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Area of Interest Management in Massively Multiplayer Online Games

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Synonyms

AOI; Area of interest

Definition

In a Massively Multiplayer Online Game, the Area-Of-Interest (AOI) is that portion of the virtual world of specific interest for a player.

Introduction

Users participating in a Massively Multiplayer Online Game (MMOG) share a synchronous and persistent virtual world with each other through Avatars, i.e., the players alter ego in the virtual world. In order to enable an engaging experience typical of MMOG, the state of entities in the virtual world, such as avatars and objects, has to be replicated in avatar nodes in a timely fashion. However, broadcasting all state changes to every node in a MMOG is not a practical solution. Naturally, each avatar is interested to be updated in only a subset of the whole virtual world, which is commonly referred to as Area of Interest (AOI). The AOI management (AOIM), often referred to also as Interest Management (2002), is a core activity in the operations of a MMOG, and can be informally defined as the following: given an avatar, identify its AOI and activate those operations that support its timely update. AOIM is also referred to as spatial publish subscribe (Hu and Chen 2011). In this model, publishers perform action and interact with the virtual world (e.g., perform some movements), whilst subscribers manifest their interest of receiving updates for a specific area of the virtual world. AOIM is a fundamental operation in both centralized and distributed MMOG architecture. In the centralized ones, it is principally a mean to reduce the volume of messages exchanged by the client and the server, as well as the amount of data stored and elaborated locally to the client. In distributed MMOG architectures instead, how AOIM is performed greatly impacts on the whole architecture. In fact, AOIM often drives the design of the whole decentralized architecture, forcing an organization of the connections between nodes so that they are only communicating with other nodes that have relevant entities. AOIM can be divided into two main categories (Carter et al. 2012): spatial and geographic.

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Spatial AOIM

Spatial AOIM is based on the concepts of aura and nimbus (Boulanger et al. 2006). The aura is the spatial area for which an entity is perceived by others, whilst the nimbus is the spatial area for which an entity can perceive. Hence, an entity A can perceive another entity B only if A's nimbus intersects with B's aura. However, in this case, B is not necessarily aware of A (i.e., the relation is not mutual). In practical implementations, however, aura and nimbus coincide in a circle (or a sphere) with a predefined radius and centered on the avatar. In such case, the circle is simple referred to as AOI, and the awareness is mutual such that if A is aware of B, B is also aware of A. Spatial-based AOIM mechanisms can employ a static and persistent implementation of the AOIs (Carlini et al. 2012), or dynamic, by adjusting the AOI shape and size according to the events happening in the virtual world (Ahmed and Shirmohammadi 2008).

Geographic AOIM

Geographical AOIM exploits the subdivision of the virtual world into regions, which are then distributed to different servers. Geographical and spatial AOIM are often used in combination: the spatial AOIM is used to select those, among the regions provided by the geographical AOIM, that are of interest for the avatars. A coarse grained geographical AOIM is usually implemented by large centralized MMOG by dividing the virtual world into large regions and instances (Prodan and Nae 2009). Normally, the nimbus of avatars is much smaller than such regions, and therefore only one region (i.e., server) is selected, as typical of centralized approaches.

More fine grained subdivisions of the virtual world are typical of decentralized MMOG architectures (Ricci and Carlini 2012). A common approach considers an uniform partitioning of the virtual world into rectangles or hexagons, with the area of interest that can span more regions. Static uniform partitioning approaches have the problem of properly defining the region size. If the size is too large, an avatar could receive state updates from entities not in its actual interest, wasting resources. Otherwise, if the region is too small, an avatar would need to manage multiple region of interests and switch very frequently between them, generating a lot of overhead. In order to overcome these problems, in dynamic partitioning, the size of the region can be optimized according to various parameters, such as the number of avatars in a region, or the computational power of the node managing a region (Deng and Lau 2014). An evolution of the dynamic partitioning approach is the hierarchical partitioning, which is usually implemented by considering tree-like structures, such as QuadTrees (Backhaus and Krause 2010). An advantage of this method is that the size of the regions can be abstracted at the correct level by simply navigating the tree structure. A special instance of geographical AOIM is the one based on Voronoi tessellation (Hu et al. 2006). A Voronoi tessellation is a decomposition of a metric space determined by the distances from a set of sites (usually determined by the position of the Avatar) of a discrete set of objects in the space. Given a set of N sites on a two-dimensional euclidean plane, the plane is partitioned into N nonoverlapping regions, each one containing all the points closer to that region site than to any other one. Voronoi-based AOIM approaches, and the corresponding Delaunay triangulation (Ricci et al. 2015), are especially used in decentralized MMOG architectures as they facilitate the task of connecting neighbors with P2P mechanisms. In general, the Voronoi tessellation is dynamically computed by considering the positions of the avatars, then a peer-to-peer communication overlay is defined by connecting two peers managing avatars whose Voronoi regions share at least an edge (i.e., are neighbors) (Ricci et al. 2013).

Cross-References

- ▶ Game Design and Development
- ▶ Interaction
- ▶ Networked Games

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