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Team 3: Communication Aspects In Urban Operations

Doll, T.

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TEAM 3 MEMBERS

T. Doll, MAJ. - Lead, Contact*
IT-Office of the German Armed Forces, Germany

B. Schneider
EADS, Germany

P. Hügelmeyer,
T. Zöller, Dr.
Fraunhofer IAIS, Germany

RESEARCH QUESTION

How do communication aspects affect operations in urban terrain?

OBJECTIVE

The main idea behind network centricity in military operations is to translate information superiority into combat effectiveness via creation and dissemination of a valid and relevant common operational picture. In order to achieve this goal, a number of preconditions have to be fulfilled. First and foremost, reliable communication lines have to be established both in gathering information about the current situation as well as in communicating a suitably aggregated CROP from the headquarter to the commander in the field. Therefore, the objective of our work is to investigate the impact of reconnaissance and communication quality on the outcome of a given military operation. Due to the nature of contemporary conflicts, we are especially interested in operations in urban terrain, which pose special challenges to reconnaissance as well as communication.

Apart from investigating the functional questions outlined above, we also seek to gain additional insights, both from modeling as well as from the contact to the international simulation and data farming community, to improve and advance the modeling and simulation toolkit ITSimBw, which is being developed at Fraunhofer IAIS under contract for the IT-Office of the German Armed Forces.

SCENARIO DESCRIPTION

The chosen scenario is based upon the battle of MOGADISHU on October 3, 1993. United States Army Rangers and the Army's Delta Force went on a mission to capture two warlords. Although the mission was successful, five American army UH-60 Black Hawk helicopters were shot down during the battle, two of them in the city area. In order to rescue survivors and to recover the dead, about 100 United States Army Rangers and Delta Force soldiers were pinned down in the city. In the Battle of Mogadishu, 18 soldiers were killed and several dozen were injured. Estimates put the number of Somali casualties at 500-1000 militia and civilians dead and 3000-4000 injured.

Figure 1: Scenario Overview.

Due to the current mission of the German armed forces in Afghanistan, the scenario plot is transferred to the city of MAZAR-E-SHARIF. In the derived

* For more information contact: MAJ Thomas Doll, ThomasDoll@bundeswehr.org.

vignette, the main focus lies upon safe return of a group of vehicles which had been involved in a raid on the stronghold of a militia leader to the blue base camp. This small convoy has to find a suitable route through the city. Dislocated red forces are spread throughout large parts of the town.

Moreover, civil informants aid red in spotting the blue vehicles. Thus, the blue HQ faces the challenge to deliver reliable reconnaissance of red forces to the commander of the vehicle group in a timely manner. To this end, it can use airborne reconnaissance means like helicopters or UAVs as well as lightly armored motorized ground patrols. Vital for the success of the mission are robust communication capabilities both in gathering observations as well as communicating locations of red forces to the leader of the vehicle column. An overview on the scenario situation is provided in Figure 1.

THE ITSIMBW III SIMULATION ENVIRONMENT

We used ITSimBw as the modeling and simulation environment for our investigations. In reaction to the challenges of network centric operations, the simulation system ITSimBw has been designed from the outset with a strong focus on the faithful representation of communication and IT aspects in contemporary warfare scenarios. Nevertheless, it is a general agent based simulation environment that can be effectively used in a large variety of different application domains including analysis and planning, CD&E, procurement management, education and training, and decision support.

The development of ITSimBw started in 2004 as a study carried out by Fraunhofer IAIS for the IT-Office of the German Armed Forces. The initial version was based on an agent simulation kernel that has been developed earlier. Before forming the basis of ITSimBw, it has been used in a variety of applications including traffic monitoring and forecast. Due to the lessons learned in the initial phase of the ITSimBw development and in order to incorporate cutting edge ideas from software design, a complete re-design and subsequent rewrite of the system has been carried out. At IDFW 14, this new simulation environment has seen its first real live usage.

ITSimBw's software architecture is now based on a service oriented paradigm which enables core functionalities, e.g. routing or line of sight computations, to be used as individual services. Furthermore, the whole system is now written in the JAVA programming language, which makes it easy to port to different computing platforms. Moreover, the excellent JAVA library support for remote object access and method invocation greatly facilitated the development of the new agent execution environment which can be spread among CPUs in a cluster, thus enabling distributed processing of simulations.

Another important feature of the new version of ITSimBw is the incorporation of LAMPS, the graphical description language for scenarios and agent behaviors which replaces the former rule language interpreter for the programming of agent behaviors. Thus the actions performed by agents in the simulation can now be specified via a graphic programming language that is based on high-level Petri nets.

An additional important driving factor for the system redesign is the improvement of usability. To this end, a number of steps have been taken in the new version. Among those is the development of a variety of new editors for scenarios, agents, and agent behaviors as well as the consequential incorporation of drag and drop facilities, to name only a view.

AGENT MODELING

In order to investigate the given scenario, a number of agents had to be modeled. In the following section, we will briefly describe them together with their major behaviors.

Environment

ITSimBw greatly emphasizes consequential agent based thinking in modeling. Therefore, not only the acting entities in a given scenario, but also the environment, are modeled as agents. In our example, the environment agent contains in its states the background – a city map of MAZAR-E-SHARIF, as well as a roadmap for all major roads in the form of an entity relation graph. In this representation, nodes that are placed at junctions or bends are linked by straight edges which form road-parts. All agents in the scenario that are able to move on their own accord can use that roadmap in order to make their routing decisions when traveling to their designated goals.

Figure 2: A Close-Up of the Background and the Roadmap.

Headquarter

As has already been stated in the scenario description, generation and dissemination of a valid and current CROP is a key factor for mission success. We have therefore modeled a headquarter agent that receives the sight information of all blue agents – the motor convoy, the patrols, and the reconnaissance helicopters and merges them into a list of spotted red agents. This list is then returned to all blue agents as the current CROP. Moreover, the headquarter can send command messages to the blue agents over voice radio connections. We thus have two main lines of communication, data streams and voice radio. They are modeled as depicted in Figure 3:

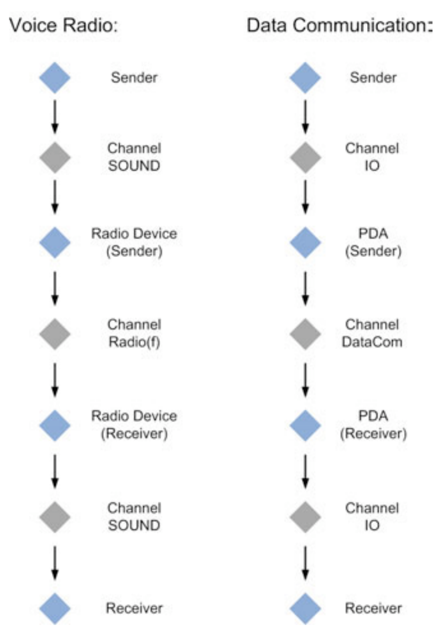

Figure 3: Communication Modeling.

As one can see from this diagram, we have individual agents modeling the communication devices such as PDAs for data, and voice radios. Moreover, the communication channels themselves are modeled as agents. In order to represent the communication acts as faithfully as possible, we even included the channels *Sound* and *IO* in our modeling. For later investigations, disturbances and malfunctions can be modeled individually for each communication device and channel.

Motor Convoy

One of the most important agents in the simulated scenario is the line of vehicles that starts out at the militia leader's stronghold moving towards the save base camp at the airport. For sake of simplicity, we have modeled this convoy in aggregated manner, i.e. the complete line of vehicles is represented by a single agent. It senses its environment via the behavior *view*, which uses a voxel-space representation of the environment together with all other agents to compute the visibility information. Moreover, it contributes to the CROP generation by sending its individual view to the headquarter over the data channel outlined above. In return, it receives the merged CROP information from the headquarter, also via data stream. In order to fulfill its goal, it has to find a save route towards the base-camp, avoiding red-forces – in particular the road-blocks – at all costs. Therefore, its standard route finding algorithm has been augmented in such a way that it avoids edges in the road-graph, on which known red unit are positioned. Furthermore, it has the ability to engage red units, when contact cannot be avoided.

Reconnaissance Helicopters

In order to provide airborne reconnaissance, two helicopters are included in our scenario. The respective agents view their environment and send the corresponding information to the headquarter via data link. They move on designated patrol routes that cover specific areas of the city.

Ground Patrols

Apart from the helicopters, blue's reconnaissance also has a ground component, given by two patrols which are comprised of two lightly armored infantry vehicles each. Each patrol is – like the convoy- modeled as an aggregated agent. The patrols follow designated routes through the city. They contribute to the CROP in the same way as the airborne reconnaissance assets. Moreover, they have the ability to engage enemy units, when being attacked.

Militia

Small groups of dismounted red militia forces are dispersed throughout the city. Each group is modeled as an aggregated agent representing the respective group. Additionally to the standard behaviors for routing and moving on the road-net, they have the capability to engage blue with light hand weapons. In case that one of them spots the convoy, it sends a message that affects the setting of a dynamic roadblock. Moreover, they have the capacity to "hear" the sound form other engagements and to move in that direction.

Civilian Informants

In addition to the militia forces, we have also modeled civilians that are sympathetic with the red side. Like the militia, they can send messages that lead to the placement of dynamic road-blocks. Moreover, they also follow the direction of combat noise in order to investigate the situation. They are, however, unarmed, and they are not attacked by blue forces.

Road-Blocks

We have two kinds of road-blocks in our scenario. The first one is static in the sense that instances of this kind are positioned right from the outset of the simulation. The second kind is dynamic, i.e. instances of this class are positioned during the course of the simulation, reacting on where red forces or civil informants spot the blue vehicle line. The road-blocks in our scenario had high fire power corresponding to multiple machine guns. Furthermore they were impossible to destroy by blue vehicles.

INVESTIGATIONS

During IDFW 14, we have defined positions and patrol routes for the reconnaissance helicopters and ground patrols. Initial positions for the fixed roadblocks as well as promising locations for their mobile counterparts were identified by trial simulations.

At the workshop, we used the latest version of ITSimBw, which, at that time, was still in a rather early phase of development. As a consequence, our modeling work did not proceed as fast as anticipated beforehand. Time constraints prevented the set-up of data-farming runs to investigate the role of communication quality. Instead, only the two extreme points of the spectrum, perfect communication quality and no communication at all could be examined in simulation runs. In the first case, the optimal result with respect to our MOE – number of vehicles that safely return to the base camp – was achieved. In the latter case, however, a complete loss of the vehicle column occurred as it was unable to avoid the line of fixed roadblocks.

CONCLUSIONS

Despite the fact that we were unable to conduct the data farming experiments in the breadth that was originally intended, a lot of interesting insights in our scenario have been gained. Moreover, we gathered a variety of suggestions for the further improvement of our simulation tool ITSimBw, especially with respect to additional advances in usability.