was the real-world capability that was applied, and it is currently being used on the global war on terror today."

J9 benefited greatly from their DoD High Performance Computing Modernization Program Dedicated HPC Project Investment (DHPI) award. Using their DHPI, J9 met their computational needs with a 256 Linux Network cluster which was hosted and supported at Wright-Patt. Mr. Blank said, "If it wasn't for the interconnect associated with the Wright-Patt system, we never could have achieved this capability."

Snapshot of a populated city

"The J9 experiment involved approximately 1,000 staff," Mr. Blank remarked, "and it would have been impossible to achieve the caliber of success through any other means than the use of a dedicated supercomputer. It would simply have been impossible to accomplish through telecoms or whiteboard discussions."

J9 Looks to the Future

"It might be useful in the future to access those capabilities based upon the human interface, the tactics, the techniques, and the procedures that are developed to use a particular tool," Mr. Blank said. "We are going to integrate our operations here more and more tightly with the capability that we now have in the HPC supercomputer, not only within the experimentation environment, but with the M&S environment, as well. This integration will include everything from the communications piece to the visualization piece and even to the C-4I and collaborative information services, as time goes on. Based on what we've learned using the Wright-Patt hosted supercomputer, we are going to more and more tightly couple our operations and our environments to that supercomputer. That's our objective and our goal." ■

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