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The Arithmetic of Peers Selecting and Improvement of Peer Selection Strategies in P2P Live Streaming

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Abstract

Peer selection strategy is one of the core issues in P2P streaming system, because peers can not only become a provider of video streaming, but also can retrieve the video stream information from its neighbor peers. In this paper the idea of similar route method was used to detect autonomous systems (AS) and substitute the known full topology information of the AS with exact position of peers in the AS. As well as combine the traditional strategy of the smallest number of hops to select the peer. In addition to the excellence of the peer and the aggregate flow rate to choose the best peer or best peer set as the supply of newly joined peers. And solve the minimum-hop candidate peers with the same priority issues. Simulation results show that in the improved strategies the network congestion has been reduced compared with the previous strategies.

1. Introduction

With the extensive development of broadband services, in recent years, video streaming systems such as network television, sports broadcasting, has been widely used. P2P technology based live streaming systems highlight the research in industry and academia. In P2P systems, peers can not only become a provider of video streaming, but also can retrieve the video stream information from its neighbor peers. Therefore, P2P live streaming system can achieve high scalability robustness.

The traffic volume between the autonomous systems (AS) is the most important performance measures in P2P live streaming system. This measure affect by the performance of peer selection strategies which determine the logical topology structure of the P2P overlay networks.

Local rarest first (LRF) peer selection strategy is widely used in conventional P2P live streaming systems. But this strategy lead to larger traffic volume of backbone network.

In order to decrease the traffic volume of backbone network, CoFetch [3] and the team of the minimum of hops have been proposed. They want to limit the number of peers in the AS.

Minimum Logical Hop (MLH) and Minimum Physical Hop (MPH) strategies [3] considered both the maximum number of joining peers and inter-AS traffic volume. They introduce upper bound of the number of relaying peers in order to keep the real-time property of the streaming video. However, MLH and MPH assumed that AS topology information is available and under this condition using the number of physical and logical hops as a measure standard. However, in practice it is very difficult to obtain the complete topology information.

Based on all the above issues, in this paper we have improved the MLH and MPH strategies. We define the improved strategies as Minimum Logical Hop modified version (MLHm) and Minimum Physical Hop modified version (MPHm) and they detect information whether the peers are in the same AS through a similar route method. And substitute the known full topology information of the AS with the AS information where peer located.

Following article explains: Section II shows assumed P2P live streaming systems and describes MLH and MPH by examples. Section III described modified versions of MLH and MPH named MLHm and MPHm. Section IV shows simulation and evaluation results. Section V is the conclusion of this paper.

2. Overview of P2P streaming systems

OSSs (Original service server) are the original streaming severs to provide live streaming videos. A newly joining peer should view the whole system and then select a list of peers that are viewing the video from the system. Then, choose an optimal subset of

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peers as a set of providing peers. We define a physical network that represents physical interconnections between peers and routers as an underlay network, and define a logical network that represents logical interconnections between peers as an overlay network.

Logical hops counts: the number of hops between OSS and the candidate peers. Physical hops counts: refers to the differentials between newly joining peer's AS number and the AS number of candidate peers. In order to keep the real-time property of live streaming, the assumed P2P live streaming system introduces the constraint on logical hop counts from OSSs with the assumption that each single logical hop was a constant delay. We denote the maximum logical hop by H, and denote the hop counts from OSS to peer x by h_x. We denote the maximum physical hop by Q.

3. The modified version of peer selection strategies without knowing topology

In the P2P streaming system, the backbone (inter-AS) traffic volume is a very important measure. When each peer select providing peer they need to take the underlying network structure into account.

MLH and MPH improved version, recorded as: MLHm and MPHm. We only know the neighbors of each peer in the domain of information, not under conditions of knowing complete AS topology information, closer to the P2P streaming overlay network of the actual situation, thereby increasing the actual operational and practical.

First, the following brief article on the introduction of the above problems, according to the known route similar to this idea [6]. Then using a mathematical model measure the quality of the peer to solve the above problems in MLH and MPH.

3.1. The description of similar route method

The similar route method [3] is described as follows.

In the same AS within the two peers A, B are far apart to reach another peer C as its goal peer. If A → C and B → C these two paths through intermediate routers are mostly the same. We say that A and B are adjacent within the same AS. The similar route method, this strategy is not required to maintain any mapping, complexity is low.

3.2. The measurement of the excellence of peers

The following article will apply a mathematical model to measure the excellence and quality of the peers, to better choose the peers, and to improve the current quality of service, while as far as possible to minimize the pressure overlay.

The actual system, a single peer to provide data flow often cannot meet the playback requirements, therefore, we will choose more than one providing peer to provide data in parallel. To ensure quality of the flow service, considering the links dynamic changed between candidates peers and between the candidates peers and request peers and also considering the performance differences. Assuming the streaming broadcast rate is V_0, the request peer obtain download rate V_i from the candidates peers Pi, the request peer obtain Link packet loss rate Li from the candidates peers P_i. Taking into account the dynamic of the system that the candidate peer join and out of the system and system load balance, for each candidate peer set two parameters: the availability A_i and connectivity C_i, were defined as:

$$A(i) = \frac{\sum_{i=1}^{n} \frac{t_i}{24}}{n} \quad (1)$$

That t_i represents the download time that peer P_i can provide in a day, that n means to take the last n days of observations.

$$C_i = \frac{C_{max} - C_{connect}}{C_{max}} \quad (2)$$

That C_{max} means the maximum number of concurrent streams that each peer can be connected. $C_{connected}$ means that current number of concurrent streams that peer P_i already connected.

The excellence of the peer P_i is defined as g (i):

$$g(1) = A(1) \times C(1) \times (1 - L_i) \quad (3)$$

Set the final subset of selected service peer contains the number of peers is m, and the receiver receives the aggregate flow rate $V_{aggregated}$ can be expressed as:

$$V_{aggrerated} = \sum_{i=1}^{m} V_i \times g(i) \quad (4)$$

Determine the request peer terminal select target as follows. Select the number of peer about m from the candidate list (including 20 [5] [6] candidate peer). So that the aggregate flow rate $V_{aggregated}$ can be maximum.

The following two constraints must be content.

(a) Service provides download speeds of peers (more peers available for download in parallel) and should not be less than the streaming media playback rate, in order to ensure the smooth stream high.

$$\sum_{i=1}^{m} v_i \geq v_0 \quad (5)$$

(b) If the service peer set is too large, the request peer need to maintain the number of concurrent streams will be too much, will increase its overhead, so the service peer set of size m should be set according to experience, a maximum value M_{max}.

$$m \leq M_{max} \quad (6)$$

Have met above two constraints, according to the above mentioned to make the maximum aggregate flow rate $V_{aggregated}$:

$$\text{Max } V_{aggrerated} = \sum_{i=1}^{m} V_i \times g(i) \quad (7)$$

Using the method of enumeration, specific strategies are described below:

(a) Enumerate all satisfying subset of peers from the candidate list which content equation (6).

(b) Using equation (5) to test all the subset obtain from step a, removing the unsatisfied subset, the final subset will both satisfied the equation (5) and equation (6).

(c) Using equation (4) to calculate the $V_{aggregated}$ of the subset one by one obtained from step b.

(d) Returning the selected set of service peer to the streaming applications.

This method allows peers in descending order according to $V_{aggregated}$. After that the best performance candidate peer can be easily chose.

3.3. Analysis of MPHm and MLHm peer selection strategies

In MLHm and MPHm strategies, use the similar route method to select those peers in the AS and substitute the complete topology information which is difficult to obtain. In addition, the MLHm and MPHm strategies can select the best performance service peer and peer set based on excellence of peer and aggregate flow rate.

MPHm strategy describe as follows.

(1) A newly joining peer (P_{new}) gets a list L1 of candidates providing peers (peers with providing bit-rates greater than or equal to *a* and physical hop count smaller than Q) from the P2P system.

(2) First, we use the similar route method detect which AS are the peers belong to. Then, from L1, Pnew selects the providing peers with the minimum physical hop count, adds them to the target list, and removes them from L1. If there are multiple such providing peers we turn to step (3)

(3) Newly joining peers select providing peers with the minimum logical hop count from the target list. If there is several same priority of the candidate providing peers after the selection. Using the method allows peers in descending order according to $V_{aggregated}$.

MLHm: The algorithm of MLHm is realized by replacing “the minimum physical hop count” in (1) and (2) of MPHm to “the minimum logical hop count” and “the minimum logical hop count” in (3) of MPHm to “the minimum physical hop count”.

We can analysis the application situation about the improved MLHm and MPHm strategies through an example system case which can fully express the improved strategies.

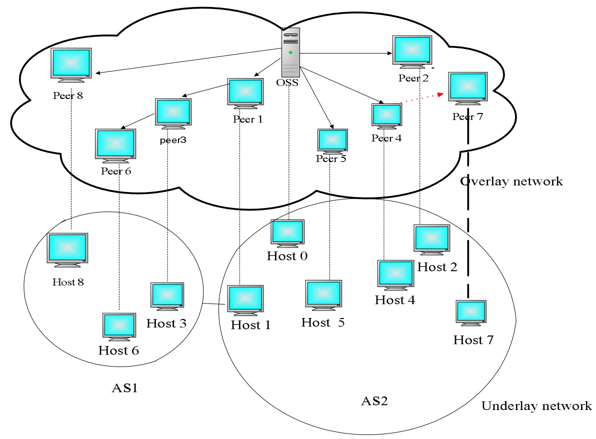

Figure 1. P2P live streaming system

MPHm: The clear logical structure of the overlay network can be seen in Figure 1. Assume peer 7 is the newly joining peer. In the MPHm strategy, (1) P_{new} gets a list L2 (peer 0, 1, 2, 3, 4, 5, 6, 8) of candidates providing peers (bit-rates greater than or equal to *a* and physical hop count smaller than Q) (2) it will first use the similar route method to detect which AS are the peers belong to. In the underlay network, peers 3,6,8 belongs to AS1,while 0,1,2,4,5 belongs to AS2. Because of the minimum physical hop count, Then add peer 0, 1,2,4,5 to its candidate peer list (they are in the same AS with peer 7) (3) Then it will use the minimum logical hop count to select candidate peer. Now the logical hop of peer 1,2,4,5 are all 1(not chose peer 0 because it is OSS). In this situation it will use the excellence and aggregate flow rate of peers to sort the candidate peers. If the $V_{aggregated}$ order from big to small is peer 4,1,2,5. The P_{new} peer 7 will first choose peer 4 as the providing peer. It also regards other three peers 1, 2, 5 as a service peer set to provide streaming applications.

MLHm: The network topology and other conditions are the same as above. When peer 7 is joining the system, to find the providing peer the steps are reverse of MPHm as described above.

4. Simulation model and evaluate

4.1. Experimental Environment

To simulate the P2P streaming system in PeerSim simulator, in the simulation process 20% peers in the P2P system are reduced randomly in order to simulate the dynamics of the system. The total number of overlay peers varies between 0 and 1400, while network coverage is divided into 16 AS. The live streaming rate of A is 1Mbps, the minimum bit-rates of A is 256kbps, the largest logic jump of H is 5, the positions of the 30 OSS are randomly placed, the test to compare the four peer selection strategy: MLH, MPH, MLHm, MPHm impact on system performance. Four peer selection strategies are compared in the simulation: the impact of MLH, MPH, MLHm and MPHm on the performance of the system.

4.2. Experimental Parameters

The following describes some of the parameters: the minimum flow unit between peer and OSS, *a* Mbps. Streaming bit rate A = N×*a*, N is a constant integer, and each video is different. If the sum of the receiving streaming rate reaches the live streaming bit rates of the video. Then each peer can play the video.

Figure 2 (a) describes a peer that can play the video. For this kind of peers they meet the following equation:

$$N = n_1 + n_2 + \cdots + n_D \quad (1)$$

$$1 \leq D \leq N \quad (2)$$

D is the number of supply peers, n_i is the smallest unit number of supply peer i. Each peer has the ability to provide flow rate of M×*a*, M is the supply capacity.

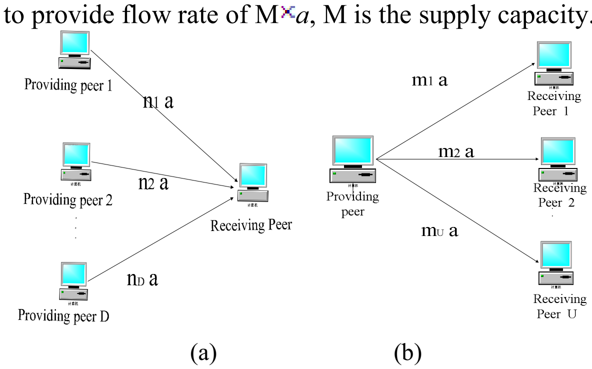

Figure 2. Examples of peers sending and receiving in live streaming media

Figure 2 (b) describes a peer providing its own video streaming to other peers. For peers of this kind, they meet the following equation:

$$M \geq m_1 + m_2 + \cdots m_V \quad (3)$$

$$1 \leq U \leq M \quad (4)$$

In this equation U is the number of receiving peers, m_i is the smallest unit number of the receiving peers.

4.3. Simulation results

As is shown in Figure 3, the most serious congestion situation in MLHm can be higher by 32% compared with MLH strategy. That is because the AS topology information is not available in MLHm, so extra cost is needed to use similar route idea to detect the position of available peers. In the same situation, the congestion in MPHm is a little more serious than in MPH when the number of peers is low than 200.This is also because the AS topology information is not available in MPHm. It is also shown in the figure that when the number of peers is more than 200, the congestion in MPHm strategy can be reduced by 36% compared with that in MPH strategy. That is because with the increasing number of peers joined in the system, the high quality peers in the MPHm strategy will gradually enter each AS. But in the MPH strategy the peers of high quality will only accumulate in the vicinity of OSSs. So in MPHm strategy it ensures that the joining peers can find the providing peers in the same AS successfully. Thus the strategy MPHm has reduced the traffic volume of backbone network and congestion. Although we should take a little more cost in MLHm, using the similar route method to detect the AS is much closer to the reality which enhances the feasibility and practicality.

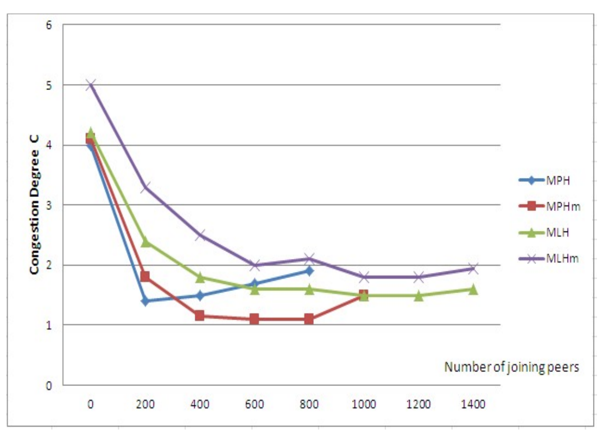

Figure 3. Congestion degree of backbone network

5. Conclusion of this paper

In this paper, we used the following methods improve the peer selection strategies MPH, MLH to MPHm, MLHm. (1) Using similar route strategy to detect the AS of peers. It ensures the peer selection without knowing the complete topology information of the AS. The MPH and MLH are based on that the full topology information of AS has been known. But it is very difficult to obtain the full overlay network topology information in practice. Although extra cost is need in the improved MPHm and MLHm strategies, but the experimental condition is much closer to reality, which enhances the feasibility and practicality. (2) Using mathematical models to test the performance and sort the candidate peers, and use the excellence of peers to distinguish a number of peers which have same priority. Because those peers that have the same logic hops and in the same AS, to descend them according to the aggregate flows in order to choose the best providing peer or peer subset.

Simulation results showed that the improved strategies can firstly choose the excellent peers of high performance in the same AS without knowing the full overlay network topology. Using the similar route method to detect the AS and this experimental condition is much closer to reality, which enhances the feasibility and practicality. With the increasing of peers, the improved strategies have enhancing the quality of streaming service because the congestion reduced between different AS and in the backbone network.

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