

DOCUMENTATION OF INFANTRY COMPANY ENGAGEMENT MODEL WITH COMMAND AND CONTROL MODEL

OVERVIEW

Purpose

Infantry Company Engagement Model with C2 (ICEMC2) is a simulation model that implements an offensive operation of the infantry company. The purpose of this model is to analyze the combat effectiveness of the infantry company engagement, thus it includes commanding agents which are the company commander and platoon leaders. The commanding process is sub-divided into several tasks so that critical tasks in commanding can be analyzed.

State Variables and Scales

Table 1 shows the model parameters and scales

Table 1. Parameters for experiment environment, modeling features, and performance measure

Type	Name	Description
Scenario parameters	Number of blue soldiers	Number of blue soldiers (90 for company infantry)
	Number of red soldiers	Number of red soldiers (48 for an augmented red platoon)
	Cell size	Size of one cell (10 meters x 10 meters)
	Size for area of operation	Size of area a company deploys (2 km x 3 km; 200 x 300 cells)
Model parameters	Movement speed	Moving speed of a blue soldier (4 km/h)
	Probability of kill given hit (P(K H))	Probability that an enemy is killed given hit (0.15 for covered position / 0.35 for open area)
	Probability of kill for mortars	Probability that an enemy is killed within casualty radius (0.13 / round within 10 meters for 60 mm mortars)
	Mountainous level	Information of level for mountainousness that affect the movement delay coefficient and P(K H) (Low: 1, open; Medium: 1.33, covered, High: 2, covered)
	Commanding times	Delay time to report and make decisions. Specified by decision-making steps and commanding agents; a company commander and platoon leaders. (varied in the experiment design)
	Probability of hit (P(H))	Probability of hit (varied in the experiment design)
	Breaching time	Delay time to breach obstacles and secure a passage (varied in the experiment design)
Performance measure	Loss Exchange Ratio(LER)	Loss exchange ratio of the blue soldiers to the red soldiers(number of red soldiers killed / number of blue soldiers killed)

Process Overview and Scheduling

Figure 1 shows overall structure of this model. DEVS (Discrete Event Systems Specification) is used to model this engagement model. EF starts the simulation and collects data to produce the performance measure. CompEngagement consists of the blue and red forces that engage each other.

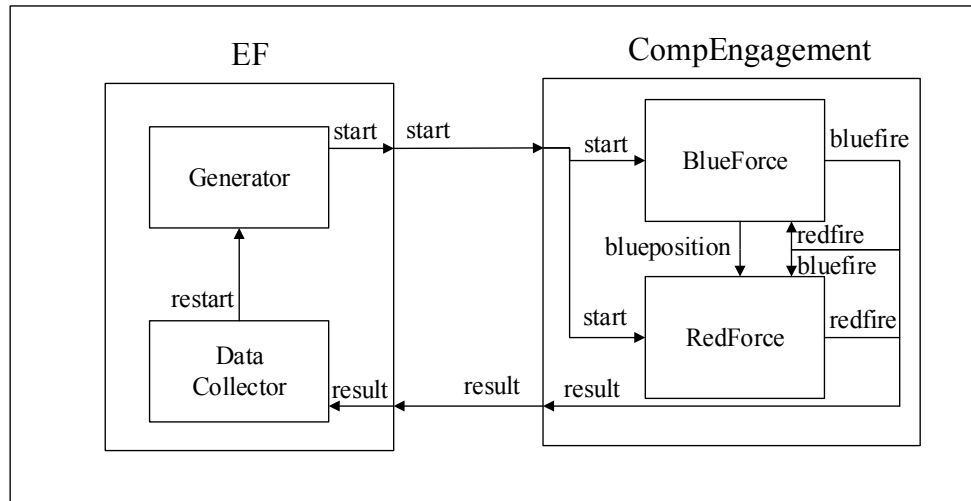


Figure 1. DEVS coupled model of the ICEMC2

DESIGN CONCEPTS

Emergence

Through the ICEMC2, emergent phenomena from the soldiers' engagement controlled by commanding agents can be found. The C2 process and soldiers' training level are highly related, and relationships among several C2 tasks are also emergent.

Adaptation

The ICEMC2 does not model adaptation. Extensions of the model can include adaptation in terms of the decision-making of the commander.

Objectives

Commanding agents of the ICEMC2 are oriented to find the way to secure the key position with minimum casualties.

Prediction

Commanding agents of the ICEMC2 does not directly predict future outcomes. They make decisions according to the Army doctrine.

Interaction

Soldier agents and commanding agents of the blue force directly interact each other by reporting and ordering. They also interact with the environmental factor which is the mountainous level when soldier agents move and fire and commanding agents find routes, designate positions. Soldier agents of the red force also interact with blue soldier agents and the environmental factor.

Sensing

Soldier agents of the blue and red force sense each other and locate positions of enemy.

Stochasticity

The ICEMC2 uses various stochastic values. Probability of hit for soldier agents and the mortar is one of stochastic values. Time related combat factors such as breaching time and commanding times by various tasks are all stochastic values.

Observation

The ICEMC2 provides visualization of the model implementation for the face validation of the model. The model output number of the blue and red soldiers that allows to calculate the loss exchange ratio (number of blue soldiers remained / number of red soldiers remained) which is the performance measure of the simulation.

DETAILS

Initialization

The ICEMC2 is initialized by deploying soldier agents according to the initial phase of the offensive operation described in the Army doctrine. The combat power of the soldier agents is 100% when the model is initialized.

Input

For the purpose of the virtual experiments, we can input combat factors. Table 2 shows those combat factors.

Table 2. Inputs of the ICEMC2

Experiment variable name	Value unit	Implications
Decision-making time for Company commander (DTCO)	seconds	Average delay time to decision-making for company commander (Poisson distribution with mean of the values)
Decision-making time for platoon leader (DTPL)	seconds	Average delay time to decision-making for platoon leader (Poisson distribution with mean of the values)
Fire request time (FRT)	seconds	Average delay time to request mortar fire (Poisson distribution with mean of the values)
Order time for company commander (OTCO)	seconds	Average delay time for company commander to issue orders to platoon leaders (Poisson distribution with mean of the values)
Order/report time for platoon leader (ORTPL)	seconds	Average delay time for platoon leaders to issue orders and report situation (Poisson distribution with mean of the values)
Probability of hit (PH)	%	3 levels of blue soldiers' marksmanship
Breaching time (BT)	seconds	Average delay time to breach obstacles (Poisson distribution with mean of the values)

Submodels

Figure 2 shows hierarchical model structure. DEM and BM are modeling methodologies that are used to model the element. DEM and BM stand for Discrete Event Model (DEM) and Behavior Model (BM), respectively.

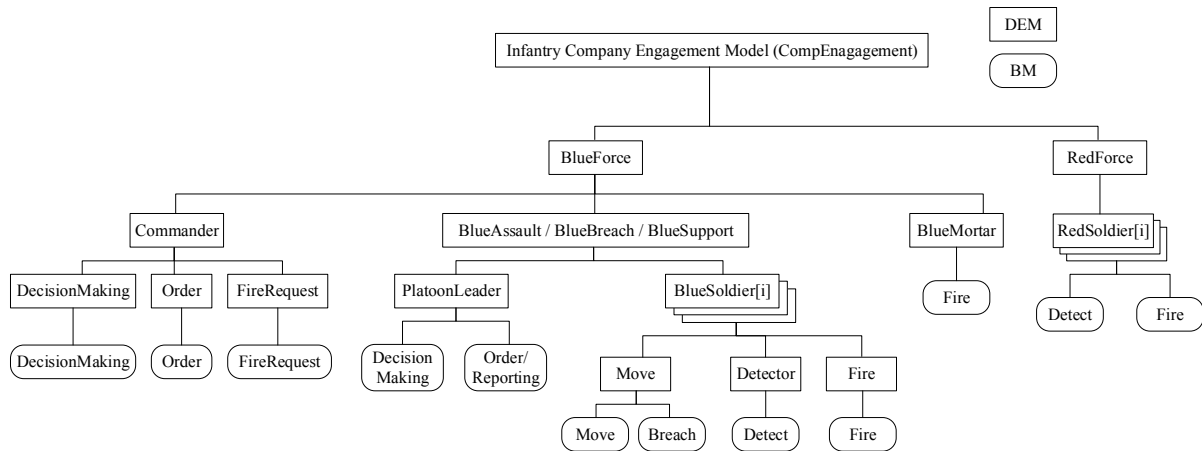


Figure 1. Hierarchical model structure