A Distributed Trust Model Based on Reputation Management of Peers for P2P VoD Services

Guimin Huang[1], Min Hu[2], Ya Zhou[3], Pingshan Liu[4] and Yanchun Zhang[5]
[1, 2, 3, 4]Research Center on Data Science and Social Computing, Guilin University of Electronic Technology
Guilin, Guangxi 541004 - P.R.China
[5]Victoria University
PO Box 14428, Melbourne, VIC 8001- Australia
[E-mail:{ gmhuang, leather0906, ccyzhou}@guet.edu.cn, 32015581@qq.com, Yanchun.Zhang@vu.edu.au]
*Corresponding author: Guimin huang

Received May 3, 2012; revised July 18, 2012; accepted August 20, 2012
published September 26, 2012

Abstract

Peer-to-Peer (P2P) networks are becoming more and more popular in video content delivery services, such as Video on Demand (VoD). Scalability feature of P2P allows a higher number of simultaneous users at a given server load and bandwidth to use stream service. However, the quality of service (QoS) in these networks is difficult to be guaranteed because of the free-riding problem that nodes download the recourses while never uploading recourses, which degrades the performance of P2P VoD networks. In this paper, a distributed trust model is designed to reduce node's free-riding phenomenon in P2P VoD networks. In this model, the P2P network is abstracted to be a super node hierarchical structure to monitor the reputation of nodes. In order to calculate the reputation of nodes, the Hidden Markov Model (HMM) is introduced in this paper. Besides, a distinction algorithm is proposed to distinguish the free-riders and malicious nodes. The free-riders are the nodes which have a low frequency to free-ride. And the malicious nodes have a high frequency to free-ride. The distinction algorithm takes different measures to response to the request of these two kinds of free-riders. The simulation results demonstrate that this proposed trust model can improve QoS effectively in P2P VoD networks.

Keywords: P2P, VoD, QoS, reputation values, markov chain.

This work was supported by the National Natural Science Foundation of China (No. 61063038), the Foundation of Key Laboratory of Guangxi Trusted Software (No. kx201114) , and the Foundation of Key Laboratory of Guangxi Wireless Broadband Communication and Signal Processing (No. 11108)
http://dx.doi.org/10.3837/tiis.2012.09.018

1. Introduction

Compared with the traditional Client/Server (C/S) networks, Peer-to-Peer (P2P) networks are a set of peers, such as computers or digital devices, which use their collective uploading capacity to provide service to each other. Each peer obtains the service from other peers such as its neighbors by means of network links, and it is a potential consumer of resources as well as a potential provider of resource. Furthermore , the P2P networks are a kind of scalable networks which can be enlarged when peers join P2P networks ceaselessly. The available uploading capacity in P2P networks is proportional to the number of peers. So if peers in P2P networks provide enough bandwidth, the service from resource peers in P2P networks becomes constant.

Because of the advantages of P2P networks, P2P streaming media or P2P multimedia technology has been of the most popular solution for large-scale Video-On-Demand (VoD) applications[1]. The networks of P2P streaming media are mainly constructed by two methods as follows: multiple trees-based P2P streaming algorithms and swarm. The multiple trees apply a video technique called Multiple Description Coding (MDC) to split the video stream into several sub-streams called descriptions [2]. A peer will be able to view the video stream with a quality which is proportional to the number of sub-streams it receives. The MDC makes it possible to create a forest structure, in which multiple trees coming from the peer which owning resource and spanning the peers which are constructed. By making the trees interior-node disjoint, the video streaming algorithm is made less vulnerable to individual peer departures, as only one tree is interrupted at a time. Furthermore, the load on the peers can be balanced as a peer that acts as a leaf in one tree can be used as an interior node in another tree. The swarm is another method for constructing networks of P2P streaming media. It splits the video stream into pieces with a fixed size. A peer requests each piece from its neighbors. Once it obtains a piece completely, it announces this to its neighbors. A set of peers exchanging pieces of the same video is called a swarm, a concept that has become popular after the introduction of the BitTorrent protocol[3]. It turns out that it is easy for the BitTorrent protocol to implement and provide good performance for offline downloading. The concept of swarm has been extended to live video streaming as well as video-on-demand.

With the change from C/S network topology to P2P network topology, service of streaming media is becoming an important network service on the Internet. However, there are disadvantages in P2P networks to be solved such as free-riding problem. The free-riding's peers attempt to get benefit from other peers without providing their service for sharing as best as one can. And it is a challenging problem to slow the applications of P2P networks. Related works show that 66% of the peers in Gnutella are free-riding peers and they do not contribute any service in the year of 2000, and the figure was 85% in 2005 and it increased to 97% in 2007. All these data state that free-riding problem becomes more and more serious in P2P networks [4][5]. Unfortunately, free-riding problem also exists in P2P VoD services. Compared with P2P file sharing services and P2P VoD services, the real-time requirements are an important factor for its quality. However, the free-rider problem has an impact on the real-time requirements in P2P VoD services.

In order to solve the free-riding problem in P2P VoD networks, the paper proposes a distributed trust model based on Hidden Markov Model (HMM) to recommend good peers for consumer in P2P networks. The rest parts of this paper are organized as follows: Section 2 introduces related work on improving free-riding problem in P2P system; Section 3 presents a distributed trust model based on HMM; Section 4 proves the effectiveness of this distributed trust model through a series of experiments. Finally, a conclusion is given.

2. Related Work

There are many methods of solving the problem of free-riding in P2P networks, such as incentive mechanisms[6][7], game theoretical approaches[8], social network[9], and economic models[10]. D.Wu et al.[11] propose a radically different cross-channel P2P streaming framework called View-Upload Decoupling (VUD). The VUD strictly decouples the downloading and uploading from service of streaming media of peers, bringing stability to multichannel systems and enabling cross-channel to share resources. Gupta et al. [12] present a reputation system that is partially distributed and it relies on the authority of a single agent that stores peer reputation. However, it does not discuss the mechanism of its multiple agents, so it is considered as a centralized system rather than distributed system in essence. Kamvar et al. [13] present EigenTrust that includes an algorithm for reputation management based on distributed computing of a globally consistent trust vector for every peer in P2P. On the downside, the EigenTrust relies on pre-trusted peers for convergence and its aim for global consistency assumes a rigid network of peers. Karma [14] is a network in which a set of nodes keep track of the transaction balance of peers. Its approach relies on a Distributed Hash Table (DHT) based on the structure of allocating peers and cryptographic mechanisms. Fenglin QIN et al. [15] present a simple probability model for studying the free-riding problem in P2P streaming systems. They theoretically analyze the effect of free riding on system performance including efficiency, playback continuity and transmission latency, and they also explore the relationship between the effect of free riding with specific system parameters like server bandwidth, peer degree and buffer length. J.J.D. Mol et al. [16] propose Give-to-Get, a P2P VoD algorithm which discourages free-riding by letting peers favour uploading to other peers who have proven to be good uploaders. Recently, M. Piatek et al. [17] present a reputation mechanism based on intermediaries that attest to the behavior of others. The mechanism relies on the availability and connectivity of the intermediaries at the time of a transaction. It is not robust in the dynamic P2P networks today. Feldman M. et al. [18] analyze free-riding and whitewashing and proposes some incentive techniques to deal with these two problems. But they assume that all peers have a complete view of the network, which is highly unrealistic in large, dynamic communities. Moreover, they ignore any discussion about how nodes acquire this information. Only a simple reputation metric which does not distinguish 'bad' peers from newcomers is provided and it does not include any experimental results on the consistency and effectiveness of max flow in practice. Guimin Huang et al. [19] design a distributed top-k query algorithm for DHT overlay networks by means of constructing a unique k-Cone structure. Silverston T. et al. [20] uncover the way that the incentive mechanisms in BitTorrent are not well suited to streaming live multimedia, and they propose a new incentive mechanism designed for distribution of live multimedia streaming over a P2P network. Mol, J.D. et al. [21] propose the Orchard algorithm for creating and maintaining ALM trees in P2P networks, which deals with both these problems. By employing a technique called Multiple Description Coding, they split a video stream into several substreams. Orchard creates a dynamic spanning tree for each of these substreams in such a way that in the resulting forest, no peer has to forward more substreams than it receives. Jongbae Moon et al. [22] propose a point-based incentive system that activates file sharing communications and prevents free-riding syndrome in advance. This system can lead users to aware their status and take part in more active communications using real-time point monitor. Lucia D'Acunto et al. [23] extend the peer selection mechanism of an existing BitTorrentlike VoD protocol, give-to-get, with techniques that allow peers to relax their reciprocity-based peer selection and choose more random nodes when their current QoS is high. In this way, more peers can be granted a good QoS and free-riding is tolerated only when bandwidth resources are abundant.

In this paper, a super node monitoring-based distributed trust model is designed to reduce the degree of free-riding in P2P VoD networks. According to the historical performance and ability of peers, the P2P networks can be abstracted to be a super node hierarchical structure to monitor the behavior of peers focusing on avoiding free-riding behavior. Besides, this paper distinguishes between free-riders and malicious peers. The free-riders are some peers that have the behavior of not allowing their resources to be shared when they live in P2P networks. And malicious peers are some peers that only download requirement resources from other peers rather than upload the requested resources for other peers. This distinction is supported by the following observations: different free-riders' behavior is different in the realistic P2P networks, so various steps that measure their reputation should be taken to deal with them.

There are some contributions as follows in this paper: 1) a distributed trust model has been proposed based on the reputation management of peers depending on HMM [24][25][26]; 2) Using the super node monitoring mechanism, a distributed trust mode can distinguish the free-riders and the hard malicious peers; 3) Different measures are taken to prevent this two kinds of peers; 4) HMM is used to calculate the reputation of peers in order to show different peers' actual behavior.

3. Distributed Trust Model

3.1 Design Idea

This paper proposes a trust model which is monitored by super nodes for VoD services in P2P networks. In such a network, the peers which play a same video are clustered into an application group; a group contains a super node in which the performance of online time and bandwidth are better than others. All of the peers are connected with a Track Server which maintains login information of peers in the network. Besides, there is a Streaming Server to provide original videos in the network.

Since peers within one group require the same video streaming, the Quality of Services (QoS) requirements for content delivery, such as latency, can be easily satisfied. Meanwhile, the collaboration among peers within one group keeps the communication overhead very low. Therefore, according to the behavior and function of peers, the P2P network is abstracted to be a super node hierarchical structure to monitor the behaviors of peers. Peers in P2P networks are divided into two categories: super nodes and the normal nodes. Each super node keeps connections with some normal nodes in same group. Besides, each super node can communicate with the outside groups through the track server to obtain resource of video streaming it needs. The network topology of distributed trust model is shown in **Fig. 1**.

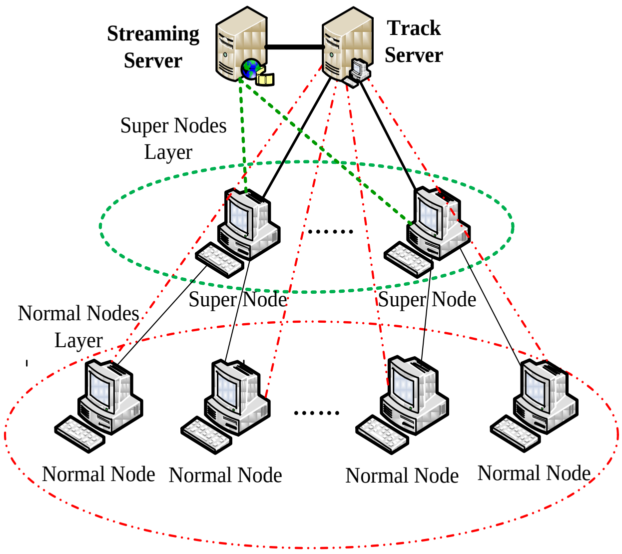

Fig. 1. Network Topology of Distributed Trust Model

3.2 Reputation Metric

The reputation of a peer stands for its contribution to its subordinate P2P network. If there are a lot of peers with high reputations in a P2P network, the performance of this P2P network will be excellent. So the higher of peers' reputations is, the better of P2P network's performance is. In order to get the reputation of a peer, super nodes need to calculate the reputation of a request peer. And if a peer wants to join a P2P network, it needs to send a joining request to a super node. When this peer is successful to join this P2P network, its living cycles can be divided into some time slots. The following Fig. 2 is an example to show living cycles of a peer in P2P networks.

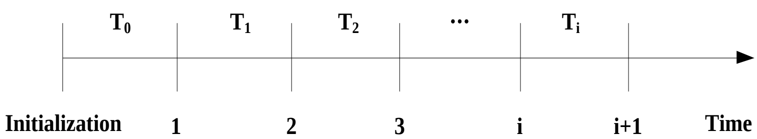

Fig. 2. An Example for Living Cycles of a Peer in P2P Networks

The reputation of a peer is defined as CR(P), please look at the following formula (1)

$$CR(P)=\begin{cases}\rho\times R_i(P)+(1-\rho)\times R_{his}(P) & i=2,3,4...\\ 0 & i=1\end{cases} \qquad (1)$$

In formula (1), CR(P) is the compound reputation of a normal node P, P is a normal node, R_{his} (P) is the historical reputation of a normal node P, R_i (P) is the current reputation of a normal node P, ρ is a weight that is a rate of current reputation in compound reputation, its value is 0.5 to 1.

$$R_{his}(P) = \frac{1}{i-1}\sum_{j=1}^{i-1} R_j(P) = \frac{1}{i-1}\sum_{j=1}^{i-1} NO_j(P)/(NO_j(P)+NA_j(P)) \quad (2)$$

$$R_i(P) = NO_i(P)/(NO_i(P)+NA_i(P)) \quad (3)$$

In formula (3), $NO_i(P)$ is the total number of service which node P provides for other nodes in i cycle and its total number of service is calculated by administering super nodes. $NA_i(P)$ is the total number of service which node P requests other nodes to provide in i cycle and its total number of service is calculated by administering super nodes. $R_i(P)$ is the ratio of $NO_i(P)$ to $NO_i(P)$ and $NA_i(P)$ in i cycle.

3.3 Simplification for Formulas

The formula (1) is too complex to compute the reputation of a node in designed trust model. For this reason, HHM is introduced to simplify it depending on the following definition 1 and definition 2.

Definition 1: The possibility of requesting resource from peer i to peer j can be represented by A_{ij}.

Definition 2: The trust relationship of the whole network can be represented by matrix A, the matrix A is constituted by A_{ij}.

$$A = \begin{bmatrix} A_{11} & A_{12} & \cdots & A_{1n} \\ A_{21} & A_{22} & \cdots & A_{21} \\ . & . & & . \\ . & . & \cdots & . \\ . & . & & . \\ A_{n1} & A_{n2} & \cdots & A_{nn} \end{bmatrix} \quad (4)$$

Using the matrix A, the global trust vector P can be calculated by the following expression.

$$P = A^T P \quad (5)$$

In formula (4), $P = [\ p(1), p(2), \ldots, p(i)\ , \ldots, p(n)\ ]^T$, where p(i) is the reputation of node i;

If an initial probability distribution vector is given that it is a peer to request video blocks from other peers at each state as P_0. And also, a transition probability matrix A is defined to refer formula (4). We will have the following formula:

$$P_0 = [\,p_0(1), p_0(2), \ldots, p_0(n)\,]^T \quad (6)$$

$$\sum_{i=1}^{n} p_0(i) = 1 \qquad (7)$$

$$\sum_{j=1}^{n} A_{ij} = 1 \qquad (8)$$

If the matrix A satisfies formula (8), A is the stochastic matrix of a Markov chain. In each Markov chain, we can determine the probability in state j in the network after one cycle by using the following reasoning.

$$p_1(j) = \sum_{i=1}^{n} A_{ij}(1) p_0(j) = \sum_{i=1}^{n} A_{ij} p_0(j),\ p_1 = \sum_{i=1}^{n} A_{ij} p_0 = A^T p_0 \qquad (9)$$

$A_{ij}(1)$ is the probability of request from peer i to j after one cycle, and it can be represented by a matrix:

$$A_{ij}(1) = A_{ij} \qquad (10)$$

So we can get formula (11):

$$p_1 = \sum_{i=1}^{n} A_{ij} p_0(j) = A^T p_0 \qquad (11)$$

In formula (11), p_0 is initial reputation and p_1 is probability reputation after one cycle. In general, the probability distribution after k cycles is:

$$p_k = A^T p_{k-1} \qquad (12)$$

By the Theorem [24][25][26] of Markov chains, a finite Markov chain defined by the stochastic transition matrix A has a unique stationary probability distribution if A is irreducible and aperiodic. So after a series of cycles P_k will converge to a steady-state probability vector regardless of the initial probability vector P_0, i.e.

$$\lim_{k \to \infty} p_k = \pi \qquad (13)$$

When peers reach the steady-state, we have

$$p_k = p_{k+1} = \pi \qquad (14)$$

$$\pi = A^T \pi \qquad (15)$$

In formula (15), π is the principal eigenvector of A^T with eigenvalue. In this paper, π is used as the trust value vector P. when node p joined in network for a long time, $\pi_i \approx R_{his}(P)$, so $R_{his}(P) \approx p_i$

Therefore, when a peer node p has joined in network for a long time, its reputations can be simplified to formula (15) in i cycle.

$$CR_i(p) \approx \rho \times R_i(p) + (1-\rho) \times \pi_p \qquad (16)$$

3.4 QoS Control in Trust Model

Before super nodes processing the request from normal nodes, the normal nodes are divided into two types: customer nodes and service nodes. The process of data transmission between nodes is shown as **Fig 3:**

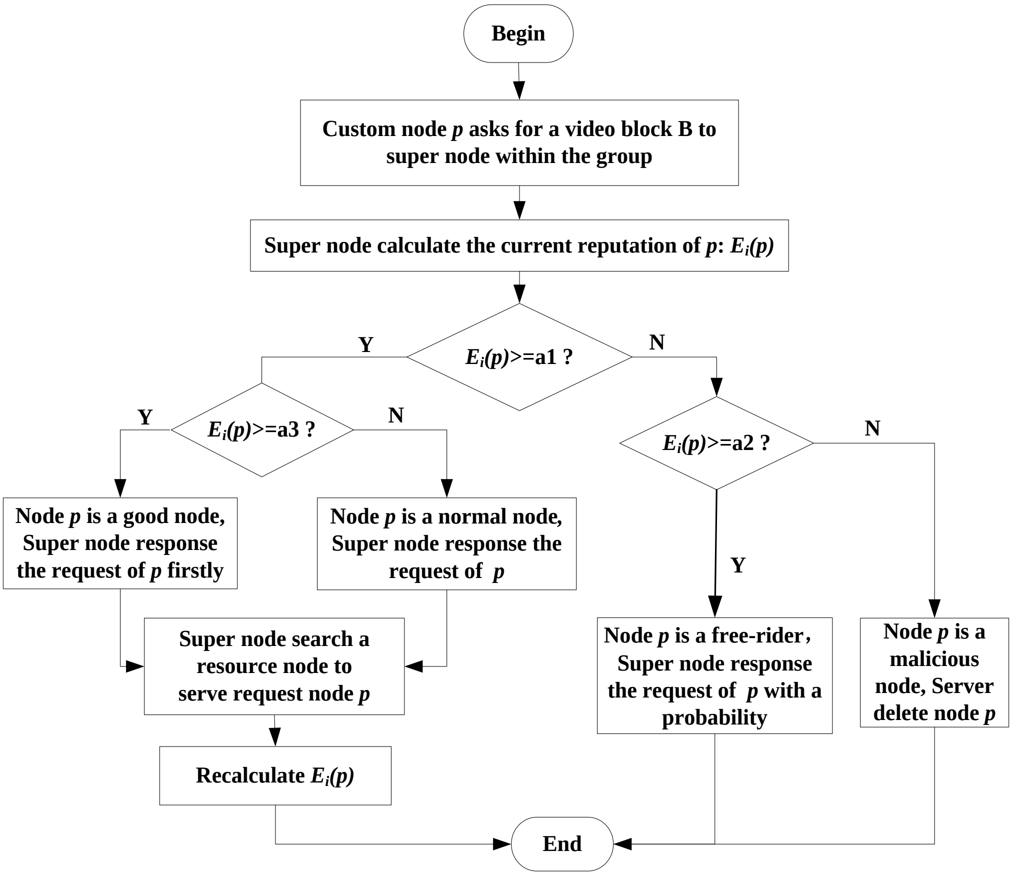

Fig. 3. The QoS Control Between Customer Nodes and Service Nodes

When a group in P2P VoD networks is formed, the request peers will seek video block within the group through super nodes firstly. If the video block exists in the group, the video block will be delivered to the request peers if request peers' reputation are greater than the threshold value proposed later. After that, the super node needs to update the reputations of request peers. If the video block not in the same group, the super node could send a request to a Track Server, and then the Track Server can either redirect the request to Streaming Server or point a peer of another group which hosts the content to respond to the request peers. Once request peers have acquired the video block from the outside groups or from Steaming Server, it could cache the video block for other peers within the same group. Since these peers only cache the new pieces of the video content which do not exist in the group, this algorithm could help to reduce overlapping content among these peers. Besides, each super node contains resource information of normal nodes in the same group and the resource information of normal nodes is kept in a data structure as **Table 1.**

Table 1. Data Structure of Super nodes

Symbol	Description
ID	Node Identification
EA_{i-1}	Historical Reputations of One Peer
NO_i	The Number of Peers to Service Other Peers in i Cycle
NA_i	The Number of Peers to Query Video Blocks in i Cycle

A. Customer Nodes Send Query to Super Nodes

Customer nodes send query requests to a super node. When the super node gets the query requests from consumer nodes, the super node replies response message that includes reputation of service nodes to customer nodes. According to customer nodes' reputation by formula (16), the super node can determine whether to assign other nodes to offer the service for customer nodes or not.

B. Super Nodes Look Up Service Nodes

Service nodes provide their own file lists to the super node; the super node selects a service node according to each service node's ability and current status to provide services to consumers. Besides, the result of selecting decisions will be sent to the service node.

C. Service Nodes Send Streaming Data to Customer Nodes

Service nodes send the streaming data to customer nodes. At the end of the service, customer nodes send feedback on the service satisfaction with service nodes to super node. Finally, super nodes recalculate the reputation of each customer node and each service node.

3.5 Incentive mechanism in Trust Model

The incentive mechanism describes that the process of super nodes deal with customer nodes request in P2P VoD networks. In incentive algorithm, the P2P VoD networks can be presented by a set of nodes such as P_1, P_2, …, P_i, …, P_n, and $i \in N$. A sequence of video blocks such as B_1, B_2, …, B_j, …, B_m, and $j \in M$. M and N are two positive integers. a1, a2, a3 are defined as threshold values that can check whether peers are good or bad. After receiving a customer node's request, super nodes offer services to customer nodes according to their reputations. The incentive mechanism of trust model can be described as follow.

```
Input: Pi, Pcurrent
Bk ← requestBlocks(Pi, Pcurrent)
SuperNode ← Pi .query(Bk)
EA(Pi) ← SuperNode.calculateReputations(Pi)
if EA(Pi) >= a3 then //
   T ← SuperNode.firstSearch (Bk)
end if
if (EA(Pi) >= a1 && if EA(Pi) < a3) then
   T ← SuperNode.search (Bk)
end if
if (EA(Pi) >= a2 && if EA(Pi) < a1) then
   T ← SuperNode.search (Bk)
end if
if (EA(Pi) < a2) then
   delete(Pi)
end if
Output: NULL
```

4. Experiment and Discussion

The simulating experiment is implemented in the PeerSim [27] simulation environment and it is to check the performance of our trust model on various scenarios. In the experiment, all peers are linked by designed trust model to construct a P2P VoD network. In the experiment, peers are divided into two kinds by their action: good peers (never providing bad services when selected) and bad peers (exploiting P2P network resources without contributing to the P2P VoD network at desirable levels). The experiment selects one online node as a super node from 100 normal nodes in P2P VoD network and initializes each normal node holding some blocks of video files at random. In experiment, 50% of nodes are set as bad nodes and 50% of nodes are set as good nodes.

In the experiment, it focuses on the performance of designed trust model to compare with random P2P VoD networks and tit-for-tat mechanism in BITTORRENT. The experiment parameters are showed in **Table 2.**

Table 2. Parameters for Experiment

Symbol	Description
Network Size	10000
Bad Peers Percentage	50%
The Initial Reputations of Every Peer	0
Links of a Peer	20
Number of Distinct Files	100
Experiment Cycles	50
Protocol	Trust Model Protocol

As is shown in section 3.5, the designed trust model needs to calculate the threshold values in order to compare with the reputations of a request node. In order to get the threshold values, the experiment calculates trust values of good peers and bad peers in random P2P networks. The following fig. 4 is experimental trust values of good peers and bad peers in random P2P networks and they are a blurry line of the distribution what the experiment wants.

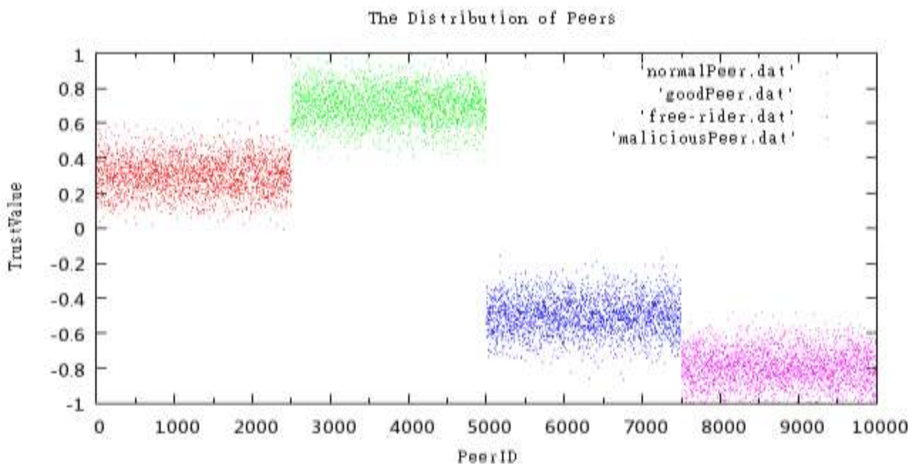

Fig. 4. The Distribution of Trust Values of Peers in Random P2P Networks

In **Fig.4,** the average reputation values of normal nodes are about 0.3, the average reputation values of good peers is about 0.7, the average reputation values of free-rider is -0.5 and the average reputation values of malicious peers is -0.8. According to these average reputation values, the threshold values are defined as a1=0, a2=-0.6, a3=0.5 that can check whether peers are good or bad.

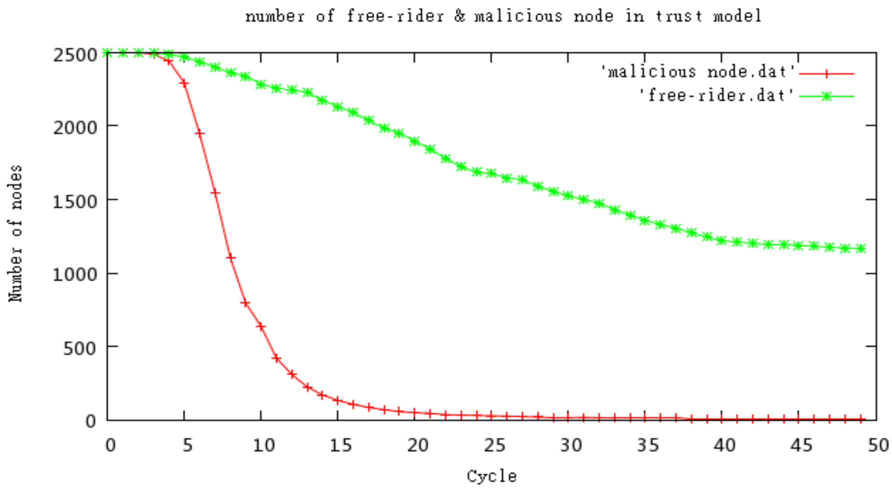

Fig. 5. The Number of Bad Peers in Each Simulation Cycle

Fig.5 shows that the number of malicious nodes and free-riders reduces gradually from cycle 0 to cycle 50 in the experiment. However, the rate of decreasing in malicious nodes is faster than that of free-riders. These results from malicious nodes' behavior show malicious nodes might cause the decrease in the performance of P2P VoD networks. If the reputations of malicious nodes are less than the threshold value a_2, the designed trust model will delete malicious nodes from the P2P VoD networks. In fig.5, the malicious peers' reputations value decreases rapidly from cycle 5 with the simulation cycle increasing.

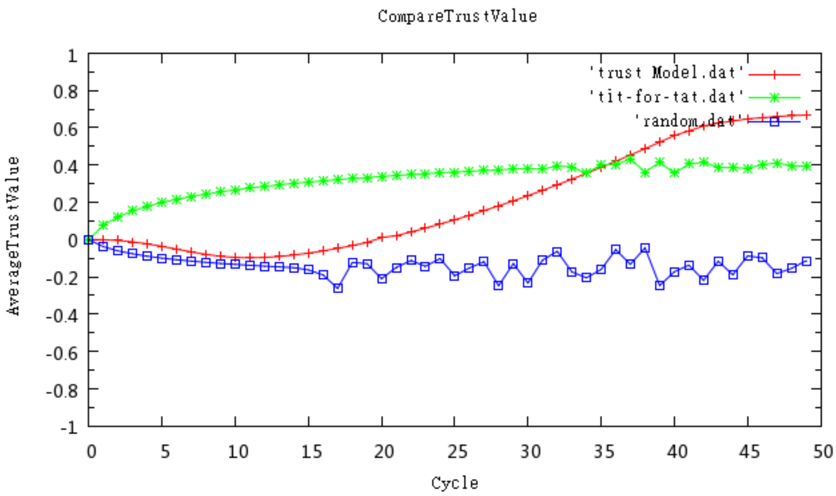

Fig. 6. The Average Number of Trust Values in Three Models

In **fig.6,** there are three lines inside such as point line, asterisk line and box line respectively. They stand for different average reputations of nodes in designed trust model, tit-for-tat model, and random model. It is obvious that the performance of designed trust model and tit-for-tat model (two rising curves) are better than random model (depression curve). It indicates that the incentive mechanism in designed trust model and the tit-for-tat mechanism in tit-for-tat model can reduce free-riders in P2P VoD networks. Therefore, designed trust model and the tit-for-tat model have more advantages than random model when they are used into P2P VoD networks.

In **fig.6**, from cycle 0 to cycle 21, the average trust values of tit-for-tat mechanism are bigger than incentive mechanism in designed trust model. The reasons are that 1) the free-riders and malicious nodes are not deleted completely from P2P VoD networks until cycle 21 in the experiment. 2) Before cycle 21 in the experiment, the decrease speed of bad peers' reputations is faster than the increase speed of good nodes'. After cycle 21 in experiment, the incentive mechanism in designed trust model deletes malicious nodes from P2P VoD networks, but the tit-for-tat mechanism in tit-for-tat model does not delete malicious nodes from P2P VoD networks. Therefore, the performance of incentive mechanism gets better than tit-for-tat mechanism after cycle 21 in the experiment.

5. Conclusion

In this paper, a distributed trust model, which is based on the reputations of nodes, is proposed in order to improve the QoS of the P2P VoD networks. The concept of roles is applied to manage the reputations of nodes and carry out the computations with a scalable and distributed manner for different roles. Normal nodes compose a decentralized unstructured network, they combine their direct and indirect experience to calculate other node's reputations, and maintain the information locally. A series of experiments show that compared with other P2P VoD service techniques such as tit-for-tat model and random P2P model, the distributed trust model is a P2P VoD service model with good performance. Further study needs to apply the designed trust model to a realistic P2P VoD system.

References

[1] D'Acunto L., Vinko T., Sips H., "Bandwidth Allocation in BitTorrent-like VoD Systems under Flash Crowds", *in Proc. of the IEEE International Conference on Peer-to-Peer Computing,* pp. 192-201, 2010. Article (CrossRef Link)

[2] YU Yi-Jiao and JIN Hai, "A suvery on overcoming free riding in peer-to-peer network", *Chinese Journal of Computers*, vol.1, no.31, pp.135-150, 2008. Article (CrossRef Link)

[3] Y.Yang, A.L.H.Chow and L.Golubchik, "Improving QoS in BitTorrent-like VoD Systems", in proc. of ieee infocom, pp.1-9, 2010. Article (CrossRef Link)

[4] Hughes, Daniel, Geoff Coulson and James Walkerdine, "Free Riding on Gnutella Revisited: The Bell Tolls?," *Journal of IEEE Distributed Systems Online*, vol.6, no.6, pp.1-13, 2005. Article (CrossRef Link)

[5] Hughes D, Coulson G and Walkerdine J, "Free Riding on Gnutella Revisited: The Bell Tolls", *IEEE Distributed Systems On-line*, vol.6, no.6, pp.1-18, 2005. Article (CrossRef Link)

[6] Anceaume E., Gradinariu M. and Ravoajia A., "Incentive for P2P Fair Resource Sharing", in *Proc. of the IEEE International Conference on Peer-to-Peer Computing*, pp.253-260, 2005. Article (CrossRef Link)

[7] M. Feldman, K. Lai, I. Stoica and J. Chuang, "Robust incentive techniques for peer-to-peer networks", in *Proc. of the 5th ACM Conference on Electronic Commerce*, pp.102-111, 2004. Article (CrossRef Link)

[8] Gupta R. and Somani A. K., "Game theory as a tool to strategize as well as predict nodes' behavior in peer-to-peer networks", in *Proc. of the 11th International Conference on Parallel and Distributed Systems*, pp.244-249, 2005. Article (CrossRef Link)

[9] M. Meulpolder, J.A. Pouwelse, D.H.J. Epema and H.J. Sips, "Bartercast: a practical approach to prevent lazy free-riding in p2p networks", in *Proc. of the 6th International Workshop on Hot Topics in Peer-to-Peer Systems in Conjunction with IPDPS*, pp.1-8, 2009. Article (CrossRef Link)

[10] Zhang Jie, Zhao Zheng and Wang Song, "A role-based trust model for peer-to-peer systems", in *Proc. of Next-Generation Communication and Sensor Networks*, pp.377-386, 2006. Article (CrossRef Link)

[11] D.Wu, C. Liang, Y.Li and K. Ross, "View-Upload Decoupling: A redesign of multi-channel p2p video systems", *IEEE INFOCOM*, pp.2726-2730, 2009. Article (CrossRef Link)

[12] M. Gupta, P. Judge and M. Ammar, "A reputations system for peer-to-peer Networks", in *Proc. of the 13th International Workshop on Network and Operating Systems Support for Digital Audio and Video*, pp.144-152, 2003. Article (CrossRef Link)

[13] S.D. Kamvar, M.T. Schlosser and H. Garcia-Molina, "The eigen trust algorithm for reputations management in p2p networks", in *Proc. of the 12th international conference on World Wide Web*, pp.640-651, 2003. Article (CrossRef Link)

[14] V. Vishnumurthy, S. Chandrakumar and E.G Sirer, "Karma: A secure economic framework for peer-to-peer resource sharing", *In Workshop on the Economics of Peer-to-Peer Systems*, pp.1-6, 2003 Article (CrossRef Link)

[15] Fenglin QIN, Liansheng GE, Qi LIU and Ju LIU, "free riding analysis of peer-to-peer streaming systems", *Journal of Computational Information Systems*, vol.7, no.3, pp.721-728, 2007. Article (CrossRef Link)

[16] J.J.D. Mol, J.A. Pouwelse, M. Meulpolder, D.H.J. Epema and H.J. Sips, "Give-to-Get: Free-riding-resilient Video-on-Demand in P2P Systems", *Multimedia Computing and Networking*, vol. 6818, pp.681804-681804-8, 2008. Article (CrossRef Link)

[17] M. Piatek, T. Isdal, A. Krishnamurthy and T. Anderson, "One hop reputations for peer to peer file sharing workloads", in *Proc. of the 5th USENIX Symposium on Networked Systems Design and Implementation*, pp.1-14, 2008. Article (CrossRef Link)

[18] Feldman M. and Chuang J., "Overcoming free-riding behavior in peer-to-peer systems", *ACM SIGCOM Exchanges*, vol. 5, no. 4, pp.41-50, 2006.Article (CrossRef Link)

[19] Guimin Huang, Yuhong Liang and Ya Zhou, "A Distributed Top-k Query Algorithm Integrated k-Cone Structure for DHT Overlay Networks", *International Conference on Multimedia Technology*, pp.24-27, 2011.Article (CrossRef Link)

[20] Silverston T., Fourmaux O. and Crowcroft J., "Towards an Incentive mechanism for Peer-to-Peer Multimedia Live Streaming Systems", *In IEEE Eighth International Conference on Peer-to-Peer Computing*, pp. 125-128, 2008.Article (CrossRef Link)

[21] Mol J.D. , Epema D.H.P. and Sips H.J. , "The orchard algorithm: building multicast trees for p2p video multicasting without free-riding", *IEEE Transactions on Multimedia*, vol. 9, no. 8, pp.1593-1604, 2007. Article (CrossRef Link)

[22] Jongbae Moon and Yongyun Cho, "A point-based inventive system to prevent free-riding on p2p network environments", *Lecture Notes in Computer Science*, vol.6785, pp.462-471, 2011.Article (CrossRef Link)

[23] Lucia D'Acunto, Nazareno Andrade, Johan A. Pouwelse and Henk J. Sips, "Peer Selection Strategies for Improved QoS in Heterogeneous BitTorrent-Like VoD Systems", in P*roc. of the IEEE International Symposium on Multimedia*, pp.89-96, 2010.Article (CrossRef Link)

[24] Lawrence R. Rabiner, "A tutorial on hidden markov models and selected applications in speech recognition", in *Proc. of the IEEE*, vol.77, no.2, pp.257-286, 1989. Article (CrossRef Link)

[25] Daniel Ramage, "Hidden Markov Models Fundamentals", CS229 Section Notes, 2007.Article (CrossRef Link)

[26] Mark Stamp, "A Revealing Introduction to Hidden Markov Models", San Jose State University, 2012.Article (CrossRef Link)

[27] Montresor. A. and Jelasity and M., "PeerSim: A Scalable P2P Simulator", *IEEE Ninth International Conference on Peer-to-Peer Computing*, pp.99-100, 2009.Article (CrossRef Link)

Prof. Guimin Huang is a full professor at Guilin University of Electronic Technology in China. He worked as an assistant professor at the Curtin University in Australia. Recently, he has published more than eighty academic papers on international journal and international conference, published one book of Peer-to-Peer network, awarded a patent of invention as well as five Software Copyright Registration Certificates. His research interest includes distributed networks and text mining.

Postgraduate Min Hu has obtained bachelor's degree at Inner Mongolia Normal University in 2009. He is a postgraduate at Guilin University of Electronic Technology. He focuses on the P2P networks and its quality of service.

Prof. Ya Zhou is a professor at Guilin University of Electronic Technology in China. Recently, she has published more than sixty academic papers on journal and international conference, published one book of Peer-to-Peer network, awarded a patent of invention, awarded tree Software Copyright Registration Certificates. His research interest includes distributed networks and database technology.

Dr. Pingshan Liu is a lecture at Guilin University of Electronic Technology in China. Recently, she has published more than five academic papers on international conference. His research interest includes distributed networks and data ming.

Prof. Yanchun Zhang is the Director of the Centre for Applied Informatics (CAI), and coordinates a multidisciplinary e-research program across the University. He is an international research leader in databases, data mining, health informatics, Web information systems, and Web services. He has published over 220 research papers in international journals and conferences proceedings, and authored/edited 12 books.