CONNECTION OF
LIVE SIMULATION
AND VIRTUAL SIMULATION

(Jochen Reimer and Eckart Walter)

ABSTRACT

The connection established in the context of an experimental program in the year 1993 for the German Combat Maneuver Training Center (GÜZ) can be regarded as one first approach to the connection of live simulation and virtual simulation. The task of GÜZ was to "strain" the battalion headquarters with the information from a whole battalion in a realistic way even though only one company actually operates in real terrain.

The connection presented here, is an example for a possible solution to the tactical problem which arises when simulated units are able to locate and engage real vehicles in a duel situation but the latter are unable to "fight back" as they cannot see virtual targets in real terrain.

The visibility problem can be solved by superimposing the virtual target directly onto the optical path of the commander's optical devices, provided that there is a theoretical visual contact with the target and the target is within the field of vision.

The connection of live simulation, a Leopard 1A4, and virtual simulation, a PC with simplified Leopard 2 data, is realized by the standardized PDU for DIS interface. To this end the Entity State PDU, the Fire PDU, the Detonation PDU and a Visibility PDU are used.

To illustrate the solution a demonstrator was set up which will be described with regard to its technology and its operational capabilities.

About the authors

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1971-1977 Software Engineer at Nixdorf Computer, working on special machine control software.
Since 1977 Scientist at IABG, responsible for simulation application in R&D and military training devices.

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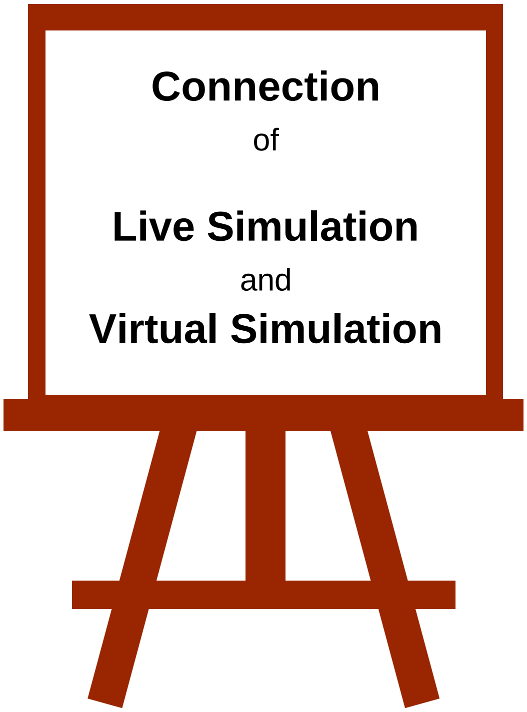
1990-1994 responsible for development and procurement of training simulators for army Air Defense.
Since 1994 responsible for development of GE Combat Training Center (CTC GÜZ).

1. INTRODUCTION



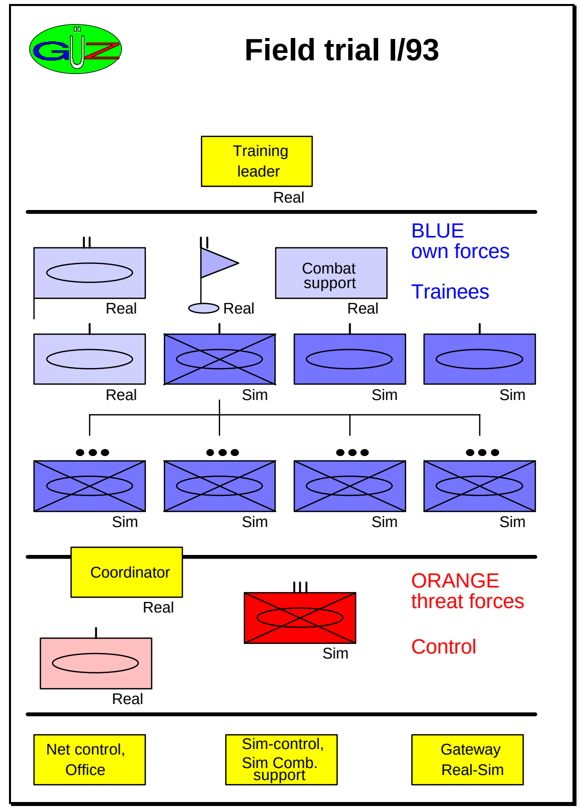
The connection of live simulation and virtual simulation is not new:

Already in 1993, a connection was made between the experimental system of the Combat Maneuver Training Center (GÜZ) and an interactive simulation system called INSIM in the context of an experimental program.

The intention of the connection was to confront the battalion headquarters with the realistic amount and type of information of a reinforced battalion, although only one company each for party BLUE and ORANGE was present in real terrain.
The area marked with intensive color in the figure 1 was simulated.

At that time, data for these connections were not yet exchanged via PDUs.

In 1994, the Industrieanlagen Betriebsgesellschaft (IABG) was entrusted with an initial small task by Section FE I 4 of the Federal Office of Defense Technology and Procurement (BWB).



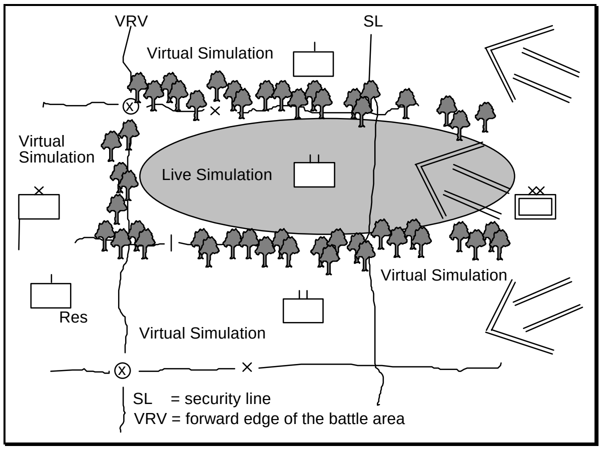
(Figure 1)

The theoretical visibility of virtual targets was established and transmitted to a real vehicle by a modified Entity State PDU, where it was represented in the Commander's optical device in a simple way by overlaying a light switched on.

In 1995, IABG was entrusted with a further task, the result of which will be summarized in this presentation. For this procedure a patent has been applied for.
To improve the system work is continuing this year.

2. THE PROBLEM

The connection effected for the GÜZ field trial made manifest a problem which gave rise to critical comment from the users, i.e. the soldiers, because they had a considerable tactical restriction in the preparation of the scenarios and in the implementation of the trials.
The problem will be illustrated by way of a scenario description (fig. 2):



(Figure 2)

Vehicle crews operating tactically in a virtual simulation have all the information they need for their mission.
This concerns information about other friendly or OPFOR weapon systems, be they simulated or real.

These crews can also open fire against the real opponents located in the field.

In a good simulation they do not even notice a difference in representation between the virtual and the real opponents.

If the crews in the real weapon systems want to fight back and open fire against the virtually simulated opponents, they will search the terrain (e.g. the opposite edge of the forest) for targets in vain.

Hence, the tactical command must ensure that in the development and direction of scenarios only real units operate against real opponents, and only virtually simulated units against virtual opponents.
A "crossover" battle must be avoided.
Thus, the live simulation can be complemented by virtual adjacent units and opponents but mutual visibility must be made impossible by choosing an appropriate terrain section.
Trees, houses or ranges of hills must form a natural boundary between the two simulation types.
A freely developing battle will hardly be possible.

3. THE SOLUTION

The following example presents a possible solution to the above-mentioned problem.
It is a demonstration example, not a fully developed product.
The example shows that, in principle, it is possible and useful to solve the visibility problem between real and computer-simulated weapon systems.

The live simulation is represented by a Leopard 1A4 weapon system, as it was freely available at the beginning of the study.
The virtual simulation is represented by a Leopard 2 weapon system in a commercial PC.
The data connection is realized by way of the standardized interface PDU for DIS.

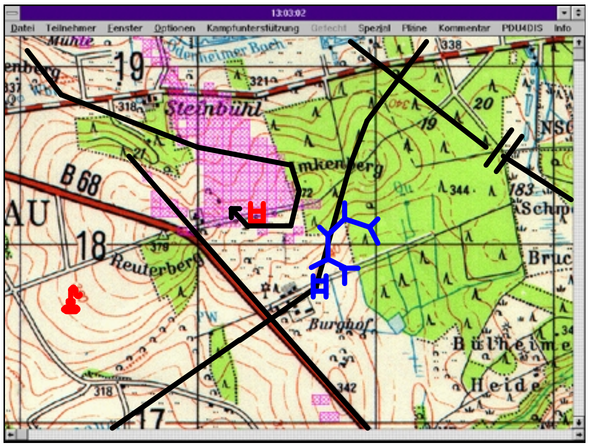
The computer-generated virtual target appears in the form of a symbol superimposed over the real view onto the terrain in the optical device of the commander of the real vehicle.

(Figure 3)

The illustration (fig. 3) shows a virtual target crossing the view in the Peri R12 optics, with an eightfold magnification, at a distance of about 300 to 400 meters.

The representation of the virtual target is influenced by the following parameters:

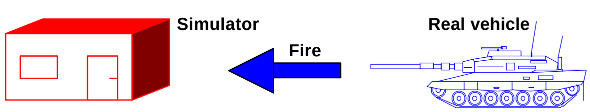
- visual contact with the target
- field of vision of the observer (vision angle 8°, firing angle 1°)
- distance of the target
- aspect angle of the target
- target firing or not
- status of the target (e.g. hit)



(Figure 4)

In a simple way, the virtual simulation represents (fig. 4):

- a digitized (scanned) UTM grid map
- colored tactical symbols in the form of an overlay, e.g. boundaries, control measures, positions, etc.
- the simulated ORANGE vehicle as a tactical symbol
- the real BLUE vehicle as a tactical symbol, if visible
- firing indicated by blinking of the tactical symbol
- a kill indicated by marking of the tactical symbol
- fields of vision.

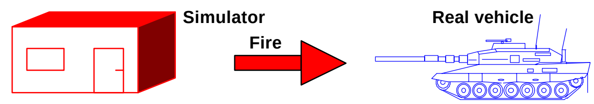


ORANGE PARTY	**BLUE PARTY**
<u>Simulated Vehicle:</u> Tactical symbol with 'X'	<u>Real Vehicle:</u> Pyrotechnique
<u>Real Vehicle:</u> Tactical symbol blinking Line of fire (long, short)	<u>Simulated Vehicle:</u> Turretless symbol

(Figure 5)

The duel situation is represented as follows:When the BLUE real vehicle fires at and kills the ORANGE vehicle, the following happens on the ORANGE side (fig. 5):

To indicate the firing, the blue tactical symbol blinks and a line of fire will be drawn from this symbol to the screen margin. If the round is a hit this line will end at the orange target, the tactical symbol of which is marked with an 'X'.
To indicate the firing on the BLUE side, a simulated ammunition will be ignited, representing the virtual target superimposed onto the optical device as killed.



ORANGE PARTY	**BLUE PARTY**
<u>Simulated Vehicle:</u> Tactical symbol blinking Line of fire (long, short)	<u>Real Vehicle:</u> Rotating lamp, sound
<u>Real Vehicle:</u> Tactical symbol with 'X' blinking	<u>Simulated Vehicle:</u> Symbol briefly

(Figure 6)

If the simulated ORANGE vehicle responds by firing at and killing the BLUE real vehicle, the following happens on the ORANGE side (fig. 6):

To indicate the firing, the orange tactical symbol will be blinking and a line of fire will be drawn from this symbol to the screen margin.
If the round was a hit this line will end at the blue target, the tactical system of which is marked with an 'X'.

To indicate the kill on the BLUE side a rotating lamp will be switched on and a loud continuous sound will be released.
The virtual target superimposed onto the optical device will blink briefly to indicate that it is about to fire.
In mid-December 1995 this approach was demonstrated in operation in Lichtenau / Westphalia.

4. DEMONSTRATOR COMPONENTS

As the demonstrator is to show a principle, it was mainly set up with existing and commercial off the shelf components. Consisting of a collection of components interconnected by a number of interfaces its structure seems somewhat complex.
Moreover, this PC calculates the symbol to be superimposed onto the optical device and displays it on a small screen.
The vehicle position is derived from a GPS in a GÜZ participant set and directly transmitted to the GÜZ headquarters. BDES provides the azimuth of the weapon.

4.4 MEASURING OF POSITION AND ANGLE

In parallel with this operational demonstrator, a geodetic differential global positioning system (DGPS) was modified, and analyzed and assessed as regards its capability to collect the following vehicle data:

- position
- weapon azimuth
- weapon elevation.

The result was surprising:

The system worked so smoothly and accurately that the DGPS, represented in green color in figure 8, was able to replace all orange components during the demonstration thus considerably minimizing the risk of a component failure.

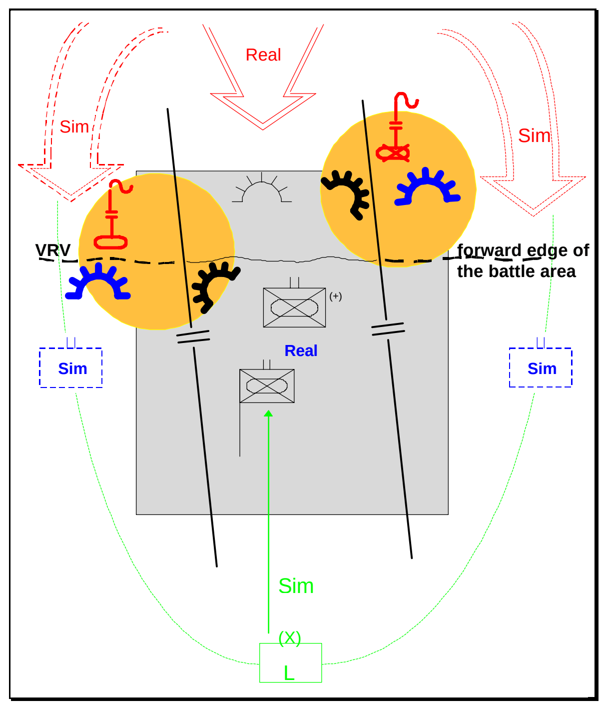
(Figure 8)

The two GPS antennas (fig. 8) were fixed on the gun of the vehicle.
Studies have shown that the antennas could determine the position with an accuracy of about 3 cm. Measurements taken over more than one hour with fixed weapon direction produced standard deviations of 1.5 mil in azimuth and 1.9 mil in elevation.
See IABG-report B-WV 0585/02, request through BWB, section FE I 4 for more information.

5. FUTURE POSSIBILITIES FOR RESEARCH & DEVELOPMENT

5.1 USE FOR R&D

The use of the demonstrator will be in R&D projects. The connection of live simulation and virtual simulation is an important tool for the further development of defense matériel, including tactical elements, which is a typical task of a technical tactical center (TTC terms of reference).



(Figure 9)

5.2 FUTURE POSSIBILITIES FOR TRAINING

Use of a fully developed virtual weapon superimposition system might be envisaged for a future version of the Combat Maneuver Training Center (fig. 9).
The appropriately equipped vehicles should then be located at the boundary between the battalion deployed in real terrain and the simulated adjacent units and their opponents (the area marked yellow).

The fully developed system could also be used for the instrumentation of garrison training areas in order to dynamically represent virtual targets and effects of indirect-fire weapon systems.