INTRODUCTION

The German Federal Office of Defense Technology and Procurement (BWB) is interested in analyzing the influence of networked sensors and effectors on military capabilities in network centric operations.

On behalf of the BWB, about one year ago representatives of EADS started developing a new agent-based model that addresses the BWB-specific requirements.

The agent-based sensor effector model (ASBEM) concentrates on modeling complex technical aspects in NCO and to do so, it integrates detailed physical theories when it comes to simulating the output of various sensors and when determining the effect of different weapon systems.

ASBEM has continuously been enhanced since IDFW17 so that ASBEM version 0.2 could be released at IDFW18.

Using a camp protection scenario, the team's objective was to investigate the effect of different electro-optical sensor systems (human view, infrared, residual light amplifier) in combination with the use of direct fire weapons in network centric operations.

Objectives

In Data Farming experiments the team's main intention is to examine the performance of some given sensor and effector systems under varying conditions (e.g. different weather-dependent atmospheric conditions, time of day, varying number of hostile units,…). To evaluate the implemented sensor- and effector systems various MoEs will be recorded, e.g. the time needed for detection / classification / identification as well as the attrition rates for both blue and red forces.

Overall, the team had the following goals:

- Review and face validate ASBEM version 0.2
- Conduct experiments with different designs analyzing the effect of parameters such as different seasons, different weather conditions, distinction between day and night, deployment of different sensor and weapon systems
- Identify needs for further work.

Scenario

The IDFW18 scenario dealt with the threat posed by adversary invaders. The military camp is guarded by several watch towers occupied with soldiers equipped with electro-optical sensors and small arms. An UAV is deployed for airborne reconnaissance. The sentry reports any detected, classified or identified unit to the command centre, which, in turn, decides how to proceed. In addition, the camp is protected by armored motorized ground patrols.

Figure 1: Camp protection scenario
In case any opponents were classified or identified by the UAV, a heavily protected and armored convoy will be sent out to patrol the area. If no enemies were detected, only a slightly protected convoy will be sent out.

The attackers, in turn, hide in a forest right next to the convoy’s patrol route.

In two different scenario vignettes we distinguish whether the attackers do have a scout reporting in advance when the UAV or convoy approximates the attacker or whether they don’t. If it’s the case, the attackers may better hide and therefore detection becomes much more difficult.

Depending on the scenario setup (and the user-defined agent behavior), the blue forces will fight the detected red entities as soon as they were classified or wait for an identification.

TEAM ACTIVITIES
What we are interested in, is if the attackers may be detected early enough and defeated so that any blue losses can be avoided.

Though, firstly, we wanted to compare the performance of different available infrared systems regarding the overall mission success and secondly, we were looking at the significance of NCO-aspects. Do the red forces profit from their scout? How does the reconnaissance UAV affect the MoE?

Data Farming Experiments
We were executing a series of data farming experiments, looking at the following parameters:
- deploying the UAV for airborne reconnaissance: yes / no
- UAV speed [30m/s; 60m/s]
- existence of scout: yes / no
- time of the day: noon / midnight
- season: summer / winter

- weather: foggy / clear
- type of sensor system used by attackers: binoculars
- type of sensor system used by blue forces: binoculars / middle wave infrared device 1 and 2 / long wave infrared device

As MoEs we were mainly looking at the damage state of the blue and red forces and the detection / classification / identification times and distances.

All of our experiments were successfully executed on the 32node German cluster owned by BWB.

Data Farming Results
In a first analysis we distinguished between day and night and summer and winter times.

There were hardly any differences between summer and winter, but, as expected, at night it is advisable to use infrared devices. The long wave and uncooled infrared device 3 performs best (see figure 3).

Figure 3: Comparing the detection times of different sensors

In a second analysis, we distinguished between foggy weather and clear sky and the existence of a scout or not. Since the use of infrared devices is not affected by fog, the following figure 4 only shows the detection distances when binoculars are used.

We could observe that the existence of the attackers’ scout actually leads to higher blue losses (see figure 5). The reason for that is that due to the existence of the scout, the attackers can better hide within the forest. Therefore it’s much harder to detect them. And if the UAV couldn’t perceive them, the...
lightly armored convoy is sent out and of course stronger damaged.

Use of infrared devices seems to be rather counterproductive in the daytime. At night, however, again infrared device 3 performs best.

**Figure 4:** Comparing the binoculars performance for foggy weather and clear sky.

Finally, we compared the deployed sensor systems with regard to the overall mission success (avoiding any blue losses). Use of infrared devices seems to be rather counterproductive in the daytime. At night, however, again infrared device 3 performs best.

**Figure 5:** Attackers profit from scout

**Figure 6:** The sensors’ performance regarding the overall mission success

**SUMMARY AND WAY AHEAD**

Overall we are happy, the model itself works very well. We succeeded in setting up an interesting scenario during the week. Analyses of the conducted data farming experiments showed that the results are consistent with our expectations and understanding of the real world scenario.

We succeeded in verifying the modeling approach we chose for physically modeling electro-optical sensors and direct fire weapons. With the implemented optical sensors, the terrain features and atmospheric conditions are adequately considered.

Despite the more advanced features ABSEM version 0.2 contains by now, the model performance is still more than sufficient for ABSEM being used within the data farming process.

In future activities we first of all want to extend and complete the effector modeling taking into account indirect fire. Furthermore we plan to integrate radar systems.