LVC Simulation for Training of Ground Commanders

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ABSTRACT

It is getting ever more difficult to get access to proper training ranges where ground commanders are able to train their skills, both because of the scarcity of training ranges and because the training requirements are becoming more and more complex. This makes it more important that they get the most training value for the time spent when out on the training range.

*An excellent supplement to live training on the range is training in a simulator. In this paper we describe a training setup for ground commanders we have created by connecting different simulators with a live BMS system. The integrated solution consisted of; a forward air controller simulator IFACTS and a radio communications simulator IRAS*Comm both provided by IFAD TS; an armoured vehicle simulator Steel Beast Professional from eSim Games; a battle management systems SitaWare BMS from Systematic. The setup was showcased during ITEC 2011, Cologne, Germany in May 2011. The paper also describes the challenges in running a joint scenario and some lessons learned in relation to creating the setup.*

1.0 INTRODUCTION

In today's joint and multi-national operations the ground commanders' mission is highly demanding and complex. They must perform at peak-efficiency in very difficult environments requiring high standards, currency and proficiency. Since effectiveness of their missions depends heavily on how well they can communicate and coordinate their efforts there is a requirement for a command team training capability that allows commanders to conduct collective training and exercises.

Current practices in team training rely either on coordinated scheduling of personnel local to a base or on training at a dedicated facility. However, limited availability of training ranges and assets, and increasing live training costs, are challenges that make it increasingly difficult to maintain high standards. As a result, there is a requirement for a cost effective mixture of simulators and the use of Live, Virtual, and Constructive (LVC) entities operating in common real and synthetic environments. LVC systems eliminate geographical constraints and allow commanders to train in almost any operating area. In addition they enable commanders to be exposed to more training scenarios in a shorter period of time, and at a substantially reduced cost.

In this paper we present an integrated LVC training solution and show how this provides realistic command team training. The solution is composed of several fully interoperable simulators that allow users to execute realistic missions, interacting in common realistic scenarios with distributed human and synthetic players from own and other units.

The integrated solution is described in the context of Close Air Support training (CAS). We describe the development of the solution which includes several armoured vehicle driver and gunner simulators (Steel Beasts Professional), several forward air controller and pilot simulators (IFACTS), computer generated forces (JCATS or Steel Beast Professional), a number of battle field management systems (Sitaware), and simulated multi-channel radio communication (IRAS).

During close air support exercises, Steel Beasts Professional, IFACTS, JCATS (Joint Conflict and Tactical System) and live units all stimulate the Battle Management System (BMS) system with dynamic tactical situations. Exercises include realistic, true-to-life scenarios in operational environments where high and low level, day and night CAS operations, talk-on's and engagements are carried out. Pilots, Forward Air Controller's (FAC) and ground vehicle crew operate in the same high-fidelity geo-specific terrain facing the same enemy threat. Scenarios may be generated and controlled by JCATS or Steel Beast Professional and include several aircraft, UAVs, trucks, pick-up's, people, and civilians. Simulated radio communication integrated into all systems enables pilots, FAC's, armoured vehicle crew and live units to communicate simultaneously over several channels. The exercises, including recorded voice, are played back in a synchronized manner during After Action Review (AAR). The total integrated solution was demonstrated at the ITEC'2011 conference in Cologne, Germany in May 2011.

The paper first describes in general terms some of the challenges there are in creating an LVC setup, then describes each system in greater detail. After that we discuss some of the lessons learned during ITEC 2011 and in the preparation for it. The last section touches on some improvements and additional work that could be done regarding training of ground commanders with the aid of LVC.

1.1 The Training Scenario

The scenario concerns a task force, "Task Force Cologne" (TF), whose mission is to stabilize its area of operations by providing local security to the population of the "Terrastan Valley". The immediate task is to investigate a report of unexploded ordnance at the southern end of LOC MARS (approx. 5100 S of TF HQ). A patrol of EAGLE IV scout vehicles, accompanied by a Tactical Air Control Party (TACP) are to investigate the location and establish contact with the local population.

Also in the area are COP ARMINIUS and two additional patrols of EAGLE IV vehicles, currently 2200 NW and 3000 East of the main village.

A Quick Reaction Force (QRF) is standing by to provide fire support; the QRF consists of one platoon MBT Leopard 2A5, one platoon IFV CV90/35, one armoured recovery vehicle, and one LAV ambulance vehicle. In addition, the TF commander may release a UAV for aerial reconnaissance. For the initial phase of approach towards the UXO site an F-16 bomber jet is loitering until H+40. After that, one Tiger gunship helicopter is on standby for aerial fire support until H+120. Theatre command provides one MRH90 transport helicopter for medical evacuation if needed.

Insurgents by and large resort to ambushes. Their major foothold in the area is a known compound approx. 6000 ESE of TF HQ in the upper part of the "Terrastan River".

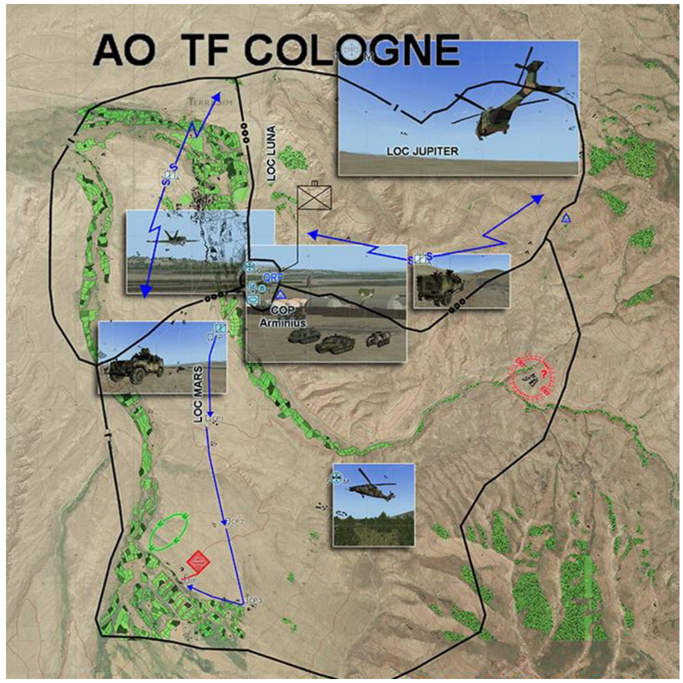

Figure 1 Map of Cologne Scenario

The main actors who are to be trained in this scenario are the ground vehicle crew and the forward air controller (FAC) from the TACP unit.

The "Task Force Cologne" training scenario includes several actors, e.g. tank drivers, gunners, forward air controllers, pilots, and higher level commanders as well as dismounted crew, friendly forces and enemy forces. They use a variety of specific systems to carry out their actions, and they need to coordinate and communicate their efforts, i.e. act in a combined joint effort to achieve mission success. Hence, successful training requires the integration of a number of different simulator systems (tank simulators, FAC/JTAC and pilot simulators, as well as BMS and CGF systems) to support a joint operation. Furthermore, in order to provide a means for communication all simulators must include radio communication. The integrated training solution described in the following sections was designed to meet these requirements.

2.0 CHALLENGES AND SOLUTIONS

There are always challenges when it comes to training soldiers. May it be availability of assets or training ranges or even adverse weather conditions. Some of these can be mitigated in simulation based training: virtual assets can easily be created; virtual ranges can easily be reused; and weather conditions can be controlled to a high degree so that training is optimal. But training in a simulator is never exactly the same as doing live training and it creates some new challenges. In this case we are trying to connect together three different simulation models of the same synthetic environment and a live system. We are therefore not only faced with the limitations in the simulated and the live domain, but also with the problems of connecting these domains. Since the virtual and constructive simulators and the live system are computer based we are left with the challenge of connecting these computers and the systems running on them and then creating a common scenario where the training can take place.

These challenges and some of their solutions are described in more detail in the sections below.

2.1 Network interconnection

Whenever you have a system that is running on more than one computer (host) you have to establish some way of communication between the different hosts. It can be a challenge to choose the right protocol. And in our case it was not just different hosts; it was different systems from different vendors.

The different systems were running a mix of proprietary and open protocols that in the end should all be able to communicate with each other. It was both a matter of matching the protocols and the data models that each system was using.

The primary data that needed to be exchanged was the location and type of the different units in each of the systems. Since each system was using a different data model there was a requirement to create some sort of mapping or translator between each system. This translator had to be able to translate bidirectionally between the different data models and types, and also make sure that the location data was translated correctly.

Additionally there was a requirement for exchanging information about the state of the units (damaged, not damaged, destroyed) and also regarding weapon firing and impact. This also required that weapon types were translated correctly between the systems.

Since much of the training would require students to communicate via radio, we also had to create a solution where systems that required radio communication could connect to each other.

2.1.1 Solution

The solution for the interconnectivity was based upon the DIS protocol. The DIS protocol was chosen for this demonstrator due to its simplicity. A bigger exercise would likely require a connection that handles network traffic more efficiently, and hence scales better (e.g. HLA). Almost all of the systems had either native support for DIS, or had an existing DIS bridge.

The radio communication part was done by integrating a DIS based radio simulation system (IRAS*Comm) into each of the different simulators. By using DIS as the common protocol for both simulation and radio communication it made it easier to provide After Action Review (AAR) since there was a lesser need for synchronising the playback afterwards.

The integration of Steel Beasts Professional in the DIS simulation was done using IFADs Steel Beasts Gateway, (see Figure 2 Overview of the ITEC 2011 setup). The gateway served 3 purposes:

1. DIS-enable Steel Beasts, bidirectionally.
2. Facilitate synchronized AAR playback between Steel Beasts Professional and the DIS simulation.
3. Expose details of all Steel Beasts Professional players' positions in vehicles thereby providing information on what radios are available to each Steel Beasts player. This allowed a tight integration between Steel Beasts and the IRAS radio simulation.

Systematic's SitaWare BMS was DIS enabled using IFADs SitaWare SimGateway. The SimGateway provides a user interface for selecting which entities in the DIS simulation are to be tracked on the SitaWare BMS system.

2.2 Terrain databases

When doing training you need some sort of training range. This is also the case when training is taking place inside a simulator; there needs to be some kind of synthetic world where the training takes place. Depending on the kind of training and the type of simulator it can be quite a big task to create such an environment.

Since we were creating an LVC setup we had to somehow create a mapping between the real (live) and the virtual and constructive worlds; and in such a way that it would feel correct to the end user. The fact that all systems participating were computer based reduced the complexity to some degree.

The virtual simulators all required a 3D world in which the user could move around. Since a great deal of the training require students to communicate and move around in the features in the 3D terrain, it is important that they correlate and look alike. If this is not the case then the students will not be able to train correct procedures and will most likely learn incorrect behaviour that they will have to unlearn when participating in full live mission training. This is most undesirable and the end result could be that simulators would not be used for training.

The live and constructive systems both required digital maps with information about elevation and features. Each system used a different format for the map and 3D terrain so we had to either create or use a tool that could output in formats that all systems could use. The tool also needed to be able to create the output in such a way that the output was correlated and the systems could create a matching visualization of the output.

Since the simulators were a mix of both ground based units and air based units, there was a requirement that the output should be visualized both from the ground commanders' view and from the air (pilot or UAV view).

2.2.1 Solution

TerraTools from TerraSim was selected since it already had support for the formats used in the different simulators. By using geo-specific and geo-typical data a hybrid terrain was created. Elevation and most of the terrain imagery was geo-specific, but most of the features (buildings, trees, roads) were geo-specific to create a view of a mountain terrain in a desert area. In addition, a geo-referenced topographical map image was generated to serve as the map background picture for the battle management systems (SitaWare BMS).

As we used a tool that already has support for Geographic Information System (GIS) data, the step to using all geo-specific maps and terrains is quite simple.

3.0 THE FINAL SETUP

The setup presented at the ITEC 2011 consisted of the following systems; IFACTS from IFAD TS; Steel Beast Professional from eSim Games and SitaWare BMS from Systematic. A third party system, JCATS, was used as an extra Computer Generated Force (CGF). IRAS*Comm from IFAD TS was running as an integrated part of both IFACTS and Steel Beast Professional.

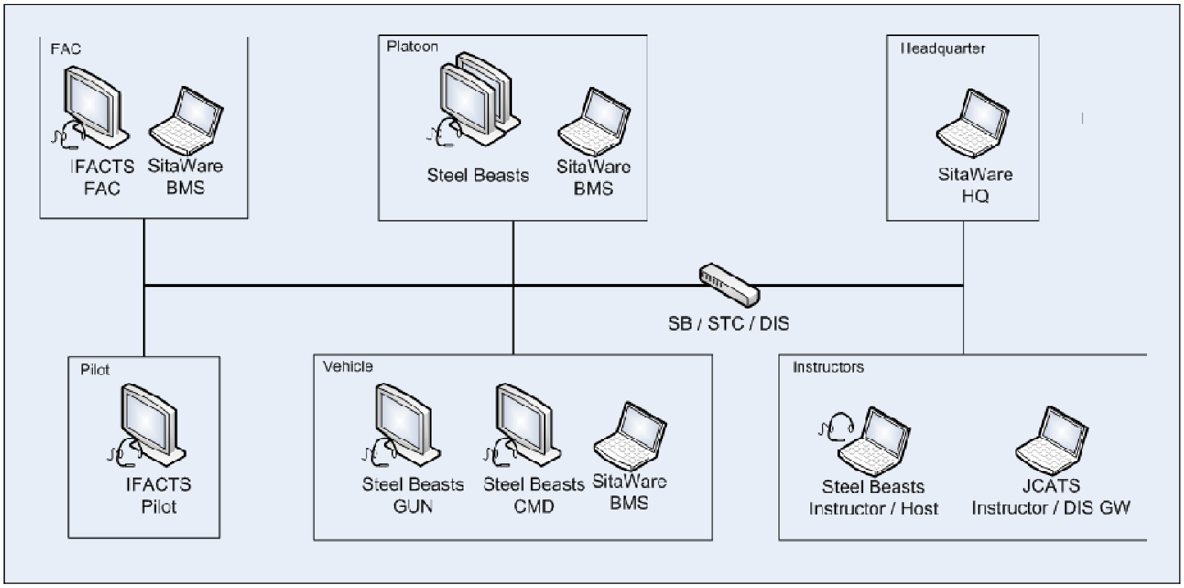

Figure 2 Overview of the ITEC 2011 setup

Figure 2 illustrates how the different systems were connected. Each ground commander had at his disposal a BMS. Pilot and FAC stations (IFACTS) are virtual simulators. Steel Beasts Professional is both a virtual and a constructive simulator that is used to train battle tank crews. By integrating an additional constructive simulator (JCATS) to the setup further assets and units could be added to the training scenarios.

The BMS setup also includes a headquarters part (Sitaware HQ) but this is only shown for illustrative purposes since it was not running in this setup.

The headsets in Figure 2 indicate which hosts were running IRAS*Comm. In our setup COTS (Custom off the Shelf) headsets were used, but these could be replaced by a combination of live radios (that interface through the simulation software) and fully simulated radios. The radio simulation software (IRAS) was running as an integrated part of the simulators on each host.

All network traffic was running on COTS network equipment; and on a single network. In a larger setup it could make sense to split the networks to distribute the network load.

3.1 Detailed system description

In this section we describe the different systems in Figure 2 in more detail, including functionality and how they were configured and used.

3.1.1 IFACTS

IFACTS is a deployable, PC-based system for training and practising the directing of close air support. It provides a synthetic environment within which the FAC can control aircraft missions using simulated communications and simulated equipment. Equipment includes GPS, ground laser target designators, laser range finders, binoculars, NVG, compass, thermal equipment and ROVER. The system can either be used with the IFACTS 'Easy-to-Fly' aircraft controlled by the instructor; or with a real pilot-in-the-loop controlling a flight simulator, e.g. F16/ACT; or in a combination of both.

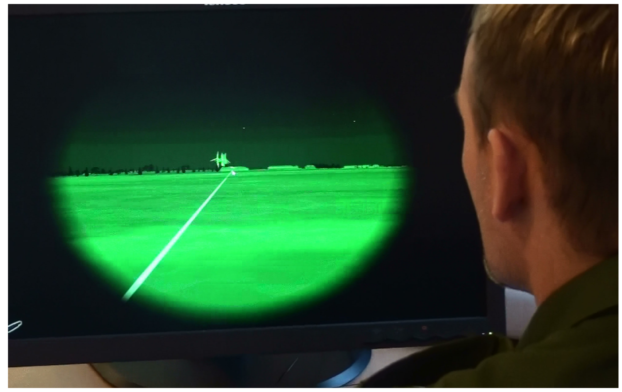

Figure 3 Usage of NVG and IR-Laser in IFACTS

IFACTS (*the IFAD Forward Air Controller Training Solution*) is provided by IFAD TS. The solution is in service at the Danish Army and SOF.

3.1.2 IRAS*Comm

IRAS*Comm is a DIS-based simulated radio communication and intercom system used for realistic voice communication in real-time training simulators. IRAS*Comm is delivered stand-alone, integrated with other systems through DIS/HLA or embedded into existing simulators through the Remote Control API. IRAS*Comm is based on COTS and open standards.

IRAS (*IFAD Radio Simulation*) is provided by IFAD TS. It is in service at several of the Danish Armed Forces' training centres, including the Army's Combat School.

3.1.3 Steel Beast Professional

Steel Beasts is a virtual and constructive simulation of combined arms combat tactics. The simulation follows a vehicle-centric approach and includes virtual crew station of more than 20 armored fighting vehicles, notably the Leopard MBT and CV90 IFV families. It covers the range from the individual crew station to battalion level exercises (and beyond).

Constituent core features are high fidelity ballistic models (of both exterior and terminal ballistics) and also high fidelity vulnerability models to simulate the capabilities and limitations of contemporary direct fire platforms. The software runs on standard Windows gaming PCs and can be interfaced with vehicle and cabin trainer hardware.

Figure 4 T72 from Steel Beast Professional

Steel Beasts Professional is being employed in a dozen armies worldwide in a broad spectrum of training roles – from desktop stations for part task training to vehicle-appended and classic cabin trainers. Flexibility for the customer is attained by computer-controlled forces and crew stations that allow a single human player to effectively direct an entire platoon of combat vehicles – or to have all crew stations operated by human players against a computer-controlled force, or as two forces under human control against each other.

Steel Beast Professional is provided by eSim Games LLC.

3.1.4 SitaWare Battle Management

The Systematic SitaWare Battle Management solution offers comprehensive situational awareness that enables commanders to respond rapidly to emerging critical situations. Through an accurate, updated overview, commanders are continuously supported in making qualified decisions hence increasing operational capabilities.

Specifically designed for intense tactical situations with a touch screen user interface and carefully targeted to ruggedized equipment, making the solution suitable for use in field. The solution offers a target management module with APIs and functionality for laser range finders, inertia navigator, and weapon system status as well as fire-request/fire guidance functionality. Systematic SitaWare Battle Management solution is currently used by a number of nations as their operational Command and Control system of choice. The solution is built for mobile use, and with its SitaWare Headquarters component, it offers MIP, NFFI and other interoperability capabilities out of the box.

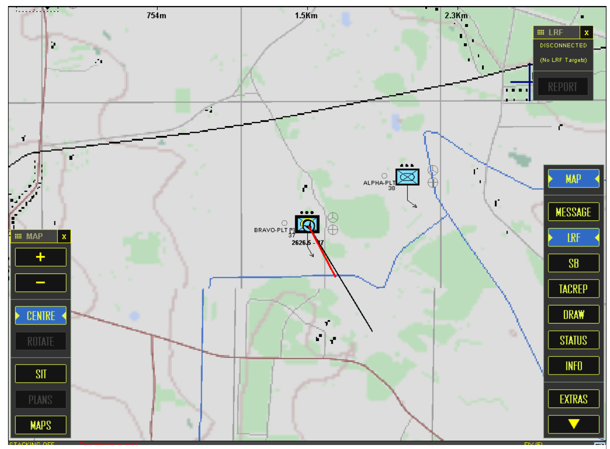

Figure 5 Screnn dump af SitaWare BMS

The latest version of SitaWare Battle Management System – SitaWare Frontline – has just been released, and has improved tactical radio and dismounted capabilities.

3.1.5 JCATS

The Joint Conflict and Tactical Simulation (JCATS) program is an interactive simulation tool sponsored by US Joint Forces Command (USJFCOM) and managed from the command's Joint Warfighting Center (JWFC).The military uses JCATS for training, analysis, and mission planning and rehearsal.

JCATS simulates operations in urban terrain, supports both non-lethal and conventional weapons, and allows users to quickly assemble and disband entities and units. JCATS provides a wide range of operations in a variety of dynamic simulated environments. The simulation models the dynamics of individual soldiers, vehicles, and weapons.

4.0 LESSONS LEARNED AND FUTURE WORK

From the previous sections it should be clear that it is not trivial to create a convincing LVC setup that can be used in practice. In this section we touch some of the lessons learned from the preparation for and during the ITEC 2011 conference. We will also cover some of the areas where it could be interesting to do additional work to create a better LVC experience for the ground commanders.

One of the lessons learned from this demo is that even with the proper tools to support you it is still no trivial task to interconnect different simulators; and the task is more difficult when combining different simulation domains.

For example when creating 3D terrains:

- is it not only necessary to have the same tree type in a forest region, but the trees must also have the same height, width and location in order to maintain fidelity in line-of-sight calculations;
- models of buildings with rooms must provide identical levels of protection against weapon effects;
- there can be no significant deviations in terrain textures, 3D object model artwork, or lighting since such deviations will easily be detected by the users and may lead to exercise friction that would not occur in real life.

All of this makes it even more apparent that the better the tools and pipeline for creating 3D content are at supporting different simulation systems the easier it is to produce solutions with different simulators running in a joint scenario.

Another big issue relates to the 3D content: how to create the right visual quality of the 3D content and making sure that the simulators perform well when using this content. It is a question of balance between performance and fidelity and finding the "sweet spot" between the two. This is not trivial even in a single system, and when trying to interconnect different systems the issue becomes more apparent.

In the "Task Force Cologne" configuration described above the BMS system (which is a live system computer based system) did not interact with the live world; it only interacted with the simulators. This made the integration much easier. As an example there was no need to translate weapon effects from the live world to the synthetic world. In this case it was only a matter of stimulating and feeding the BMS device with location and GPS information.

4.1 Future work

When making a setup like this you always have to somehow try and set a limit for how large and how complex the setup should be. Since the setup was located in an exhibition hall we were limited to what we could put on display.

One interesting setup could be to create a 3D terrain of a live training range and then exchange the simulated battle tanks (or some of them) with live ones and feed their locations into the virtual world. Then the FAC could use the BMS system for blue force tracking; and it could also be used to report targets. Limitations on how detailed the virtual terrain needs to be should be discussed. Since the radio simulation software is able to integrate with live radios all of the radio communication (live as well as simulated) could be running as an integrated part of the simulation. This could then be used as part of the AAR and enable location and movement of vehicles to be replayed.

Another option could be to integrate the "Task Force Cologne" setup in a larger exercise (for example a division level exercise dominated by a constructive simulation). Then "Task Force Cologne" could be used to play a smaller scenario within the much larger scenario ("Hot spot Simulation").

All of the systems described in this setup are in operational use within the Danish Armed Forces. Since ITEC, further work has been done on both the IFAD SimGateway and the Steel Beast DIS bridge. Both solutions are now in operation at different simulation centres in Denmark. Additional work is also planned for adding a DIS bridge to SitaWare HQ.

5.0 CONCLUSSION

In this paper we have presented an integrated LVC training solution as an excellent supplement to live training. We have shown how we were able to combine several COTS simulator solutions into one integrated training solution. We have shown that the integrated solution provides a realistic team training of ground commanders in a realistic current training environment. We have also touched upon some of the challenges in integrating different simulator systems and the challenges in creating and running a joint scenario. The integrated solution was presented at ITEC'2011 in Cologne. During this event many training sessions in the context of Close Air Support (CAS) were conducted by combat-experienced military commanders who jointly performed missions in the "Task Force Cologne" scenario.

All solutions presented in this paper are at service in the Danish Armed Forces. Work is currently being done on interoperability issues leading to future cost-effective LVC solutions that can help overcome problems such as limited access to training ranges and increasing live training costs; and allow commanders to train realistically together in almost any operating area.