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A dynamic management scheme for DVEs

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ABSTRACT

Advances in computer technology and networking infrastructures in combination with advanced applications and services, have expanded the adoption of distributed virtual environments and promoted their use in a wide range of areas, such as learning and training, collaborative work, military applications and multiplayer online games. The characteristics and requirements of such DVEs differ significantly given the diverse objectives, scope and context that each virtual world aims at supporting. However, one common characteristic of DVEs is their dynamic state with users entering and leaving the system randomly, resulting in changes of the requirements for the DVE system. These changes require effective load distribution and management of the communication cost so that consistency is always maintained. This paper presents a dynamic management approach for DVEs driven by the diversity of different applications' characteristics and requirements. This approach exploits the dynamic nature of these systems for selecting and assigning, on an on-demand basis, the resources necessary for the efficient operation of the system. The experiments conducted to validate the behavior of the approach illustrate that it can significantly minimize communication cost among the system servers together with effective workload distribution.

1. Introduction

Distributed virtual environments (DVEs) simulate real or imaginary worlds by incorporating rich media and graphics. DVEs became more popular during the last decade, which is likely attributable to the wide expansion of high-speed internet access providing the basic support medium for these systems, as well as to the significant advances of both hardware and software. A large number of platforms and applications were designed and developed for supporting large-scale DVEs, which were gradually adopted in a wide range of both academic and industrial environments. However, the large number of users these systems aim to support in combination with the need for rich graphics and a high level of realism raise a constant trade-off between system performance and fault tolerance. The decision on the techniques and approaches used to deal with this trade-off is usually related to the objectives, scope and context that each virtual world aims at supporting, along with its special characteristics. In particular, the requirements may vary significantly among virtual worlds with diverse simulated scenarios. For example, in the case of an educational DVE, the consistency of the world would not be significantly affected if a number of position messages (i.e., messages sent each time a user changes his/her position) were lost. However, if position messages were lost while in a virtual battlefield, where soldiers move and run, then the sense of realism, users' awareness and performance would be significantly impacted. One common characteristic of DVEs is their dynamically changing state with users entering, navigating, interacting and leaving the system randomly (at will), resulting in continuously changing utilization of resources for the DVE system. These changes, in turn, call for effective load distribution and management of the inter-server communication cost so that consistency is always maintained and extended scalability is supported.

Research has focused on algorithms and techniques for load distribution as well as resource and communication management to improve the performance of these highly demanding systems. Recent research indicates that one of the main issues of networked servers DVEs is scalability. Morillo et al. (2005) presented that DVE systems reach saturation when any of the available servers reach 100% of CPU utilization which dramatically decreases overall system performance, while severely damaging awareness. On this basis, algorithms and techniques for performance optimization and scalability should focus on

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