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Research of NCS Algorithm in Cloud Demand System

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Abstract

In order to reduce the bandwidth overhead and the node request rejection rate of the cloud video-on-demand server, this paper builds the cloud auxiliary framework and proposes the neighbors and chunks selection algorithm, which contains the node selection sub-algorithm and the block download sub-algorithm. The buffer-based node selection algorithm treats the download point as the benchmark to effectively find the neighbor nodes that can provide the video data, and the buffer-based block download algorithm calculates the required minimum buffer values of the two different kinds of block download strategies under the framework, which provides the theoretical basis for the download method of the video block. The experimental results show that the algorithm in this paper achieves good effects in the aspects of the bandwidth overhead of the server, the request rejection rate and the download rate.

Keywords: *System, Node Buffer, Bandwidth Overhead, Download Algorithm*

1. Introduction

In the cloud demand system, when the asymmetric access way leads to the available uplink bandwidth of the users be restricted or affected by other applications, allowing the mutual sharing between the users cannot meet the demands of the on-demand, a large number of user's requests will cause the rapid increasing of the load of the media server, and then the scalability of the system will be affected [1]. The traditional VOD system uses the content delivery network to send the video data to the nodes, but with the increasing of the number of the nodes, the investment of the infrastructure presents a linear growth. The current VOD system uses the P2P and the mutual exchange of the video data between the nodes to make the VOD service provider service a larger number of nodes with a smaller overhead [3-5].

The existing solutions mainly adopt the following two strategies: one is to provide sufficient service capacity by extending the media server [6]; such as deploying the server cluster [7], the marginal caching server of the network or carrying out the expansion of the service capacity with the aid of the content delivery network and so on. This way is simple and easy, but it cannot adapt to the changes of the user scale, and it has a high cost of deployment and a poor scalability. Another consideration is to provide the service capacity help by using the spare nodes in the system. In the on-demand systems that have already been widely deployed and applied [8], such as PPLive, UUSee, Gridcast, Thunder KanKan and so on [9-12], the client usually opens up a relatively large space in the user disk and caches the movies reviewed by the users [13]. After that, as long as the client process still resides in the system, the user can use the uplink bandwidth to provide help to the arrived requests.

This paper mainly has development and innovation works in the following aspects:

(a) On the basis of P2P VOD system model, the thesis proposes the node selection algorithm of node video to improve the efficiency of selection, and on this basis, the

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video node can select to buffer and download the video database, and the speed is faster and better than the traditional ones.

(b)Cloud auxiliary network model to P2P VOD system has been made the performance test. Through the improved node algorithm of the video crash to the cloud auxiliary and the test with traditional methods, the results show that the improved node selection algorithm not only can increase the node load rate, but also change the load of the servers with the increase of buffer node rate, which makes its load to the minimum, so the waste load in the system is reduced and the i the rate of the network is improved.

2. The System Model

A. System Architecture

The structure of current P2P VoD system roughly inherits the structure of file sharing P2P, but due to the P2P-VoD system most requires content manageable, robust and stable, and also the structure of file sharing P2P ignore or not emphasis the characteristics, so it has its specificity. For example the GnuStream [14] adopts the topological structure based on Gnut ella, which is a kind of improved centralized directory structure; for most P2P-VoD system, a hybrid topology is adopted, such as PPLive and PPStream, which inherits and combines the respective advantages of C/S and P2P architecture. Considering the IPTV P2P VoD system has the advantages and disadvantages of features and comprehensive measures of all kinds of architecture. This paper is based on P2P-VoD system architecture of the BitT orrent agreement. This framework of the proposed system is shown in Figure 1. Peer node according to time order obtains the useful Peer node list from the Tracker, and then these nodes have the node owned block location and they owned block location are matched. According to a certain rules of algorithm the block is asked for the needed to be blocked node. At the same time the own block information is periodically reported to the Tracker, which provide the content distribution service for other peers.

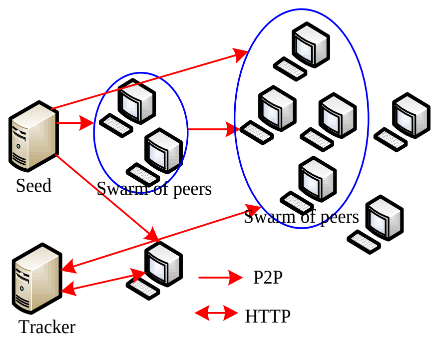

Figure 1. System Framework

B. The System Model

Set that the P2P network constitutes an undirected graph $s=(i+j)$, in which each node that meets $h_i \in h$ represents the node in the network. In graph s, the edge that meets $s_{ij}=(h_i+h_j)\in i, h_{ij}=1$ represents the neighbor relationship between node h_i and node h_j, and it is marked as $h_j \in NBR(h_i)$. For the live system of the P2P streaming media, in the various factors that cause the heterogeneity of nodes, the uplink bandwidth is the main factor, therefore the uplink bandwidth s_i of the node represents the service ability of node h_i. Set that $d_i(t)$ is the degree of node h_i, namely the number of the neighbor nodes. This paper uses the undirected graph to describe the neighbor relationship between the nodes in the overlay network of the P2P streaming media system, but actually the data transmission between the nodes is still restricted by the uplink bandwidth s_i of the node.

Definition 1: set that the playing demand rate of node h_i in the live system is R, and the actually obtained data rate is $s(t)$, then $h_i(t) = \min\{s(t)/d, 1\}$ represents the playing ratio of node.

The playing ratio of node is an important index for reflecting the playing quality of node, and when the value of $h_i(t)$ is more close to 1, the playing will be more fluent. The playing ratio of node will dynamically change over time, and it is related to the updating and exiting of the neighbor nodes.

Definition 2 shows the level of the service ability of node h_i.

$$h_i(t) = s_i / \left[(1 - h_i(t) + \alpha)(h_i(t) + \beta)\right] \quad (1)$$

Among them, ∂ and β are constants, and they meet ∂, $\beta \in (0,1)$. It can be seen from definition 2 that when the playing ratio is more close to 1, the level of the service ability of node will be higher, and at the same time, the high playing ratio shows that the data segments cached the node are more rich, and they are more able to provide services to other nodes. However, with the increasing of the nodes in service, the degree $h_i(t)$ of node will increase, and the level of the service ability of node will reduce. Considering the time-varying characteristic of the playing ratio $h_i(t)$, $d_i(t)$ can dynamically describe the heterogeneous characteristic of the node. $h_i(t)$ has the same dimension with h_i, and it treats the as the measuring unit, thus it can intuitively reflect the level of the service ability of node.

3. The NCS Algorithm

A. Model of the Node Buffer

For the nodes in the cloud auxiliary cloud demand system, for example, the node may be reported to the higher capacity data, so this kind of nodes can be selected as the super nodes, while the actual capacity of this node is far below than its capacity reported, which cause the node may become a bottleneck in the super node network, resulting in the decline of network performance. In order to avoid this phenomenon, when the node capacity is assessed, the credibility parameters of nodes are introduced. Literatures study the reputation mechanisms in P2P networks, and these mechanisms may be combined the selection algorithms with the super nodes. What's more, in order to avoid that the ability parameter of some nodes are low while but the ability parameter of other nodes are higher and the integrated capacity is high, so the probability of being selected as the super node is large. When assessing the integrated node capability, the capability threshold parameters for each ability parameter are introduced. When some capability parameter of a node is less than the threshold, the node would not have been chosen as the super node even the other capacities are higher. So the comprehensive capacity of a node can be described by Equation 2:

$$s_u(i) = \left(c_{computation}(i) + c_{stauge}(i)\right) + c_{onlinetime}(i) + ...U\left(c_x(i)\right) \quad (2)$$

Wherein $c_x(i)$ is the unified ability parameter; $s_u(i)$ is the credit value of the node; $c_{onlinetime}(i) + ...U\left(c_x(i)\right)$ is the index function; $c_{stauge}(i) = 0$.

B. The Buffer-based Node Selection Algorithm

In order to avoid the occurring of the mismatching problem during the formation of the Overlay network, the tracker server puts the nodes with a relatively near geographic location to the same node list according to the existing methods. When the new node p joins the system, it firstly connects to the tracker server and sends the video data request to the tracker server. The tracker server returns the list that contains a set of nodes with the similar download points with p, while p selects a set of nodes as the neighbor nodes from the list, and establishes the connection with the nodes to obtain the video data. What calls for attention is that, because each node has the maximum number of connections, it may lead to the rejection of the connection request of p, therefore, p needs to send the current download point and the contribution level to its neighbor nodes. The contribution level is defined as the uploading ability of the nodes, namely its speed to upload data to each neighbor node, and the greater contribution level can make the neighbor nodes to obtain larger download speed. The response nodes collect the contribution levels of the request nodes, sort the contribution levels and choose the nodes with greater contribution level to service. Because the newly joined nodes have no contribution level and cannot obtain the video data, therefore, each node needs to set aside a randomly selected connection node to carry out the service. This article assumes that the nodes can faithfully transmit their contribution levels to the neighbor nodes, and the hypothesis can be guaranteed or deployed to the existing dark nets by the widely researched reputation incentive system. When new nodes join, the tracker records their arrival time, and places them to the end of the list. In this article, the scope of the neighbor list is [$r \in N, \varepsilon N$], among which ε is the parameter that value from 0 to 1, N is the number of online nodes that can be traced to the server statistics. What calls for attention is that different nodes have different downloading abilities, and the nodes in the system may have faster download speed than the early arrived neighbor nodes, because they have bigger download points, their download rates will decline at this time, because the buffer of the neighbor nodes is lack of the current needed video data, thus, the nodes need to choose the nodes with bigger download points as their neighbor nodes. In order to adapt to this kind of circumstance, the tracker server needs to know the current download points of the nodes, and returns to the new neighbor list of the nodes. The nodes need to get in touch with the tracker server regularly and upload the their latest download points to the tracker server, then the tracker server updates the list of the nodes according to the new download points of the nodes.

The broadcast process of node number is as follows:

Step 1 the proxy nodes are responsible for reassessing the number of nodes and AA broadcast to the partial super nodes of $AS-DHT$ in the super node network. The specifics are as follows, firstly the agent nodes will divide the super nodes in $AS-DHT$ to several broadcasting group, each group will has a super node; and then the proxy nodes will randomly select a super node in the broadcasting group and broadcast the number of nodes IV to the selected super nodes; finally, the received number of nodes N of the super nodes will be continuously AA broadcast to the other super nodes.

Step 2 the first super node of each sub-space in the ID space will TV broadcast the number of nodes to the starting node.

Step 3 the node IV broadcasts the number of nodes to its gathering nodes in the sub-space.

Step 4 the gathering node TV broadcasts the number of nodes to ordinary node in the unit.

When all the nodes in network are obtained to estimate the number of nodes, K and C nodes can be estimated again and the networks can be initialized. When the number of nodes in the network changes little, there is no need to initialize the network, so the threshold can be set and updated, and when they reached the update threshold, the network is initialized again. At the same time in order to guarantee the stability of the system, the existing super nodes can continuously provide service to the general node. In the process of network initialization, the existing super nodes in the network have large probability to be super nodes, so there is not big impact of initializing the super nodes to the network.

C. The Rarest Priority and Greedy Block Download Algorithms

Compared with the P2P file system, to ensure the smoothness of the broadcasting in the cloud demand system, each data block must be downloaded to the node buffer within the specified time, therefore, by what kind of download strategy to ensure the high availability of the video data block is the problem needs to be solved. There are two strategies that can be considered, the rarest priority and the greedy strategy. The rarest priority is to firstly download the data block with the farthest distance from the play points, which will have a larger cost price when obtaining the urgent blocks. The greedy strategy is to download the data block with the nearest distance from the play points, which cannot guarantee the availability of the sparse blocks. Build the block download algorithm model under the cloud auxiliary cloud demand system. Assume that the lacked collection of blocks in the node buffer is A, and the block download scheme is u, which represents the strategy used to choose the data blocks of A. When the system reaches the steady state, the downloaded probability of block i in the buffer is $t_u(i)$, then the downloaded probability of block $i+1$ is as follows:

$$\begin{aligned} &t_u(i+1) = t_u(i) + s_u(i)t_u(i)(1-t_u(i)) + \\ &t_s s_u(i)(1-t_u(i))(1-t_u(i)) \end{aligned} \tag{3}$$

It can be seen from formula (3) that the downloading of block $(i+1)$ is implemented by moving one block to the right after the downloading of block i, because its probability is the downloaded probability of block i at the beginning of this period of time, and plus the downloaded probability of block i by the P2P way or the probability of obtaining the data from the server at the end of this period of time. $t_u(i)(1-t_u(i))$ is the probability when the node does not have block i but its neighbor node have, which shows that the block can be downloaded from the neighbor. And $(1-t_u(i))(1-t_u(i))$ is the probability when the node and its neighbor node both does not have block i, which shows that the block can only be downloaded from the server. What calls for attention is that in each time period, the server cannot reply the entire node requests due to its limited number of connections. Therefore parameter Ps represents the probability that the server is able to service this request. Formula (4) shows the probability value that the first block in the buffer can be downloaded by the server or the neighbor nodes, |m| is the number of the elements in the degree set of the nodes, and R is the number of the nodes that is waiting in the queue in the server. $s_u(i)$ is the probability when node p requests block i from the neighbor node k, and p does not have block i, but k have block i. The calculation of $s_u(i)$ can be represented as follows:

$$s_u(i) = \sum_{A: i \in A} t(i \mid A) t(A) \tag{4}$$

The definition of $s_u(i)$ given by using literature "Exploring the optimal chunk selec-tion policy for data-driven P2P streaming systems" is as follows:

1) The rarest priority is marked as u.

$$s_u(i) = 1 - t_r(i) \tag{5}$$

2) The greedy strategy is marked as g.

$$s_u(i) = 1 - \frac{1}{R} - t_g(b) + t_g(i+1) \quad (6)$$

Among which, b is the avearge buffer size of the node.

The seeking goal is to assist the nodes to choose the appropriate block download scheme to achieve the goal of obtaining the needed video data as soon as possible, according to the buffer size of the nodes. Through formula (7) and formula (8), the built differential equation is as follows:

$$\frac{dp_u(i)}{di} = s_u(i)t_u(i)(1 - t_u(i)) + s_u(i)(1 - p_u(i)) \bullet (1 - t_u(i))t_s \quad (7)$$

$$t_u(0) = \begin{cases} 1/R, \text{Download from the server} \\ 1/|m| \text{ Download from the neighbor} \end{cases} \quad (8)$$

The node sends the request of data to the server when there is ui< δ, due to the existing of the cloud distribution server, it can assume that the requests of all the nodes within the same time can be satisfied, so there is $t_s = 1$. By the same token, the value of 1/R is 1. Through the analysis and calculation of the above mathematical model, the minimum size values of the buffer required by the two block download strategies are obtained.

Conclusion 1 is that the minimum buffer required by the rarest priority scheme is $i = \left(1 - t_r(i)\right)^{-1+c}$.

Demonstration: from formula (8), (9) and (10), it can be obtained that the difference equation of the rarest priority is $dt_r(i) = t_r(i)\left(1 - t_r(i)\right)2 + \left(1 - t_r(i)\right)$, it can be obtained by solving the differential equation that there is $d_i = dt_r(i)/t_r(i-1)$, thus to obtain the following formula.

$$i = (1 - t_r(i))^{-1} + c \quad (9)$$

Among which, there is:

$$b = \begin{cases} (t_g(a) - 1)^{-1} \ln(R^{-1} - 1), \text{Download from the server} \\ (t_g(a) - 1)^{-1} \ln(|m|^{-1} - 1), \text{Download from the neighbor} \end{cases} \quad (10)$$

Conclusion 1 is that the minimum buffer required by the greedy strategy is $i = \left(1 - t_g(a)\right) - 1In\left(t_g(i) - 1\right)^{+c}$.

Demonstration: from formula (10) it can be obtained that there is $s_g(i)(1 - t_g(i))(1 - t_g(i)) \geq 1 - t_g(a)$, this is because $t_{g(i)}$) is an increasing function and there is $s_u(i)$, replace $s_g(i)(1 - p_g(i))(1 - p_g(i))$ for 1- pu(b)). From formula (11) and (12) it can be obtained that the difference equation of the greedy strategy is as follows:

$$\frac{dp_g(i)}{di} = s_g(i)t_g(i)(1 - t_g(i)) + s_g(i)(1 - t_g(i))(1 - t_g(i))t_s \quad (11)$$

By solving the differential equation, the obtained formula is as follows:

$$i = (1 - p_g(b))^{-1} \ln(p_g(i) - 1) + c \quad (12)$$

Among which, there is:

$$c = \begin{cases} (p_g(b) - 1)^{-1} \ln(R^{-1} - 1), \text{Download from the server} \\ (p_g(b) - 1)^{-1} \ln(|m|^{-1} - 1), \text{Download from the neighbor} \end{cases} \quad (13)$$

As shown in Figure 2, take $t_u(i) = 0.96$ as an example, when there is $120 \times 6b_i - t_i \prec 254 \times 6$ and the size of each block is 6 KB, in the two block download strategies, it will make it easier for the downloading of the block $i+1$ to choose the rarest priority.

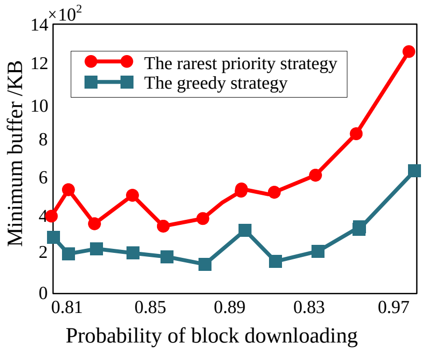

Figure 1. Size Of Minimum Buffer Of Rarest Priority Strategy And Greedy Strategy

4. The Experimental Simulation and Analysis

A. The Experimental Environment and Settings

The experimental environments of this paper are as follows, the Myeclipse 8.9 platform, the dual-core CPU and the server with the 4GB memory. Experimental parameter set is the code rate of the film is as 450 KBPS and the length is as 3000 s. The film is divided into 3000 fragments and each node can cache at most 250 pieces. The number of neighbor nodes of each node is 17. Nodes will change the caching bitmaps and the neighbor node list with neighborhood nodes at every 10 seconds; they will synchronize the directory server nodes at every 26. Each node will cache the fragment maintaining 10 second playing time before playing in advance. The survival period of nodes is generated by the distribution function of the node lifetime in the PP - live system obtained according to the literature [5]. The simulation time is set as 4000 s, and the size of the nodes in simulation is respectively set as 224456 and 1000. In the simulation, the process of adding the nodes into the system refers to the modified poisson distribution proposed by literature [8]. In the process of simulation, the distributed parameters will be changed in different time to realize the process of normal join and emergent to realistically simulate the arrival process of users in P2P-VOD system.

B. The Performance Analysis of Algorithm

First of all, when there is no joint of the helping nodes, in the system the number of users in different times and the load of the media servers when the users are in the continuous broadcasting are observed. Then, set that the average service time of the helping nodes in the system is 1600s, the helping nodes submit to the uniform distribution, and 25% of the leaving helping nodes are temporary leaving. Respectively compare the output loads of the media server with the user’s continuous broadcasting when the US is 30Mbps and 20Mbps. The results are shown in Figure 3 and Figure 4, it can be seen that when the number of active users in the system is between 700 and 800, and there is no joint of the helping nodes, the load of the media server remains at around 51Mbps, and it has a more obvious change with the changing of the number of the users. While in the system with the joint of the helping nodes, the proposed strategy can efficiently use the helping nodes to reduce the load of the media server. Specifically speaking, under the above two scenarios, the load of the media server has a small jitter around the rated value, and it is not particularly sensitive to the change of the size of the user. Figure 4 describes the number of the active helping nodes and its variation trend under the two scenarios. When there is US=32Mbps, the number of the helping nodes in the system basically remains at around 50 and 70, and when there is US=21Mbps, it basically maintains between 100 and 110. Therefore, under the current experimental settings, when the number of the helping nodes reaches about 10% of the user nodes, the load of the media server can be reduced to the 61% of its original load. And when the proportion of the number of the helping nodes in the system reaches about 13%, the load of the media server can be reduced to the 40% of its original load.

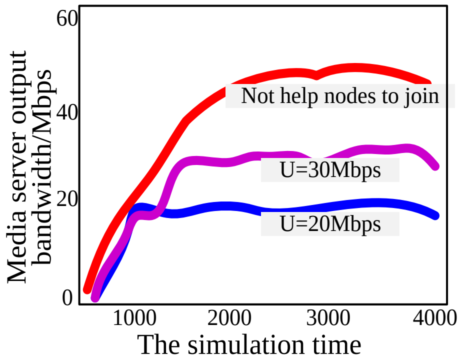

Figure 1. Comparison of the Load of the Media Server

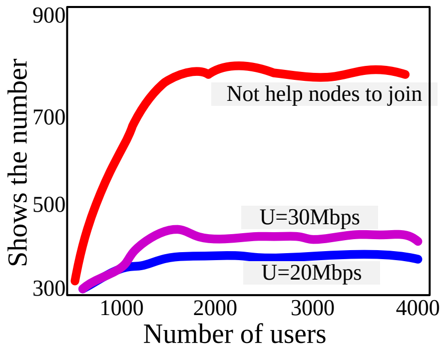

Figure 1. Comparisons between the Number of User Nodes and Helping Nodes in the System

C. The Rejection Rate Of The Node Request

In order to study the condition that the requests of the node are rejected the simulation experiment monitors how each node can send the download request and response to the requests from the other nodes, and records the number of the rejected requests. Figure 5 shows that the refused number of the NCS algorithm reduces by 27.76%, which is caused because that NCS makes the required video data the nodes with the similar download points have a larger probability to exist in the buffer of the neighbor nodes, even when the buffer of the neighbor nodes is relatively small. Figure 6 shows that due to the number of the candidate nodes in the neighbor list increases, the rejection number decreases obviously.

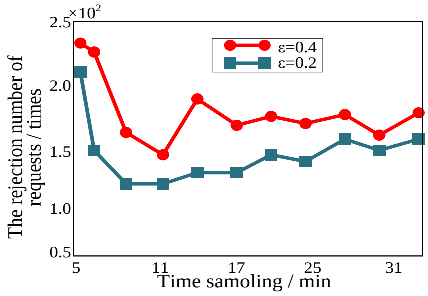

Figure 1. The Rejection Number of Requests

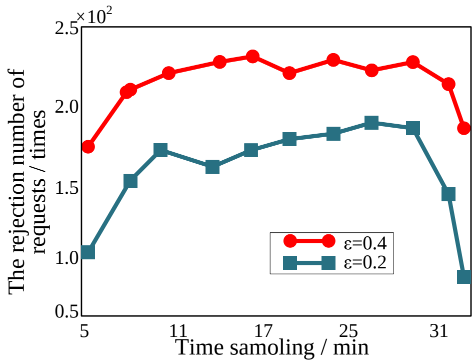

Figure 1. The Rejection Number of Requests with Different Value of ε

D. Comparison Of The Performance of Node Cache

The PDF algorithm, MA algorithm and the proposed algorithm are simulated, and the proposed algorithm are making buffer performance analysis. As shown in Figure 7, 8 and 9.

Firstly, the average degrees of continuous of three algorithms are compared as shown in Figure 7-9. As can see in Figure 7, when the size of the node is 220 or 450, the broadcast continuous degree of the algorithm is superior than the PDF algorithm and MA algorithm; when the size of the node is increased to 1260, the proposed algorithm has obvious advantages, and the continuous degree of MA algorithm is slightly better than the PDF algorithm. In addition as can be seen the average broadcast continuous degree of the proposed algorithm has good ability to adapt the change of nodes, while when the size of nodes increases to 1260, the average broadcast continuous degree of PDF algorithm rapidly decrease; compared with the proposed algorithm it has good stability.

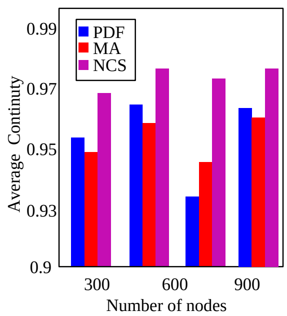

Figure 1. Average Broadcast Continuous Degree of Node Algorithm

Can be seen in the Figure 8, with the increase of system size, the load of the servers of three algorithms have a faster growth; when the size of the node up to 1260, the advantage of the proposed algorithm is more obvious. The performance of PDF algorithm and MA algorithm are similar. Combined with Figure 2 it can be seen that the proposed algorithm consumes minimal server load in the case of a higher degree of continuous playing, which illustrate that the resource utilization efficiency of the proposed NCS algorithm is high.

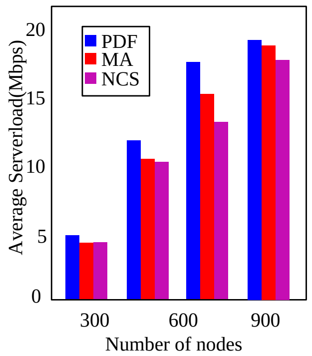

Figure 1. Comparison of the Media Load Size of the Node Network

As can be seen from the Figure 9, with the increase of the system size, the startup delay of PDF algorithm and MA algorithm increase quickly, while the startup delays of the proposed algorithm is relatively small. When there is only 220 nodes in the system, the average startup delay of the proposed algorithm, PDF algorithm and MA algorithm are roughly the same, but with the increase of the node size, the average startup delay of the proposed algorithm increases more slowly; when the node size is up to 1260, compared with other two algorithms, the proposed algorithm has significant advantages of performance.

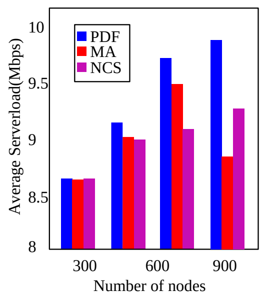

Figure 1. Average Download Rate of Nodes Start

E. The influence of the Different Numbers of The nodes With Small Buffer on the Bandwidth Overhead of The Server

The bandwidth overhead of the server is finally tested, when the numbers of the nodes with small buffer are different. Figure 10 shows the changes of the bandwidth overhead of the server, when the number of the nodes with small buffer accounts for 22%, 31% and 43% of the total number of the nodes in the network. With the increasing of the number of the nodes with small buffer, the bandwidth overhead of the server only has a small amount of increasing. Take the number of the nodes with small buffer accounts for 12% of the total number of the nodes in the network as the benchmark, when the value is 22%, the bandwidth overhead of the server increases by 4.79%, when the value is 31%, the bandwidth overhead of the server increases by 5.16%, when the value is 43%, the bandwidth overhead of the server increases by 5.29%. This suggests that with the increasing of the number of the nodes with small buffer, the increase degree of the bandwidth overhead of the server is less than8%, which is because the nodes can obtain enough download speed from other nodes to ensure the smoothness of the playing, so as to reduce the requests to the server.

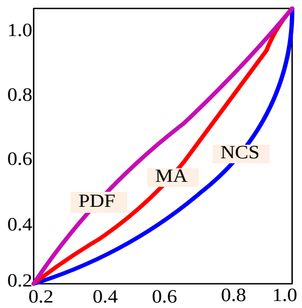

Figure 1. Bandwidth Overhead of the Server with Different Numbers of Nodes with Small Buffer

5. Conclusion

At first, this paper introduces the architecture of the cloud auxiliary Cloud demand system, and illustrates the node selection algorithm for the nodes with different buffer sizes to obtain the video data from each other when their play points are asynchronous, which through reducing the requests to the server of the VOD service provider to reduce its bandwidth overhead. Then, this paper analyzes the two different block download strategies, which provides a basis for the nodes to select which block to carry out the first download, thus ensures that the blocks need to be downloaded are highly available. Finally, the simulation experiments carry out the analysis and comparison in the aspects of the bandwidth overhead of the server, the rejection rate of the requests and the download rate, the experiments prove that the NCS algorithm can obtain better effect.

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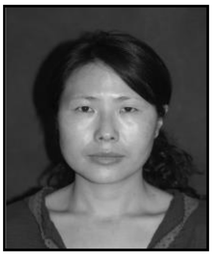

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