# Distributed Virtual Environments for Military Training Applications: Trends and Challenges

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*Abstract*—An introductory tutorial of distributed virtual environments for military training applications is provided. Current trends and research focus in the distributed virtual environment arena are discussed from both the modeling and simulation points of view.

*Index Terms*—distributed virtual environment, distributed simulation, modeling, networking, virtual environment

## I. INTRODUCTION

Historically, military training simulations in Thailand have been developed and deployed in a rather ad-hoc fashion, due primarily to distinct military doctrines and incoherent procurements among the armed forces. Little efforts had been made in linking geographically distributed, normally cross-platform, military simulators for joint-training purposes. Even within the same domain of operations (either air, sea or land), such military training simulations are still being carried out independently, let alone the joint-force operations.

Recently, however, a visionary initiative in the Defense Technology Institute's Master Plan for Virtual Military Simulation and Training 2011-2022 [1] has called for the integration of military training simulation systems - built for separate purposes, with technologies from different eras and vendors, and on various platforms - to allow them to interoperate in a single, highly interactive, virtual world.

Such integration involves developing an interactive, immersive, multi-sensory, computer-generated virtual environment (VE) into which individual trainees, possibly at geographically distributed locations, can be embedded. Such a distributed virtual environment (DVE) provides a basis for developing a wide range of military training applications each of which may comprise several entities such as man-in-the-loop simulators, instrumented vehicles, simulated troops, and passive data viewers for monitoring purposes.

As part of executing the above mentioned master plan and preparing the new comers for this field, our objective in this paper is to provide a gentle introduction to DVEs especially for military training applications. This work only represents an initial step in the development of our functional DVE prototype. We first review important concepts and components of DVEs. Later, we discuss the trends and challenges of DVEs from the modeling and simulation perspectives and point out important research directions.

The remainder of the paper is organized as follows. We first highlight various aspects of DVEs in Section II. General network requirements for DVEs and a quick look at High Level Architecture (HLA) are provided in Sections III and IV, respectively. From the networking perspective, we then discuss the trends and challenges in the development of DVEs for military training in Section V. Section VI concludes the paper.

## II. DISTRIBUTED VIRTUAL ENVIRONMENTS (DVEs)

A Distributed Virtual Environments (DVE) composes of entities that are modeled and simulated on a near real-time basis. The following types of entities may be present in a DVE [2], [3]:

1) *Virtual (or human-in-the-loop) simulators* - A simulator involving real people operating simulated systems. Virtual simulations inject human-in-the-loop in a central role by exercising motor control skills (e.g., flying an airplane), decision making skills (e.g., committing fire control resources to action), or communication skills (e.g., as members of a C4I team).

2) *Constructive simulators* - A simulator that involves simulated people operating in simulated systems. Real people make inputs to such simulations, but are not involved in determining the outcomes, e.g. simulated troops or platoons.

3) *Live elements* - An entity involving real people operating real systems, e.g., instrumented tanks or aircraft.

4) *Passive data viewers* for real-time monitoring or after-action-review purposes.

An example of DVEs is shown in Fig.1 which includes only tank and flight simulators manned by human users, splitting into two sides irrespective of their actual locations in the network. Such integration of tank and flight simulators in Fig.1 provides a good example of how military training at an operational level of war can be conducted by utilizing the distributed simulators meant for a tactical level of war.

### A. The Primary Goal

In general, the primary goal of most DVEs is to achieve a sufficiently realistic representation of the actual world the DVEs attempt to create [4]. How sufficiently realistic is best determined by the perception of individual trainees embedded