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A Scalable and Efficient Live Video Streaming Over DHT Overlay Network

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Abstract: Live video streaming becomes one of the most popular internet activities in the recent years. Along with its popularity, the problems such as scalability, availability and low-latency are still the main drawbacks of the peer-to-peer (P2P) live video streaming. The DHT-aided chunk-driven overlay (DCO) [3] tried to overcome these problems by using the Distributed Hash Table (DHT) in live video streaming. Even the performance of DCO is better than other traditional works such as tree-based system, in terms of vulnerability to churn, and mesh-based system, in terms of high delay and message overhead, there are some problems in DCO which need to be solved. The coordinator is easy to get overloaded by many requests because one coordinator is responsible for storing the chunk index of several segments. Moreover, the number of nodes that the video server is responsible for sending the video segment to are not clearly defined. To solve these problems, in this paper, a more efficient approach of using the coordinator nodes is proposed. Furthermore, the threshold is carefully calculated in order to use the server capacity efficiently. The server is only responsible for sending the video segment to the threshold nodes. After that, the video segment will be shared among nodes in the network until every node receives the video segment. The performance evaluation results show that our work is more efficient than DCO, and the server capacity can be used efficiently if the threshold is careful defined.

Keywords: Live video streaming, Peer-to-Peer network, DHT, Threshold

1. Introduction

Nowadays, the Distributed Hash Table (DHT) [1] has been widely used in distributed systems and applications, especially in large-scale distributed environment. DHT is a decentralized system that provides a lookup service similar to a hash table. The (key, value) pair is stored in DHT and all nodes which participated in the DHT network can use a key to lookup for the value associated with it as well as send the value to store in the DHT space. The DHT has two primitive operations: *put* ( ) and *get* ( ). The *put* ( ) operat

ion is a function that can be used to insert the data (value) to the DHT space. *Get* ( ) is a function that can be used to obtain the data (value) from DHT space by using the given key. The central server is not required in the DHT and all the DHT nodes in the distributed system are treated equally. DHT possesses three properties: high efficiency, decentralization, and scalability [2]. High efficiency—in DHT, node can efficiently locate where the data are stored in the DHT space without knowing the global information. Decentralization—in DHT, all nodes are equally deployed and it is not depend on a single. It means that there is no central node, which could avoid the hot spot problem and achieves a good load balancing. Scalability—because of the decentralization of the DHT network, it can be applied to distributed system with varying sizes, ranging from several thousand up to millions of nodes.

DHT is one of the most effective methods which

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can be used to locate a node in mesh-based P2P network. DCO [3] is one of the recent works and also maybe the first work that used DHT to improve the scalability, the availability and the low-latency of P2P live streaming systems. The performance of DCO is far better than that of the traditional mesh-based and tree-based system. However, in DCO, only some nodes can be chosen to become the coordinators. The coordinator is responsible for storing the chunk indices of several segments and all nodes, include other coordinators, request the chunk indices from this coordinator. Moreover, the lower-tire nodes which connected to the coordinator need to request the chunk index through that coordinator. Thus, the coordinator in DCO is responsible for many tasks and it is easy to get overloaded by many requests when the number of nodes join the system is suddenly increased. In addition, the threshold—the number of nodes that the video server is responsible for sending a video segment to—is not clearly defined in DCO. In order to efficiently use the video server's bandwidth, the threshold must be clearly defined.

In order to solve DCO's problems, a more efficient method is proposed in this paper. In this paper, all nodes can join the DHT network and one node is only responsible for storing one buffer map information list (or chunk index in DCO) of one video segment, hence, this node can handle more requests than the coordinator in DCO. Moreover, in order to effectively use the video server bandwidth, the threshold is also carefully defined in this work. The threshold refers to the number of nodes which has to receive a video segment at each delay time (T_{delay}) in order to effectively share the video segment in the system with reasonable delay time. The delay time is the time limit for a segment to be available in the network. For example, the number of nodes join the network is set to 1000 nodes, and the delay time is set to 3 seconds. At the delay time zero, the video sever needs to send the video segment i to the threshold nodes, which is 16 nodes (how to define the threshold will talk in detail in Section 4). For the first delay time, those 16 nodes will forward the video segment to the threshold nodes at the first delay time, which is 48 nodes. Thus, there are 64 nodes received the video segment i at the first delay time. Then, at the second delay time, those 64 nodes will transmit the video segment i to the threshold nodes of the second delay time, which is 192. Therefore, the number of nodes which received the video segment at the second delay time is 256. Finally, at the third delay time, those 256 nodes will share the video segment to all the remained nodes since it is the last allowable time that this segment can be available in the network.

The rest of this paper is organized as follows: Section 2 will talk about related works. The overall architecture of the system will be discussed in Section 3. In Section 4, the threshold modeling will be elaborated in detail. The performance evaluation will be presented in Section 5. Finally, the conclusion will be illustrated in Section 6.

2. Related works

Choosing the distribution topology is very crucial in P2P live video streaming. There are many existing works that focused on tree-based [4-6], mesh-based [7-9], and hybrid structure [10-12]. However, only a few research works have focused on using DHT [3], [13,16].

Many research works have been proposed to solve the problems of live video streaming. Because the traditional methods such as centralized, hierarchical, and flooding methods cannot effectively solve the problems of live video streaming, most of those works do not concentrate on doing the research on those methods anymore, and turn the attention to DHT-based and gossip-based methods. Because of the advantages such as high scalability, reliability, and self-organizing, the DHT-based method can effectively be used in P2P live video streaming. DCO [3] is one of the most recent research works and also the first work that used DHT to improve the scalability, the availability and the low-latency in P2P live streaming systems. This work has a two-layer hierarchical DHT-based infrastructure where big capacity nodes form a Chord DHT in the upper tier and other nodes connect to the DHT nodes in the lower tier. In DCO, the upper tier nodes can be used as the coordinators. The coordinator in DCO is responsible