Red Force Modeling in JFCOM Experiment Urban Resolve

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ABSTRACT

The nature of urban warfare and the challenges of creating a reasonable and effective Red force for the urban environment are considerably different and divergent from the traditional and legacy approach in JSAF. This paper will address modeling an adaptive and challenging RED urban defense in support of the Joint Urban Operations Human-in-the-Loop (HITL) Experiment "Urban Resolve". The presentation will include a discussion of the challenges associated with aligning the Red force order of battle and simulation behavior requirements within the three phases of the experiment, developing the most cost effective approach to building the simulation code, and implementing a strategy for executing a war plan by a simulation cell. In the past, JSAF efforts have focused on fighting Cold War-type scenarios with fast-moving formations of armored vehicles rapidly crossing open terrain while engaging a similarly organized, equipped and trained opponent over several kilometers distance. Although recent events have shown the continued utility of such thinking, larger more densely populated urban areas may preclude such an approach to modern warfare, resulting in drastically reduced operational tempos and focusing on smaller areas of interest. This is especially true when facing a prepared and technologically advanced Red force. Recent events have also demonstrated effective low-tech alternatives for U.S. adversaries to apply in the confrontation of forces with superior technologies. The challenge for JSAF in Urban Resolve is carrying these ideas into the simulation environment, as well as applying them to an appropriate Red force.

ABOUT THE AUTHORS

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INTRODUCTION TO RED FORCES IN URBAN RESOLVE

Simulation of operations in an urban environment presents unique challenges in Joint Semi-Automated Forces (JSAF), a system that has traditionally been used for simulation of mechanized forces in open terrain. Additionally, operations involving dismounted infantry have traditionally been very limited in JSAF. The focus of Urban Resolve is on future operations in an urban environment, and the concept of operations for the Red Forces rely largely upon the use of dismounted forces in an urban battlespace. Therefore, much work was done to JSAF to effectively model a Red Force in an urban setting.

The Red Team's mission in the Urban Resolve experiment is to support a thorough exploration of the future urban warfare concept by modeling an adaptive and challenging Red Force urban defense with the potential to eventually stress the joint Blue Force beyond the point of failure. The Red Force Modeling and Simulation (M&S) Team is responsible for executing this task of modeling the Red Force for Urban Resolve. Additionally, the role of the Red M&S Team is to use the Red Team concept of operations to create the "signature" within the JSAF simulation system for the actions, Techniques, Tactics, and Procedures (TTPs) that the Red Forces perform in the urban defense. It is not practical for a simulation to exactly model real life, but it is important that the result portrays the appropriate signature to the Blue Forces and sensors. A major challenge to the Red M&S Team is supporting a long-term, 3-phase experiment while maintaining a common signature to sensors throughout. In some regards this forces the M&S Team to compromise on behaviors in the early phases of the experiment in the anticipation that those behaviors will be fully functional in future phases. Initially, much of the effort of the Red M&S Team has been focused on improving route planning and movement in the dense urban environment.

Experiment Overview

Urban Resolve is a distributed, concept based, HITL experiment to explore three key capabilities in future (circa 2018) concepts for joint urban operations:

- The capability to achieve a high level of situational awareness.
- The capability to shape the urban battle space through precision strikes against targets in urban areas.
- The capability to engage by maneuvering joint forces in the urban environment.

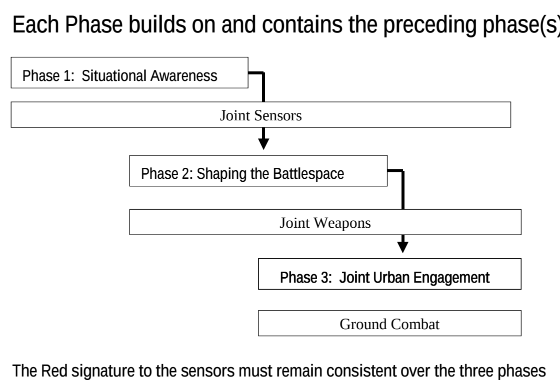

Figure 1. Interaction of the 3 phases of Urban Resolve experiment and the importance of Red maintaining a consistent signature throughout.

The Urban Resolve experiment consists of three phases. Each phase will build upon the preceding phase(s) and will consist of workshops and wargames, constructive simulation runs and HITL trials. Phase 1 of Urban Resolve is focused on developing situational understanding against an adaptive Red force within the joint urban battlespace. A Joint Task Force-level Fusion Cell will use previously developed Intelligence Preparation of the Battlefield (IPB) and a combination of high, medium and low altitude airborne sensors, unattended ground sensors and human intelligence (HUMINT) to develop a fused picture of the Red force. Phase 2 will explore the capability to shape the urban battlespace through precision strikes against targets in urban areas. Finally, Phase 3 will examine the capability to engage by maneuvering joint forces in the urban environment.

Red Forces Overview

Red Team forces have three different capability levels and will become progressively more capable through each phase of the Urban Resolve experiment by using asymmetric countermeasures and weapons that attempt to mitigate Blue advantages. The "Baseline" Red Force for use in Phase 1 has equipment and weapons systems as of 2003, and limited signature reduction and anti-sensor technologies. Comparatively, the Red Force will approximate the asymmetric level of Iraq circa 2003. The "Enhanced" Red Force will be upgraded with multi-spectral camouflage, reflectors, decoys, radio frequency jamming plus improved ISR, anti-armor, and anti-air capabilities. They will model the fighting skill of Chechnya but with enhanced technology circa 2009. Finally, the "Enhanced Plus" Red Force will be further upgraded with improved multi-spectral camouflage, reflectors, decoys, radio frequency jamming, radar jamming, small and large electro-magnetic pulse warheads, information warfare, and active and passive vehicle protection systems. This "Enhanced Plus" force will represent the asymmetric level of China circa 2015. In all three phases Red will portray forces drawn from a Light "Urban Guards" Brigade, Mechanized Brigade, Air Defense Forces, Ballistic Missile Battalion, Irregular Forces, Special Purpose Forces, and political and military Leadership.

During Urban Resolve, the Red Forces plan to impede Blue ability to approach the urban battlespace, via air, sea or land, by keeping Blue forces, sensors, command and control and logistics at risk. Red Forces will minimize movement of their units and equipment, and infiltrate when movement is necessary. Vehicles will hide in warehouses, garages, and factories whenever available, or under tree canopies or next to buildings while concealed under camouflage nets. They will fight a distributed and elastic defense of urban zones and create a layered strongpoint defense, with heavier forces defending critical nodes. Red Forces will follow a creed of win by not losing – "If we are still fighting we are winning". The Red Leadership has developed Tactics, Techniques and Procedures (TTPs) that support these concepts.

JSAF M&S RED TEAM EFFORTS

Due to the complexity and density of the Urban Resolve environment, overcoming issues with route planning and movement presented the greatest challenges to the Red M&S Team.

The operational area for Urban Resolve is a large Third-World city, in this case Jakarta, Indonesia. The Jakarta Terrain Database has 1.8 million buildings, approximately 65,000 of which are Multi-Elevation Structure (MES) buildings. The MES buildings may be entered, and entities inside the buildings will be sheltered from line of sight. Within this large terrain database, a smaller sub-area was selected to support Urban Resolve activities, this area, referred to as the Western Area of Interest (AOI), is approximately 10km by 14km and contains about 47000 MES buildings. Terrain intensification has included adding digitized tree canopies, individual trees, jersey barriers, dumpsters, trashcans and parked cars. Each of these terrain features affects line of sight. This terrain is more complex than any previously used in a JSAF experiment and as such provided challenges for route planning, movement, and behaviors.

Figure 2. A portion of the Western AOI showing MES buildings on the right side of the river and non-MES buildings on the left side.

Route Planning

Prior to the start of JSAF development for Urban Resolve, it was already known that JSAF's long-range route planner was not coping well with urban environments of even moderate complexity, e.g. the Houston terrain database. This was clearly going to be a major for the Urban Resolve events, which would involve the Jakarta terrain of far greater complexity.

DISAF ("Dismounted Infantry SAF") had created a very interesting short-range route planner based on an A* search algorithm, and work was begun in JSAF to expand this to handle long-distance planning. The route planner was modified to handle a much larger area. Unlike the original JSAF planner, which was designed to create plans in a single tick, the A* planner was able to spread its planning over multiple ticks. This required modifications to behavioral tasks – both to utilize the new route-planning routines, and to add new states to the tasks' Finite State Machines to enter a "holding pattern" when route planning required multiple ticks to complete.

Urban Movement

Traditionally, JSAF vehicles have used an assortment of tick-based models for their movement. High-level models set and update goals for the unit and its individual vehicles. Low-level models keep track of obstacles in the area and perform short-range changes to the vehicle's movement to avoid these obstacles, maintain station-keeping with other vehicles, and so forth to try and achieve the high-level goals. Changes to direction and speed are sent to the vehicle's dynamics model, which computes the results and updates the vehicle's position, direction, etc. This approach had been used successfully in many exercises over the years, but has proven problematic in an environment as complex as Urban Resolve.

Keeping track of all the obstacles in a terrain with large numbers of closely packed buildings and scores of other civilian "clutter" vehicles driving in close proximity, and then updating movement plans to avoid all these obstacles proved excessively CPU-intensive.

The large numbers of clutter vehicles introduced another problem. The JSAF obstacle-avoidance code attempts to avoid collisions with other vehicles. Clutter traffic, on the other hand, uses a cooperative planning system that avoids movement conflicts with other clutter vehicles, but takes no notice of non-clutter vehicles. The combination resulted in undesirable situations where heavy combat vehicles using the traditional JSAF movement models would spend much of their time dodging out of the way of small civilian clutter vehicles.

To accommodate the large numbers of entities in the exercise, the tick interval was increased to 500 milliseconds. This means that vehicles could only perform route analysis, course corrections, and dynamics updates at *most* twice per second. Often, due to the CPU-intensive processing, machines did not have sufficient power to update all their vehicles even that often, and it could be many seconds between movement updates. This in turn would result in vehicles failing to slow down in time to turn corners, or taking so long between updates that they would fail to negotiate a turn and instead collide with nearby buildings.

Station keeping between vehicles within the same unit was similarly affected by these factors. Lead vehicles would be constantly adjusting their speed and direction to avoid buildings and clutter traffic, forcing the following vehicle to make adjustments to maintain position while *also* trying to avoid buildings and clutter, and so on and so forth through the remaining vehicles in the unit. Often the demands of station-keeping and obstacle avoidance would require conflicting solutions (needing to speed up to maintain position, but also needing to slow down to negotiate a turn).

Clutter-Based Vehicle Movement

Although these are issues that can eventually be solved, there was a pressing need to come up with some form of basic urban movement that would work during the early stages of the exercises. To accommodate this, a new movement model was created which allowed a JSAF vehicle to temporarily use the clutter application's planning and movement code. This approach allowed JSAF vehicles to seamlessly integrate with the clutter traffic by utilizing the same route deconfliction routines.

This is not a long-term solution. Clutter-based movement completely ignores buildings, so is insufficient for movement between or within structures. But it allows JSAF Red Force vehicles to move from place to place along roadways, and making use of the same logic for all road-based vehicular movement allows the Red Force vehicles to more effectively blend in with the civilian clutter traffic.

The clutter-based movement code does not support station keeping between members of the same unit. Vehicles may enter the traffic flow in close proximity, but as they travel along the roads they become increasingly spread out – the clutter movement code implements intersection logic (stop signs, traffic lights, etc), and clutter vehicles will often end up mixed in with military vehicles. For long routes, elements of a unit may be spread out over several kilometers. In some ways this is beneficial, as the intervening civilian vehicles mask sensor signatures that could identify a group of military vehicles moving in tight formations.

Difficulties With Clutter-Based Movement

However, having a unit spread out over a long distance also led to complications. The Red Force was using a series of pre-created primary travel routes to organize their movement. Various routes would cross one another, and by selecting a sequence of primary routes an operator would ideally be able to quickly set up tasks for moving forces around the city.

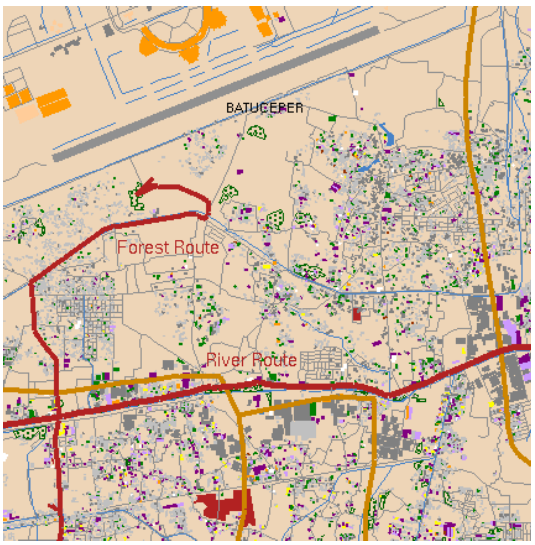

Figure 3. Primary routes, one along the river for moving troops from eastern to western areas, and another for moving forces north into a forest overlooking the airport.

Initial attempts were based around using a series of movement tasks, with one task assigned to each leg of the route, and the transition between tasks/legs activated when one of the vehicles in the unit crossed a control line where the routes intersected. This looked reasonable "on paper", but proved problematic in the actual exercises. The first vehicle to reach an intersection would trigger the task transition, causing all the vehicles in the unit to start moving towards the next goal. With the vehicles spread out over long distances, the remaining vehicles in the unit would not be in sensible positions to begin the next phase of the unit, and the trailing vehicles would start cutting cross-country in an attempt to get on-route for the next leg of the trip.

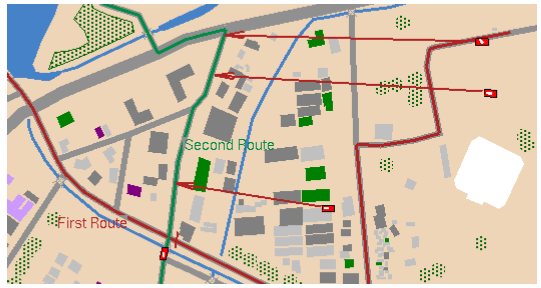

Figure 4. Trailing vehicles moving cross-country after unit transitions from task moving along First Route (red) to task moving along Second Route (green).

One way of working around this would have been to draw a unique route for every movement task that encompassed the entire path, and have a single movement task for the entire route, rather than a series of movement tasks for each leg. But this approach would vastly increase the amount of work needed to create a scenario, and involved a large amount of redundancy, since most of the travel would be along these primary routes.

Automatic Routes For Point Goals

To lighten the operator workload, two new options were added to the clutter-based movement task. In cases where the exact path was irrelevant, the operator could simply specify the goal point, and the clutter route planning

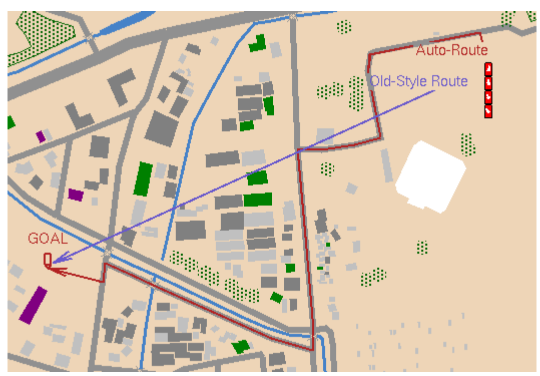

Figure 5. Point goals: Old-style direct route versus new auto-generated road route.

logic would be utilized to find an appropriate sequence of roads to reach the point. (Prior to the addition of this option, if a goal was specified without a path, the clutter movement code would make a beeline direct to the goal, regardless of any intervening obstacles.)

Multi-Route Plans

The other option, known as a "multi-route", allowed the operator to select a series of pre-drawn, intersecting routes (the primary travel routes), which would be automatically synthesized by the software into a single contiguous route which could be executed in a single movement task. This allowed the operators to use these organized, predefined paths, but eliminated the problems encountered with using separate tasks for each leg of the trip.

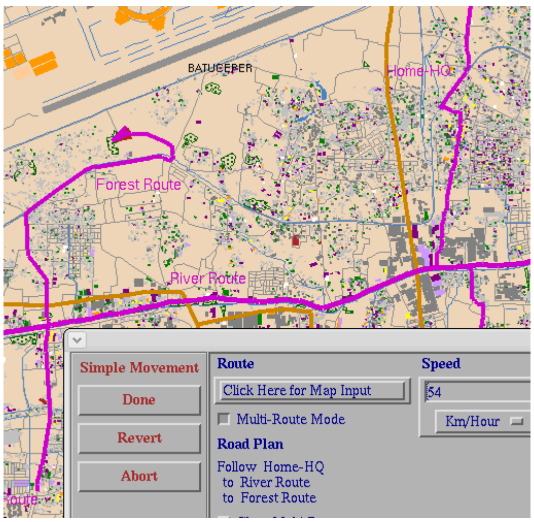

Figure 6. Example of a multi-route plan created from a series of primary routes.

Urban Formations

Maneuver space in an urban environment is very restricted. Legacy formations and behaviors in JSAF were modeled to accommodate open terrain with abundant maneuver space. The Urban Resolve density of buildings caused issues when units utilized the traditional combat formations, such as a wedge or staggered column (see Figure 3). Formations needed to be tighter with less spacing between vehicles, and units cannot indiscriminately disperse off of the road without hitting buildings. "Urban" formations were created to limit dispersion by tightening the interval between vehicles and removing logic that dispersed vehicles off of roads ("herringbone") when halted.

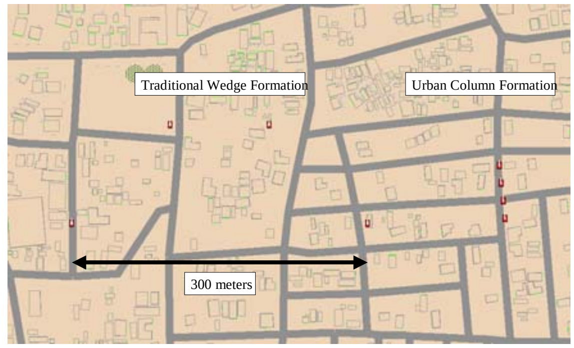

Figure 7. Red Tank platoons in the traditional wedge formation and the Urban Column formation.

Dismounted Forces

The primary Red Urban Forces, and the main plans to defend the urban area, are based on a Light "Urban Guards" Brigade. This brigade is primarily comprised of "Strike" companies based on a Chechen insurgent model, augmented with heavy crew-served weapons, "technicals" (vehicles armed with heavy weapons), light transport trucks, short range air defense forces and artillery support consisting of mortars and howitzers. Additional Red dismounted forces include the Irregular fighters (civilians armed with rifles and RPGs), military and political Leadership and Special Purpose Forces.

JSAF's dismounted infantry (DI) behaviors had received little attention in recent years, and the existing behaviors were relatively rudimentary. Movement within MES buildings was not supported, and behaviors for common urban operations tasks such as clearing rooms did not exist. Clearly there was a need for improving and expanding JSAF's DI behaviors to support the JUO HITL experiments.

JSAF Enhancements From DISAF

DISAF had developed a number of behavioral and support libraries specifically targeted at urban environments (Science Applications International Corporation, 2002, Conceptual Model, chap. 7; Software Design Description, chap. 4-5). DISAF and JSAF evolved from a common ancestral baseline, and while the two projects have understandably diverged over time, the codebases are still similar enough that software can be merged back and forth between the projects. Rather than reinventing the proverbial wheel, the Red M&S Team obtained a copy of DISAF 9.4 and began merging portions of their DI-related behaviors, support libraries, and units into the JSAF codebase. Although most libraries required some rewriting to merge into JSAF (due to differences in architecture and program requirements), this was still significantly less effort than developing similar behaviors from scratch.

As a result of the DISAF merge, JSAF picked up a number of valuable features that would be useful for urban operations.

New DI dynamics models were introduced. Direction of movement and orientation of the DI were decoupled, providing more flexible options such as walking backwards and sidestepping. MES support was vastly improved; allowing DIs to move inside buildings, climb stairs, etc. Posture support was expanded to include kneeling and crouching, and options were added for climbing and descending structures.

More detailed weapon states were introduced, allowing DIs to stow, deploy, raise, and lower their weapons. This in turn allowed for DIs to more realistically model primary and secondary weapons, as well as concealed weapons.

DISAF's visual representation of DIs was also far more advanced than the traditional JSAF "stick figure" pictures. This was incorporated into JSAF, and provided the same top-down perspective as other JSAF vehicles, with separate depictions encompassing posture, weapon state, and injury.

DISAF's excellent hand grenade dynamics model was also merged into JSAF. In addition to basic modeling of the ballistic phase of the fly out, this code modeled rebounding off of walls and bouncing/rolling along the floor.

The traditional JSAF route planner avoided all buildings, treating them as obstacles. A new route planner was merged in which could handle MES structures. This allowed units to plan movement into buildings. Since the new planner understood doors and stairs, it could plot paths between rooms, and would utilize stairs if the goal was on a different floor. Such planning is of obvious importance for simulations in an urban environment.

New tasks were acquired that utilized this new MES-capable planner to perform building-related activities. These included a set of behaviors for performing room clearing. One version of this provided full control over the room clearing process, allowing the operator to specify initial positions, exact entry path, and final positions for the force. Another version was more automated, requiring the operator to simply select the target room. Although room clearing is not utilized in JUO Phase 1, tasks like this will become increasingly important in later phases.

A new unit type, the "crowd" was introduced, for simulating groups of people. A corresponding "Crowd Behavior" task allowed these groups to perform simple tasks, such as randomly wandering around, or moving towards or away from combatants. Although intended for civilian units, the wandering variation was also used with Red Force DI units in JUO, allowing these units to blend in more effectively with nearby civilians and making it more difficult for sensors to identify Red combatants.

Another set of DISAF tasks that were merged into JSAF for JUO supported mounting and dismounting vehicles. JSAF already had some limited support for this, but the tasks were targeted more towards mounted infantry combat units. The DISAF version was more generalized, supporting both combat and civilian units, and both ground and air transport vehicles. The DISAF dismount tasks also had some incomplete (as of version 9.4) but intriguing options related to aerial insertions, including rappelling and parachuting. These have not been explored or expanded on in JSAF yet, since they are not needed for JUO Phase 1, but will likely be revisited during subsequent phases.

A hostage-taking behavior was brought in from DISAF, allowing an armed person to take another person hostage, maneuvering to make use of the hostage as a "human shield", and to shoot the hostage should opposing forces engage in certain threatening counter-actions. Although this is not being used in JUO Phase 1, it may be useful in later phases.

Additionally, an "Autonomous Defense" task was merged into JSAF. This is a nice, general-purpose defensive task, which has a combatant constantly scan their environment for approaching threats, and can automatically engage, seek cover, and pursue attackers. This is not currently used in Phase 1 exercises, but should prove useful in later phases, either on its own or as a building-block for more advanced tasks such as establishing perimeter guards, patrols, etc.

DISAF provided an interesting entity type, the "Armed Civilian". The armed civilian would change from neutral to hostile if it drew its weapon, and revert back to neutral if it subsequently stowed (concealed) its weapon.

Red Infantry TTPs

The Red Team's primary infantry TTP is for these Strike companies to create multiple fighting locations throughout the city and prepare each battlefield with fortified buildings, barriers, mines, and booby traps. The augmented Strike companies are mobile and fight autonomously, and this makes the city a web of fortified nodes from which the Strike companies can ambush and attrite Blue forces, and then relocate to other fortified positions before Blue can respond effectively. The vehicles and personnel infiltrate with civilian traffic in small groups of platoon or below to avoid detection by Blue sensors while moving. Nine different civilian and military leaders were developed, each having a different level of authority within the Red order of battle. The leaders travel throughout the AOI with bodyguards in convoys, each providing a unique footprint for possible detection. Leaders replicate a command and control (C2) function with routines that vary between conducting routine meetings to the extreme of visiting theater ballistic missile units to authorize launches or use of WMD. Irregular forces use civilian clothing and vehicles, infiltrate civilian traffic and converge on a location to set up ambushes. Special Purpose Forces represent Martyr suicide bombers, truck and car bombs, and scout/snipers whose TTPs are not represented during phase 1 of the experiment.

JSAF behaviors were expanded or created to facilitate the Red dismounted TTPs. Phase 1 prioritization concentrated on the signature provided to the blue sensors. Efforts emphasized basic behaviors, leaving ground combat issues for later development.

The initial DI group movement tasks simply maintained the relative positions of the individuals in the unit. This proved insufficient for JUO – members of a unit might become spread out moving through the city, or have ended up randomly organized after running the Crowd Behavior task, etc. To allow a unit to regroup in an organized fashion, the Group Move and Withdraw tasks were extended to optionally allow the group to end up in a particular formation at the end of the movement.

New tasks were added to allow operator control over the posture and weapon state of both individuals and units.

The random wandering version of the Crowd Behavior task was extended to allow the operator to restrict the people to a particular area. This avoided problems where the random goal selection would effectively disperse the people throughout the city over time. Another option allowed the operator to keep the people outdoors to maintain a dense sensor target environment.

The "Armed Civilian" concept was expanded for JUO Phase 1 to create irregular combat forces with a variety of weapons.

Significant effort was put into making the new A* route-planning code faster, and to reduce its CPU and memory requirements. These may not have been issues for DISAF, which used much smaller terrains and relatively low numbers of entities. For JUO, with its large, complex terrain and thousands of entities, the effects of even small inefficiencies in the route-planning code tended to be magnified.

Replicating the Fortification Process

Additional effort was required to provide the opportunity for the Blue sensors to detect areas and buildings that are being fortified. Modification (fortification) of a building could be apparent to certain sensors based on visual external changes. Changing the attributes of buildings during runtime is accomplished through the use of the JSAF Building Attribute Editor in conjunction with the Dynamic Terrain Simulator / Scribe (DTSim/Scribe) federate. Through the building editor, modification requests are sent to the DTSim/Scribe to serialize and arbitrate changes to the selected buildings. The DTSim/Scribe updates the appropriate categories within the CTDB Feature Attribute Table (FAT) and publishes these changes to all federates to update their runtime representation of the environment. The different building attributes that are capable of being changed include Construction, Roof Type, Occupied, and Modified. Construction and Roof Type attributes refer to the material composition of the building's walls and roof, for example cinder block or wood. Occupied attributes can be changed to indicate what type of personnel or vehicles are occupying a building; e.g. civilian, military, or mixed. Finally, Modified attributes refer to whether physical changes have been made to the building to indicate that a building has being modified or fortified.

External fortifications are accomplished by emplacing JSAF entity structures that represent jersey barriers, concertina wire, and minefields. To create the signature of emplacing these external fortifications, teams of dismounted infantry conduct crowd behaviors in the area where the fortification structure will be placed. After the team conducts crowd behavior for a suitable amount of time, designated by the operator, the operator will create and place the structure. Appropriate sensors are able to detect these building attribute changes and fortification structures.

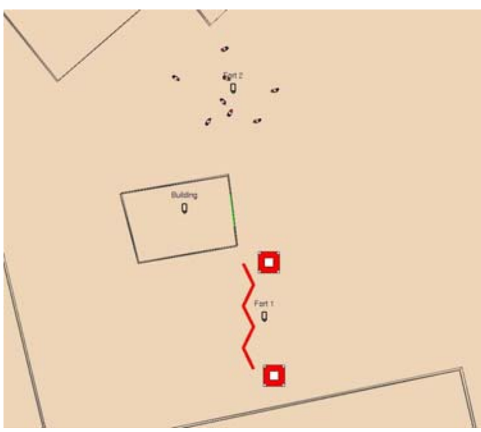

Figure 8. Red infantry conduct crowd behavior (top), barbed wire and minefield fortification structures (bottom).

Other Red Forces and TTPs

Red Air Defense Forces TTPs are based on Serbian Air Defense tactics circa late 1990s for moving, radiating, and firing. Red air defense forces want to keep Blue sensors and aircraft at risk, not necessarily kill them, obliging Blue Forces to plan around Red defenses. Survivability of air defense assets is important to keep Blue from achieving air superiority. Air defense systems will briefly turn on radar (up to 30 sec) and then quickly move into prepared hide sites that offer protection. Occasionally systems will engage blue aircraft or blindly fire a missile, and then relocate quickly to a new hide site. Forces move individually, and maintain a loose C2 structure.

Air Defense Forces utilized legacy JSAF assets, supplemented with new command and support vehicles. The Red Air Defense TTP required a task that would combine movement, vehicle emplacement, radar emissions and the possible application of camouflage. The ADA Operations task was created and allows the operator to task missile launchers and radars to move, radiate, move to a new location, and then, if necessary, apply camouflage.

Red Mechanized and Theater Ballistic Missile (TBMs) forces followed more traditional TTPs. Mechanized forces are utilized to protect high value assets. TBMs provide a long-range threat to include weapons of mass destruction (WMD) capability. Legacy tasks and behaviors were available and modified/utilized such as moving, hiding, firing, and reloading.

Command entities for all forces are modeled to provide a C2 signature and an interface between the Leadership and the combat forces. The C2 signature required the addition of radio transmissions to provide an ESM signature. A new JSAF tool, the Radio Transmit editor, provides the operator the means to select a command vehicle and cause or schedule a future radio transmission to occur. The command vehicle will then emit "radio noise" for the desired duration. The transmission is detectable by the appropriate blue sensors.

Red Simulation Cell

Establishing a functional Red Operations Cell provided additional, but less technical, challenges. The Red leadership's concept of red cell operations called for:

- The physical separation of the Red team's leadership and the Red subordinate unit commanders.
- Simulation operators provided by the military services. The simulation operators control the Red subordinate units, acting as subordinate commanders executing orders and commander's intent.
- The Red forces do not possess the capability for a shared common operational picture.

To support this concept, the Red M&S Team had to establish the physical layout of the simulation cell, establish simulation procedures for the execution of the Red TTPs, developing and implementing a strategy for training Red simulation operators on JSAF and execution of the TTPs, and oversee the daily operations and management of the simulation. The Red leadership did not intend the M&S team to assist in the operational execution of the plan, just ensure operators were following proven simulation procedures.

The experiment design identified time for player training. The M&S Team created standard TTP training documents and trained the Red simulation operators first on the JSAF simulation, and then on the Red Team concept of operations, and the associated modeling and behaviors required to create the correct signature to the Blue sensors. Conflict existed in that the Red operators were required to train Blue but both were expected to train at the same time. The Red simulation operators possessed varying levels of expertise, both in simulations and ground tactics. Training required a crash course, attempting to create simulation "experts" in minimal time, while attempting to portray accurate signatures of Red TTPs, supporting all training requirements.

The physical separation of the Red leadership from the subordinate commanders and the lack of a shared common operational picture introduced several issues. The operational picture was to be developed by reports from the subordinate units. A means of communication was required that would not only allow the vertical and horizontal communications within Red but also allow the Urban Resolve White Cell and analysts to monitor. A working low cost solution was to establish a local chat client using Xchat. The chat client was setup with channels that replicate the different communication means available to the simulated units. The simulation operators can model radio traffic in JSAF using the Radio Transmit editor, and then send real-life messages to the appropriate Red leader via Xchat. This method of communications allows the white cell to eavesdrop and provide intelligence as necessary to the Blue Team. These communications are also saved in the form of text file. The chat text files are also available for later analysis.

The physical separation also introduced a management issue on how to control the simulation operators in the simulated execution of the Red TTPs. This appeared to be a function of operator expertise in the simulation and actual TTP and the problem reduced over time. The Red leadership and M&S Team found they were spending more time initially interfacing and coaching the operators than intended to fill the voids.

Conclusion

Portraying a viable Red Force in a large urban environment poses many challenges. The transition from the "rolling countryside" to the "dense urban" terrain has been non-trivial, and continues to be an ongoing effort. In order to effectively model the Red Force for Urban Resolve many changes had to be made in the legacy JSAF simulation, Red TTPs had to be modeled in the simulation to create appropriate behaviors, and a Red Simulation Cell had to be established. The Red concept of operations relies largely upon the use of dismounted forces in a complex urban battlespace. Therefore much work was done to JSAF to effectively model route planning, urban movement and other behaviors to cover all the emerging TTPs. A "cost effective" approach was chosen based on the adaptation of existing code from other simulations. But even when code is merged from another project, a significant amount of work may be required to modify the results to meet the experiment's requirements. The overriding concern through all the changes and improvements to support Phase 1 of Urban Resolve has been maintaining a consistent Red force signature to the sensors that will be utilized in all three phases.

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