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Multimedia Streaming in Peer-to-Peer: Approaches and Challenges

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Abstract: Peer to Peer network make an application level overlay network on the top of physical network. It is a group of connected clients called peers. A significant part of the Internet traffic is generated by peer-to-peer (P2P) applications. Dynamic nature makes P2P challenging for media applications streaming although initially P2P networks were designed for file sharing. P2P could be a promising start for enabling large-scale streaming systems because current internet does not widely support IP multicast and content distribution network is costly. Better availability of multimedia contents depend upon Streaming architecture.

There are many recent advances in streaming P2P multimedia system but many research challenges remain to be tackled. In this paper we present a study on several solutions which increase the power of P2P to improve the current multimedia streaming. Several points are diagnosed so that peer to peer multimedia streaming issues are point out. Our objective is to actuate and steer the current research to tackle these issues and help to recognize effective streaming multimedia P2P mechanisms.

Keywords: P2P, Overlay Network Architecture, Multimedia streaming, peer heterogeneity, federated overlay

I. Introduction

Most important multimedia applications like video on demand, IP-TV, video streaming are based on P2P network. P2P network provides the structural possibility of mutually sharing and distributing user-created contents video and music in a variety of user community environments. These networks aggregate large amount of heterogeneous nodes known as peers. These peers have some interesting characteristics like self-configuration, self-adaptation and self-organization. Peer-to-Peer networks are distributed systems where software running on each node provides equivalent functions. The main targets of such systems are file sharing applications like Kazaa [1], eDonkey [2], BitTorrent [3]. These features make peer-to-peer to solve the problems related to multimedia streaming. P2P networks were designed and were considered suitable for huge contents distribution across networks. Distributed, scalable, cost-effective, cooperative resource sharing, self-organizing encourage service providers to deploy real-time applications over heterogeneous network.

Multimedia streaming over internet is managed by content distribution networks (CDN) [4] such as Akamai [16], Limelight Networks [17]. CDN contain dedicate servers which perform the functions of content storing and serving the client demands. Multimedia streaming require high bandwidth. The server generates a multimedia stream which is divided into blocks and delivered to a small subset among the participating peers. All peers exchange these blocks to reproduce the stream. Those peers which are involved may have heterogeneous upload bandwidth capabilities. For efficient streaming the service rate should be near about average upload capability with smallest possible delay. To define an effective multimedia streaming application P2P technology gives novel opportunities but due to its heterogeneous and dynamic nature it induces many technical challenges. Some problems has been already discussed in ([9], [10], [13], [14]) which shows that P2P multimedia steaming is still in its growing stage and for improvement in P2P multimedia streaming important research and investigations efforts are required. Objective of this paper is to provide basic knowledge of multimedia streaming over P2P and consider the issues related to this area. Paper is divided into four sections. Multimedia streaming architecture is describe in section II, Multimedia streaming on P2P network is presented in section III, Challenges in multimedia P2P streaming are illustrated in section IV and paper is summed up by making conclusion in section V.

II. Multimedia streaming architecture

P2P streaming architecture states the methods used for multimedia content transfer. It also state the entities involved during the streaming. Network structure remains roughly stable throughout a transmission, in terms of diameter, average shortest path and maximum degree. In contrast, the network clustering coefficient tends to decrease with time, possibly in response to changes in the partnerships of individual nodes. [12] In the case of P2P streaming peer can be a source, destination or intermediate. In the case of source it contains the media contents and share with other peers. Peer can store the full content or part of a given content. If peer play the role of destination peer then it is the client who make the request for content. It can get contents from one or

more senders. In the case of intermediate, peer will receive content and transmit it to the next peer. It will work as a transport node. Multimedia contents are distributed using tree structure of overlay network. In the case when contents are store in multiple sources then contents can be either replicated or can be split and dynamically placed in many peers. If contents are replicated then any content can be found in several emplacements into the network. In second case analyses of client request is required to place the different pieces of content in the network. In single source, multimedia contents are stored into single source peer. That source starts transmitting the contents to all clients' peers who are requesting for it. Intermediate peers store some part of the content in their buffer which can be directly retrieved by the new client peer when it joins the network.

P2P can be unstructured which do not maintain any specific structure on the network topology. As such; there is not much systematic information to help index objects across nodes. So nodes often locally maintain objects they share, and search in the network is more or less a blind process, passing queries around nodes to check whether they have the desired Objects. Search space grows in proportion to recall rate because search is a basically a blind process. [8] Structured maintain a structure or topology to maintain a network. Most Structured peer to peer operate using distributed hash tables (DHT) where given a key, they can efficiently locate an object having the key by just maintaining neighboring tables entry. Nodes cooperatively maintain routing information about how to reach all nodes in the overlay [11].

A hierarchical overlay is an overlay architecture that uses multiple overlays arranged in a nested fashion, and the nested overlays are interconnected in a tree. Hierarchical overlay lookup have two steps higher level routing and lower level routing. The higher level routing is use to locate the destination domain and lower level routing is used to locate the destination node. To perform the task of higher level routing or lower level routing a node has two ID: a group ID and a node ID.

A federated overlay is an overlay that is formed from a collection of independent overlays, each implemented by a separate administrative domain, and which may use different routing algorithms and addressing mechanisms in each domain.

In semantic Peers are clustered according to content. These clusters overlap, because peers can contain different content and belong to several clusters. Query, coming into the network, is distributed to relevant clusters only and flooded among relevant peers.

III. Multimedia streaming on p2p network

Streaming refer to the delivery method. Numbers of digital video being streamed over the Internet each day are all growing exponentially. This obviously is placing an intense demand on the network bandwidth at the Internet backbone as well as on the servers that are offering the digital video and audio services. Multimedia streaming over internet is managed by content distribution networks (CDN) [4]. CDN contain dedicate servers which perform the functions of content storing and serving the client demands. Dedicated servers provide not only better distribution of files but also better streaming of real-time media. Since servers are geographically distributed therefor it reduces network congestion and better serve clients in given regions with low latency. Servers placed at the edge of the network and closer to users, better quality of experiences can be expected for real time media streaming. Streaming applications can be one-to-one, one-to-many and many-to-many. Live personal video is an example of one-to-one or one-to-many. Internet video is an example of one-to-many and video conferencing is an example of many-to-many. According to the streaming application protocols can be unicast, broadcast or multicast. In a P2P network, content can be streamed via a tree based, mesh based or multicast overlay.

A. Tree based streaming

In tree based approach content rooted at the source node, is pushed along the tree to the destination peers. If any member leaves the tree then tree is broken and children of departure node reconnected to the tree. Tree based system is unbalanced and does not utilize the bandwidth of leaf node. Multiple trees may be built to improve the fairness in resources.

B. Mesh based streaming

Mesh-based overlays implement mesh distribution graphs for content streaming. Each new node first obtains a content block availability map. It lists the peers who have the desired contents blocks. New node then contacts a subset and request for streaming and obtains the content block.

C. Multicast streaming

When there are multiple clients (receivers) simultaneously requesting/receiving the same media stream in a streaming application, multicast can be implemented. Multicast is a special type of streaming where protocols are defined to deliver a packet to a group of destinations at the same time using efficient strategies. Multicast can be deployed at different network layers. IP multicast which implements multicast at the IP routing level is generally high in implementation cost. P2P overlay multicast was invented to reduce deployment cost and improve scalability. AP2P overlay multicast system should implement [11]

IV. Challenges in multimedia p2p streaming

A. managing peer dynamically:

During streaming session dynamicity is difficult. Behavior of peers is unpredictable. They can join and leave the system at any time due to their dynamic nature. Other node doesn't find any prior notification regarding these changes. To manage the changes, strong and adaptive mechanism is needed because peer leaving and entrance interrupt the smooth working. A mechanism to handle these sudden changes which happened in network must be implemented. Perform streaming in smooth manner it is essential that when any peer leave the system it must be known as early as possible and that node should be change with another peer. [5] Explain how to deal with network dynamicity and how semantic should be adjusted accordingly but still problem is there.

B. peer heterogeneity:

Accurate characterization of peer heterogeneity is difficult due to huge population and disparate properties of individuals [6]. Peers are not homogeneous because they have different capability. Heterogeneity may be due to different access networks which connecting the peers, or due to difference of peer's desire regarding contribution. Bandwidth is another reason because each peer has different bandwidth which may also fluctuate. Mechanism must consider these heterogeneity problems when selecting the peers.

C. Efficient overlay network construction:

Constructing an efficient overlay network on top of which one can efficiently provide services such as routing, broadcasting, information gathering, routing and data searching is a big problem. To understand the underlying topology peers must be organize into logical topology. Overlay topology if not suitable can decrease the system performance and can generate extra overheads there for overlay network construction should be scalable.

D. Best peer selection:

The selection of peers is a key issue for improving resource usage and end users Quality of Experience (QoE) [7]. For selection of sender and intermediate peers a flexible and efficient strategy must be there. In fact Overlay network is a group of connected intermediate nodes and multimedia contents go through these intermediate nodes which cause end to end delay. Minimizing end to end delay is main feature of multimedia streaming which depend upon best peer selection. For providing more live multimedia contents, this delay should be less. Using different routing policy by intermediate node is another reason of end to end delay. To overcome all these problems Global overhead control for network topology management should be innovate and selection criteria of peer should be intelligent.

E. Encouragement to participating peers:

In literature, it is found that mainly peers join the network for their own benefit. They never share their own resources but share other's resources. In 2000, near about 70% of Gnutella users shared no file but they only download contents [15]. This issue let the P2P network work like client-server because no peer shares its resources but want to get the resources from others. This model will fail when number of client peer increase. To overcome this issue there must be some encouragement for peers who participate in streaming. Encouragement can be in economical form.

V. Conclusion

Within coming years it is expected that multimedia services will grow up significantly. To define an effective multimedia streaming application P2P technology gives novel opportunities but due to its heterogeneous and dynamic nature it induces many technical challenges. It is very difficult to manage the peers dynamically and prior knowledge of required peers.

The main motivation behind our work is to discuss issues regarding multimedia streaming in P2P network. First we have disclosed research work about the problems of streaming. Furthermore we have exposed issues which should overcome for better designing of reliable solution.

In our future works, we plan to investigate the above issues and provide methods which will be used for selecting responsible peer and to organize the peers for improvement in multimedia streaming.

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