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Guest Editor's Introduction: Massively Multiplayer Online Games Technologies and Applications

MASSIVELY multiplayer online games (MMOGs) entail a number of new challenges to science, engineering, and industry. The challenges can be categorized into three areas that are closely linked to each other, namely: computing, information, and communication. Computers capable of dealing with massive data and computations per time unit are essential for online games demanding interactive rates or real-time, but it is not least true we need enough network bandwidth in order to guarantee that the game updates across the network are conveyed and received without lags. Recall that online games as, for example, World of Warcraft has over ten million subscribers with a peak of about half a million players interacting simultaneously within a virtual world. In more general terms, we can even say that computer games constitute the driving force behind the new generation of high-end GPU-based personal computers that produce stunning graphics and deliver massive general-purpose computations. Thus, this special issue covers enabling technologies for MMOGs in the three aforementioned areas, i.e., the computing (e.g., load balancing), information (e.g., persistent worlds), and communication (e.g., networking architectures).

This special issue starts with the article entitled "A Survey and Analysis of Techniques for Player Behavior Prediction in Massively Multiplayer Online Role-Playing Games" surveys and discusses the most relevant techniques for player behavior prediction in online games. The novelty of this article lies in demonstrating how player modeling techniques commonly found in single player games or small-scale multiplayer games can be transposed to MMOGs. More specifically, the authors discuss three behavior modeling techniques, namely *manual tagging*, *collaborative filtering*, and *goal recognition*, including their strengths and weaknesses with respect to their performance in an MMOG environment. In its essence, the article can be seen as a (partial) answer to the Richard Bartle's question "Can anything be done to prevent MMOs from fading away?"

The next article entitled "Towards Consistency of State in MMOGs through Semantically Aware Contention Management", is authored by William Blewitt, Matthew Brook, and Graham Morgan. Usually, there are either conservative or optimistic solutions to the state consistency problem in distributed systems and applications. Conservative synchronization solutions avoid game state inconsistencies using a process of lockstep advance under the control of a centralized logical clock, which is an impractical solution in scenarios with thousands, not to say millions, of clients. Thus, MMOGs are built upon optimistic synchronization schemes because they are not so strict, so that a client enjoys the freedom to continue pursuing its local activity, unless an inconsistency occurs in the meanwhile, being then necessary to initiate a rollback or backup. Based upon the concept of contention monitoring for distributed systems, this article introduces a novel optimistic approach to MMOG state consistency control for distributed and shared variable updates (i.e., game updates). As usual with contention management systems, the authors take advantage from some degree of predictability inherent to sequential data access patterns—which depend on both application design and player behavior—, in order to improve the performance of the MMOG state consistency system. Remarkably, the client system does not play any role in the contention management, preventing in this manner the undue exploitation of data by malicious players. The described system is particularly suited to deal with patterns of access to partially predictable data, lending itself to state update tasks in interactive environments, particularly those related to the physics of motion in MMOGs.

The special issue closes with the article entitled "A Dynamic Networking Substrate for Distributed MMOGs", which is authored by Mohsen Ghaffari, Behnoosh Hariri, Shervin Shirmohammadi, and Dewan Ahmed. The article describes an efficient communication architecture that well adapts to the MMOG dynamic scenarios. Such architecture builds upon on computational geometry principles and tools since it is inspired by Delaunay triangulations. More specifically, the article presents a new geometric routing overlay for message exchange among a large number of players, as needed in MMOGs, as a way of avoiding a centralized indexing service for the purpose of forwarding the multicast updates generated by the action of a certain player to those players standing in its area of interest (AoI).

Such geometric routing essentially uses a greedy forwarding strategy to take a message from one point (player node) to a set of other points (player nodes), i.e., relaying the message along the edges of the graph connecting those points. Taking into consideration that players move in the virtual environment quite often, the graph (representing the overlay) must be continuously updated, what rises serious difficulties in ensuring the message delivery over a generic overlay (a graph). The authors solved this problem of multicasting updates to players in an elegant manner by guaranteeing that the graph dynamically satisfies the Delaunay triangulation constraint. Besides, the greedy forwarding routing was enhanced in order to more efficiently cope with long distance messages.

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