Weekly Report

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Locality of P2P live streaming

One simple way to improve the locality of P2P live streaming is biased peer selection. Below is the analysis of the biased peer selection: The environment of P2P live streaming considered is: N_1 peers in ISP_1,N_2 peers in other ISPs, which are outside ISP_1; the upload capacity is assumed homogeneous, suppose the upload capacity u_p is equal to the playback rate r. The buffer has N units. The probability of buffer unit i is filled by a chunk is $p_1(i)$ for peers in ISP_1 and $p_2(i)$ for peers in other ISPs. One chunk will be played in one time slot. The chunk in buffer unit N is playing. And due to the upload capacity, no more than one chunk will be uploaded by a peer. The server's capacity in ISP_1 is $u_(s1)$. Each peer has n partners chosen from their peer list.

First, we calculate the probability that the partners of one peer has chunk i under different situations.

1)calculate the probability that the partners of one peer in ISP_1 has chunk i when a peer just builds intra-ISP connections:

$$Pr[H_p(i)] = 1 - [1 - p_1(i)]^n$$

Here, an interesting question is that how to determine the appropriate number of partners. (?)

2)calculate the probability that the partners of one peer has chunk i when a peer randomly selects neighbors from ISP_1 and other ISPs.

$$Pr[H_p(i)] = 1 - [1 - p_0(i)]^n$$
$$p_0(1) = \frac{N_1 p_1 + N_2 p_2}{N_1 + N_2}$$

$p_0(i)$ is the probability that a peer's buffer unit i is filled by a chunk under the random peer selection. The initial value $p_0(1)$ equals to the mean value of ISP_1 and other ISPs.

3)calculate the probability that the partners of one peer has chunk i under biased peer selection. Suppose every peer has n_i intra-ISP partners. The inter-ISP partners is then $n - n_i$. For different ISPs, the probability is different. For peers in ISP_1, the probability is:

$$Pr[H_p(i)] = 1 - [1 - p_1^{'}(i)]^{n_i}[1 - p_2^{'}(i)]^{(n-n_i)}$$
$$p_1^{'}(1) = p_1(1); p_2^{'}(1) = p_2(1);$$

Next, The relationship between $p_1(i+1)$ and $p_1(i)$ is given as follows:

$$p_1(i+1) = p_1(i) + q(i)$$

The $q(i)$ is the probability that one peer gets the chunk to fill buffer unit i+1 in time slot i from partners, $p_1(i)$ is the probability that the peer's buffer unit i+1 is filled by the chunk in the buffer unit i after one time slot.

The calculation of $q(i)$ is:

$$q(i) = Pr[H_p(i)] \times Pr[W(i)] \times Pr[S(i)|H_p(i), W(i)]$$

$Pr[W(i)]$ is the probability that one peer doesn't have chunk i:$Pr[W(i)] = 1-p_1(i)$. $Pr[S(i)|H_p(i), W(i)]$ is the probability that one peer selects chunk i to download when this peer doesn't have chunk i and its partners have chunk i. This probability is related to the chunk selection strategy. Here we refer to the rarest first strategy. And for the rarest first strategy, $Pr[S(i)|H_p(i), W(i)] = 1 - p_1(i)$.

So,

$$p_1(i+1) = p_1(i) + q(i) = p_1(i+1) = p_1(i) + [1 - p_1(i)]^2 \times Pr[H_p(i)]$$

So, substitute the $Pr[H_p(i)]$ of three different cases into the above recursive equation, we can get:

(1) the case that a peer just builds intra-ISP connections:

$$p_1(i+1) = p_1(i) + q(i) = p_1(i) + [1 - p_1(i)]^2 \times [1 - [1 - p_1(i)]^n]$$

(2) the case that a peer selects partners randomly from ISP_1 and other ISPs:

$$p_0(i+1) = p_0(i) + q(i) = p_0(i) + [1 - p_0(i)]^2 \times [1 - [1 - p_0(i)]^n]$$
$$p_0(1) = \frac{N_1 p_1 + N_2 p_2}{N_1 + N_2}$$

(3) the case of biased peer selection:

$$p_1^{'}(i+1) = p_1^{'}(i) + q(i) = p_1^{'}(i) + [1 - p_1^{'}(i)]^2 \times [1 - [1 - p_1^{'}(i)]^{n_i}[1 - p_2^{'}(i)]^{(n-n_i)}]$$
$$p_1^{'}(1) = p_1(1); p_2^{'}(1) = p_2(1);$$

Next step, it is necessary to analyze the influence of $Pr[H_p(i)]$ on $p_1(N)$ and inter-ISP traffic.

Analyze inter-ISP traffic: With the same server deployments and number of peers, how to calculate the inter-ISP traffic:

(1) the case that a peer just builds intra-ISP connections:
inter-ISP traffic is 0.

(2) the case that a peer selects partners randomly from ISP_1 and other ISPs:

(3) the case of biased peer selection:
inter-ISP traffic is $\sum_{i=1}^{n-1}[1 - p_1^{'}(i)]^2 \times [1 - p_1^{'}(i)]^{n_i}[1 - [1 - p_2^{'}(i)]^{n-n_i}]$
The impact of server deployments and number of peers: