Reducing Server Load in MMOG via P2P Gossip

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Abstract—A fundamental problem for the development of Massively Multiplayer Online Games (MMOGs) is the definition of a mechanism supporting interest management, i.e. determining all the entities of the virtual world that are relevant for a given peer. To this end, we propose a hybrid architecture combining centralized and P2P solutions. Our proposal exploits a P2P gossip-based approach supporting a best-effort resolution of interest management, so that it can be mostly supported through the P2P overlay, with minimal intervention of a centralized entity.

I. INTRODUCTION

Massively multiplayer online games acquired lots of popularity in the last years from both commercial enterprises and research communities. To enable the engaging experience typical for these applications, information about the entities in the virtual environment has to be replicated in users machines. This issue is referred to as Interest Management (IM) [1], [2], [3] and it can be abstracted using a publish-subscribe model. Publishers, which may be avatars or objects, perform actions (e.g. they move) and subscribers should receive the result of these actions (i.e. their local replica should change accordingly). IM is a core MMOG operation, since it must guarantee to an avatar the complete knowledge of the entities it may interact with. These may include further avatars, objects and computer-controlled entities. IM poses well recognised scalability challenges, due to the large number of participants and the fast-pace nature of the MMOGs. A widely used optimization to address IM is to replicate only the entities in the visual/interaction area of players, which is called Area of Interest (AOI) and is typically a circular area whose center is the avatar position. A plethora of approaches have been proposed to support IM (see [1] for a comprehensive list). In this paper we propose a solution integrating P2P overlays and centralized architectures. The P2P overlay is exploited for a best effort management of IM.

II. OUR PROPOSAL

We propose an IM approach that is lightweight, simple and scalable. To meet these requirements, our solution combines a centralized server and a best-effort mechanism providing support for IM. With this combination we are able to reduce consistently the load on the central server. The best-effort mechanism is based on the definition of a gossip-based P2P approach where each peer, i.e. player, exploits the local knowledge of its neighbours to discover as much entities as possible belonging to its AOI. To achieve this task, we use a gossip-based protocol connecting each peer to a relevant subset of its nearby peers.

The best-effort nature of our approach pairs seamlessly with hybrid MMOG architectures [4] which combines centralized and P2P solutions to support MMOGs platforms. For example, in the context of on-demand computing, our approach can be used to query servers only when necessary, thus to reduce the economical effort in maintaining a MMOG platform.

In order to resolve IM, each node is connected with two components (see Figure 1a). The first component is a centralized server, which maintains all the positions of the entities in the virtual world. Nodes communicate their position to the server, which updates the information in its state. The server periodically communicates to each node the entities in its AOI. The interval between two consecutive messages from the server, TS, is common for all the nodes. The main goal of the proposed mechanism is to reduce the bandwidth consumption of the server. To measure the reduction of outgoing bandwidth at the server, we have performed several tests by varying TS, which is the distance in time between two consecutive communications from the server and considering networks with 200, 500, and 1000 peers. As expected, the amount of outgoing data transfer is greatly reduced by increasing the time. With this reduction, the MMOG operator is able to evaluate alternative choices regarding the deployment of the IM server. For instance, let us consider an operator willing to deploy the IM server on a on-demand platform. With 1000 nodes, and T S = 0.25 the bandwidth requirements are 3MB/s. Using the prices of a current commercial on-demand platform (0.12 US$ per GB, Amazon EC2 prices, July 2012), the deployment would cost 30 US$ per day only considering bandwidth. With T S = 1 the cost would be reduced to 10 US$ per day. Besides the server, nodes are also connected to a custom P2P overlay. Each node has associated a profile that contains the node network address (which is also used as unique identifier) and the position in the virtual world. Nodes maintain a set of profiles that represents their partial view of the network. When a node n has another node m in its view, a connection between n and m exists in the overlay, but this does not imply that the reverse connection exists. By exploiting the overlay, it is possible to learn about the entities in the AOI so increasing TS and, as a consequence, reduce the load imposed to the server.

The construction of a best-effort overlay for Interest Management has been inspired by T-Man [5] that proposes a...
A gossip-based probabilistic approach to build, starting from an arbitrary initial peer configuration, a target overlay characterized by a set of well-defined properties. The definition of a proper ranking function is the core element to build the target overlay. Each peer maintains a local view storing the descriptors of its neighbours. At each gossip cycle each peer exchanges a subset of its view with a subset of its neighbours. The ranking function selects the “best neighbours” according to the properties of the target topology.

### A. Dynamic Overlay Construction

Unlike most existing approaches, our goal is to build a continuing evolving overlay rather than a predefined one. The view of a peer changes continuously to reflect the position updates of the peers in the virtual space. In our case, instead of evolving toward a predefined target topology, peer continuously gossip to each other to update their neighbour set.

Each peer refreshes candidate knowledge by means of two gossip protocols, whose organization is shown in Figure 1b. The first protocol is a random peer sampling, enabling each peer to maintain a set of long range links that guarantee the connectivity of the overlay. These links serve in situations where a peer have few knowledge about its nearby candidate neighbours and must incrementally acquire new information. These situations include the bootstrap phase and when an avatar is “teleported” form one place to another of the MMOG.

In the second protocol (coverage peer sampling) each peer chooses its neighbour configuration by exploiting a ranking function based on spatial AOI coverage. To consider the AOI coverage offered by its neighbours, each peer should choose the best configuration of its neighbours in order to optimize the number of entities which may be retrieved from them. We have defined two heuristics to rank neighbour peers. The first heuristics approximates the continuous surface of the AOI of a peer as a tile grid and assigns a score to each tile. The tiles that are intersected by the AOI of a few neighbour peers have a higher score than tiles intersected by a larger amount of peers. The idea is then to favour such peers that overlap high score tiles. The second heuristics is a greedy heuristics that chooses, at each step, the peer that yields the higher increment on the number of unique tiles covered. These two heuristics are described in details in [6].

Since avatars are continuously moving, a large part of the IM performances depends on the freshness of peers knowledge. In order to maintain the selection of the neighbours as fresh as possible, each entry in the view of the peers is marked with a time-stamp. We consider the age of the entries in two situations. First, before ranking the neighbour candidates, all the candidates whose age is greater than a certain threshold are not considered. Second, during the ranking, fresh configurations are favoured with respect to the stale ones. From an application point of view, our approach builds a set of neighbours to retrieve the most entities in a peer’s AOI. The application level queries these peers to actually perform the retrieval. We do not provide further details on this mechanism since it is very dependant on the particular MMOG requirements and it has little impact on the underlying gossip protocols.

Since peers communicate directly to each other, a relevant issue is dealing with cheating. In particular there is the need to provide the authenticity of the sender and the integrity of the information. To this end, a distributed reputation mechanism can be built on top of the peer sampling service. Nodes periodically check the information received by the peers with the authoritative version from the server. A possible malicious peer is reported to the other peers using the peer sampling. When a sufficient amount of reports for the same peer are received, the peer can be removed from the sampling and isolated.

### III. Conclusion

This work proposes a gossip-based mechanism to build P2P overlay for best-effort IM in DVEs. We have tested our protocol by a set of traces derived from Second Life and the results we have obtained are encouraging, as, on the average, in both the proposed heuristics, the 80% of entities in the AOI of a peer may be retrieved by exploiting the overlay built with the gossip-based construction. We are currently improving the precision of the result by defining further ranking functions by considering, for instance, movement predictions.

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### REFERENCES