

## Chapter 12

# Designing Multiplayer Online Games Using the Real-Time Framework

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### **ABSTRACT**

*This chapter describes a novel, high-level approach to designing and executing online computer games. The approach is based on our Real-Time Framework (RTF) and suits a wide spectrum of online games including Massively Multiplayer Online Games (MMOG) and First-Person Shooters (FPS). The authors address major design issues like data structures and Area of Interest (AoI), with a special focus on the scalability of games implemented on multiple servers, including distribution of the game state, inter-server communication, object serialization and migration, etc. The chapter illustrates the approach with two case studies: the design of a new multi-player online game and bringing the single-server commercial game Quake 3 to multiple servers in order to increase the number of simultaneous players. The authors show the place of their approach in the taxonomy of game development approaches, and they report experimental results on the performance of games developed using RTF.*

## INTRODUCTION

The development of *Massively Multiplayer Online Games* (MMOG) is significantly more complex as compared to games with small user numbers. Higher user numbers cause more events to be processed and data to be exchanged while larger game worlds accommodating multiple users increase the amount of maintained environmental data. Although hardware performance advancements have increased the number of users that a single server can serve, going beyond these limits requires a multi-server design which is able to employ multiple resources for the game processing and data distribution tasks. This leads to a number of new, challenging design issues, including inter-server communication, object migration between servers, synchronization of data across servers, load balancing, latency hiding, etc. The current practice of game development usually relies on the know-how of developers and employs low-level programming and networking tools, which makes it quite an expensive, time-consuming and risky endeavor.

This chapter describes a novel, high-level approach for developing real-time interactive MMOG and their efficient execution. Our approach is based on the new software platform – Real-Time Framework (RTF) – developed at the University of Muenster for a wide spectrum of online games: from traditional single-server games, over first-person shooters to large-scale multi-server MMOG, with an additional possibility to enhance an initially single-server design to a multi-server solution in order to support an increasing number of players. The RTF, whose architecture and the supported development methodology was introduced in (Ploss, Glinka, Gorlatch, & Müller-Iden, 2007), provides integrated solutions for both game development and their run-time execution. In the chapter, we focus on the following topics: the object-oriented design and efficient transmission of game data structures; interfaces and services that allow the developer to

efficiently process an MMOG on multiple servers; integrated monitoring and controlling functionality; management mechanisms for the multi-server distribution of MMOG; and the trade-offs for employing the proposed development approach and its multi-server design.

The contributions and the structure of the chapter are as follows. We start by describing the contemporary design model of online games based on a real-time loop and present a comprehensive taxonomy of the current game development approaches, with respect to their complexity and flexibility. We then outline our high-level game development approach and describe the concepts of the supporting RTF middleware as a development tool. We continue with a practical case study on how a single-server multiplayer game is designed using RTF. The following section describes the multi-server distribution mechanisms in RTF and demonstrates how they allow to realize a seamless virtual environment across zone borders and a transparent transfer of game parts between resources. Then, we show how the originally single-server commercial shooter game Quake 3 was ported to a multi-server design using RTF, and we experimentally evaluate the RTF-based version against the original Quake 3 with respect to the most important performance and quality metrics: the achieved maximal client numbers, resource consumption, and client-server response time. The conclusion summarizes our contributions in the context of related work.

## GAME DEVELOPMENT APPROACHES

The majority of today's online games simulate a spatial virtual world which is conceptually separated into a static part and a dynamic part. The static part covers, e.g., environmental properties like the landscape, buildings and other non-changeable objects. Since the static part is pre-known, no information exchange about its state is required

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