Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

Content Replication Strategy in BitTorrent File Sharing System

Fanfeng Shi
School of Information Engineering, Yangzhou Polytechnic Institute, Yangzhou 225127, China

Abstract:

Peer-to-Peer (P2P) file sharing systems, most notably BitTorrent (BT), have achieved tremendous success among Internet users and played an important part in quick prosperity of Internet. However, the accompanying huge backbone traffic has brought numerous Internet Service Providers (ISPs) close to break-point. How to coordinate the conflict between ISPs and BT systems has always been the center of attention in the research of worldwide network architecture, for which many institutions had supposed a great deal of solutions. But new research result of network measurement shows that locality policy of peer selection may not be the best choice. In this paper, we focus on the downloadable file content resources scheduling, examine different peer properties and BT swarms distribution in Autonomous Systems (ASes) through large-scale measurement, replicate the most desirable torrent file content to designated BT peers, and keep the total file resources balance of BT network. In this way, most BT users could download the desired file locally and naturally, and the inter-ISP traffic would be reduced substantially. Our trace-driven simulation shows that outside traffic is decreased by 50% to 70%.

Keywords: *BitTorrent Protocol, File Sharing, Content Replication, Network Measurement*

I. INTRODUCTION

BitTorrent (BT) is the most popular file sharing system for the worldwide Internet and it empowers millions of global users to share tens of thousands of files online. The BT file sharing system adopts a peer-to-peer (P2P) network architecture that allows users to exchange data with neighbor nodes, instead of the designated server. However, this architecture brings huge backbone network traffic to Internet Service Providers (ISPs)[1]. Statistics show that BT file sharing accounts for 60% of the backbone network traffic between 2002 and 2007[2]. Starting from 2008, video websites represented by YouTube ignited Internet users' huge market demand for online videos. In recent years, many streaming media service systems based on P2P network technology such as PPLive, QQLive, and AnySee have been deployed on a large scale, and video-on-demand (VOD) systems based on the BT protocol such as Thunder Player and QVOD Player have been launched one after another. A large number of audio and video files burst on the BT file exchange network with an average file size of 1 GB, and 90% of the files exceed 100 MB in size[3]. Many ISPs cannot bear the huge backbone network traffic brought by mass P2P connections across Autonomous Systems (ASes), and have deployed middle-boxes[4] to restrict or even block the BT protocol. On the other hand, the BT protocol developer has optimized the protocol to avoid these restrictions.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

The disparity between ISPs and BT systems[1] attracts high attention of the Internet industry and research institutions. Solutions proposed in recent years can be classified into two categories: ISP-friendly P2P technology[2,5,6] and P2P locality-ware node selection[7,8]. However, according to the BT network measurement and research[9-11], user nodes are evenly distributed on the BT file sharing network (see Section 3.2) and only a few number of local BT users in an ISP AS download the same file. As a result, the locality-aware node selection policy or ISP-friendly P2P design has little role to play and it is extremely hard for ISPs and BT systems to achieve win-win. Furthermore, it is a common consensus in the industry that the efficiency, robustness, and scalability of the BT system benefit from random distribution of the P2P overlay network topology of the BT system[12,13]. If the BT system must select neighbor nodes from an ISP AS, the overall system performance will be deteriorated[14].

In this paper, we measured and analyzed the BT file sharing network named ByrBT and found that most BT users remain online after they complete file downloading and the seeding duration can be up to several hours. Possible causes for the phenomena are the popularity of home broadband network in recent years and BT users' habits to maintain online long. This unconscious altruistic action is exactly what needed to achieve the goal of BT traffic localization. We prove that a large number of potential seeders exist in the BT system (see Section 3.2), even if the asymmetry of uplink and downlink bandwidths of the access network is taken into account. To some extent, large amounts of inter-AS connections emerge on the BT network because file resources are not effectively managed and utilized, rather than no file resources are available in an ISP AS for downloading.

This paper proposes a BT file sharing service model that converts common BT users with high resource potential in ISP ASes into seeders and supports file content replication between different ISP ASes in the BT swarm, so that BT users preferentially download files from ISP ASes. This model eliminates the need for deploying a complex cooperation mechanism between ISP ASes[2,5,15] and reduces inter-AS BT connections and backbone network traffic.

II. REPLICATIVE BT NETWORK

The BT system is designed based on the worldwide Internet standards and aims at realizing high-speed online file sharing by scheduling the upload bandwidth resources of various common nodes on the entire Internet. At the initial stage, the BT download protocol did not consider the inter-AS traffic that ISPs may need to process. We believe that the root cause that determines the operational efficiency of the BT network is the distribution characteristics of BT download resources rather than peer clustering of BT user nodes. This section briefly introduces the basis of the BT protocol, analyzes the globalized characteristic of the BT network, and further proposes a policy of replicating file content among BT user nodes and adjusting the distribution of file resources available for downloading on the BT network.

2.2 BT Protocol

The BT network can efficiently distribute large-sized files (films or TV programs) because it uses the P2P file download protocol. Each BT user can download files and share files to other BT users. BT users

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

that download the same file constitute a P2P overlay network, which is also called a BT swarm. Figure 1 shows the BT file sharing principle. In this figure, the BT swarm consists of two types of BT user nodes (seeder and leecher) and one track server (tracker). A seeder has completed file downloading and can share the file content to other BT users. Leechers are BT nodes that are downloading the file content. The tracker stores the metadata of shared files in the BT swarm, the number of seeders and leechers, and IP addresses in a centralized manner. When a new BT user joins the BT swarm, the tracker randomly selects some active nodes from the swarm and provides them to the user.

2.2 Global BT Network

The BT protocol ignores the physical topology of the underlay network and allows BT users to select neighbor nodes by checking whether file resources for downloading are available but not whether the neighbor nodes are in the local AS. Many BT users establish inter-AS links with remote BT users to share files, even if they can download the same file from the local ISP AS.

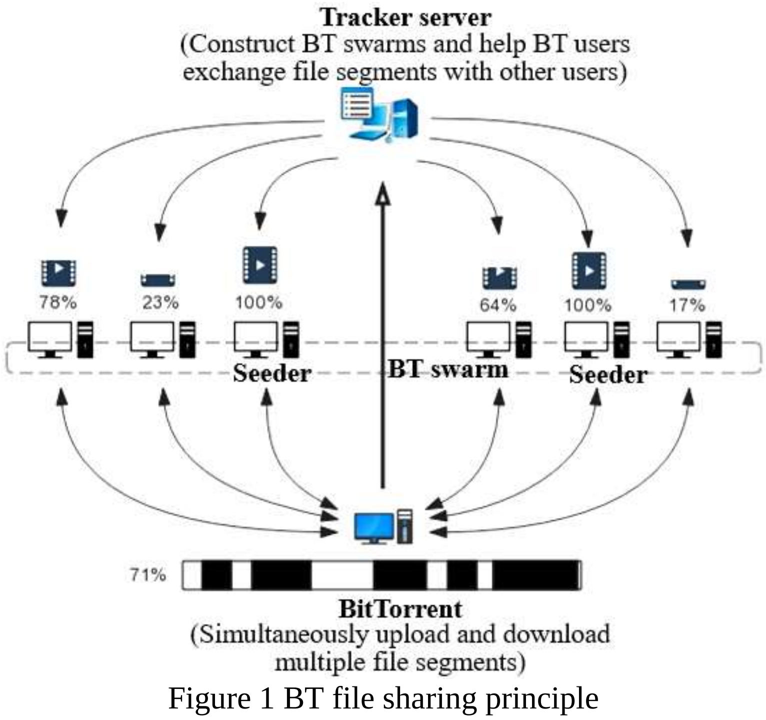


Figure 1 BT file sharing principle

From the global Internet view, the BT network takes full advantage of upload bandwidth resources of common network nodes to implement load balancing. From the ISP view, the BT network is absolutely budget unbalanced and far from load balanced. BT users in an ISP AS pay only for network connections, so the ISPs need to pay the extra fees for inter-AS links. From this perspective, conflicts between ISPs and BT systems are inevitable. Existing P2P ISP inter-AS cooperation mechanisms[2,5,15,16] are either complicated[2,15] or difficult to deploy[5,16], and they cannot solve the problem from the root.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

2.3 Implementing BT Traffic Localization Through File Content Replication

The distribution of BT network user nodes in each ISP AS is the prerequisite for implementing the locality-aware P2P node selection policy. However, the latest BT network measurement results[3,9,10,14] show that the BT user nodes are sparsely distributed, more than 95% of BT swarms (composed of user nodes downloading the same file) contain no more than 300 BT users, the ratio of the number of BT users in the same ISP AS to the size of the BT swarm shows Mandelbrot-Zipf distribution, with the maximum value of 30%[3,14], and no more than 10% of BT users download files from the local ISP AS[10]. To sum up, the locality-aware P2P node selection policy has a limited effect on reducing backbone network traffic.

BT users are most concerned about "where to find a resource" rather than "the location of the resource". The locality-aware policy tries to limit neighbor nodes of BT users within the local ISP AS as many as possible, instead of linking as many file download resources as possible to the local ISP AS. With this policy, BT users still have to establish inter-AS connections to remote BT nodes with file download resources if they cannot find required resources in the local ISP AS. If BT users can find sufficient file download resources in the local ISP AS, the amount of inter-AS traffic initiated by BT users will naturally be reduced, and there will be no need to modify BT protocol specifications or replace BT application software.

As shown in Figure 2 (a) (BT network), BT users in ISP AS 1 download files from seeder 2 in ISP AS 2 and they constitute BT swarm 2, and BT users in ISP AS 2 download files from seeder 1 in ISP AS 1 and they constitute BT swarm 1. Almost all BT traffic is inter-AS traffic. The reason for this phenomenon is that the file download resources are not in the local ISP AS, although the neighbor nodes are in the local ISP AS. If seeders 1 and 2 can copy file resources from each other, as shown in Figure 2 (b), the file content copied from remote BT nodes to the local ISP ASes, BT users can download files from the local ISP ASes, thereby effectively reducing the inter-AS traffic.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

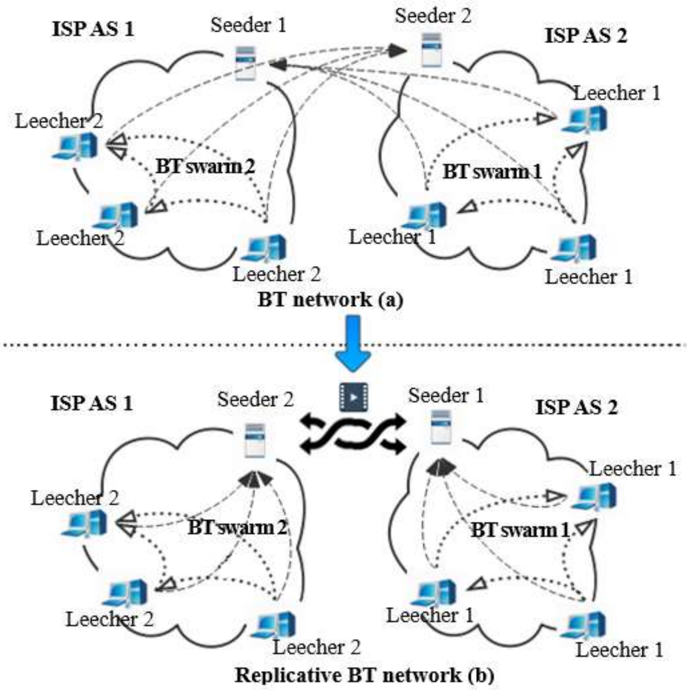


Figure 2 BT network and replicative BT network

We will describe the file content replication policy in details in Section 4. But now, we still have one more question: Can the BT network offer sufficient file download resources? For a long time, selfish actions such as "going offline immediately after completing file download" will result in scarcity of download resources in the BT network and then lower the overall efficiency of the BT system due to the lack of an effective reward and penalty mechanism in the BT protocol. However, BT network measurement comes to a different conclusion from the preceding common consensus in the industry. We will describe the measurement result in Section 3.

III. BT NETWORK MEASUREMENT

3.1 Measurement System Architecture

We designed a BT network measurement system for monitoring the operational status of the BT network and executing the file copy policy. As shown in Figure 3 BT network measurement architecture, the system is mainly composed of a monitor and a scheduler. This system performs BT network measurement in two steps: (1) Find the BT seed files and the tracker in the BT network. (2) Collect and record the P2P traffic data in each BT swarm, and then measure and analyze the data. For Step 1, we set three program modules in the measurement software:

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

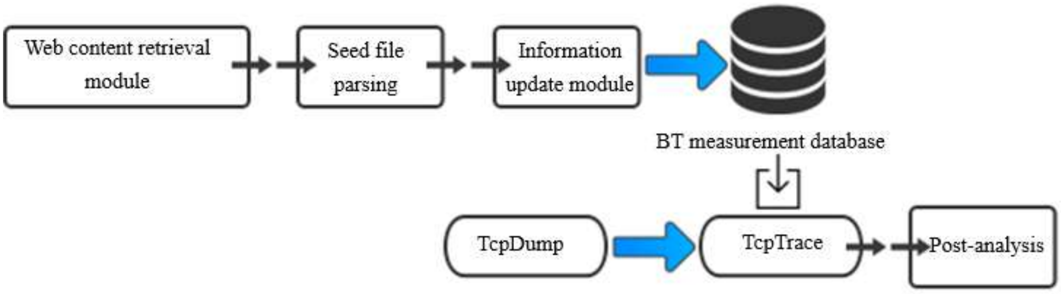


Figure 3 Three program modules in the measurement software

- **Web content retrieval module (HTML crawler):** This module repeatedly crawls the HTML web pages of a BT site and downloads BT seed files so long as they are found.

- **Seed file parsing module:** This module analyzes BT seed files to obtain information such as the file name, number of seeders, number of leechers, and URL and IP address of the tracker, and creates a separate data record for each file in the database.

- **Information update module:** This module periodically parses the URL of the tracker, verifies the accessibility of the URL, and updates the database records. If the URL is invalid, save the last IP address parsed from the URL.

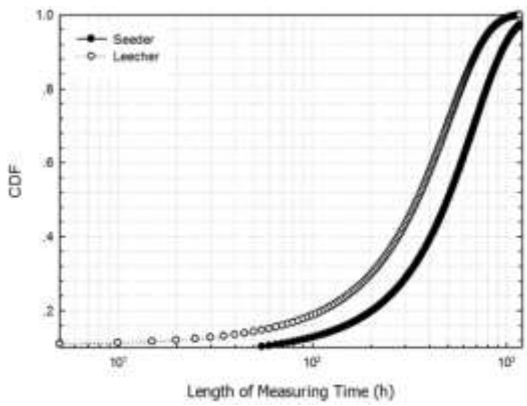
As BT network nodes interact with each other by using the TCP protocol, we use the TcpDump and TcpTrace programs in the BT[17] network measurement system to collect and analyze BT traffic in Step 2. Considering that the measured host resources are limited, we use the TcpDump program to convert data packets captured from the data link layer into data sets for measurement and then use the TcpTrace program for protocol analysis. After information such as the IP address of the BT user node is parsed, we test the upload and download bandwidths of the node and record the node status (seeder or leecher).

We spend four months starting from October 2013 collecting and analyzing the BT traffic of the most popular ByrBT site on the China Education and Research Network (CERNET). This site has more than 68,000 registered users and more than 27,000 BT seed files. During the four months, we have collected more than 2 TB of BT traffic data, parsed more than 11,000 BT seed files and more than 2,200 tracker service nodes, and monitored more than 3,700 management and operation agencies and approximately 100,000 independent IP addresses. The CERNET architecture is divided into three layers, namely the backbone network, the provincial/city education network, and the campus network. Most of the management and operation agencies on CERNET are educational institutions at various levels, which differ greatly from ISPs in terms of the nature of the organization, but are similar with ISPs in terms of the network operation and management. Therefore, we still use ISP AS in the following section to refer to the network operation and management scope.

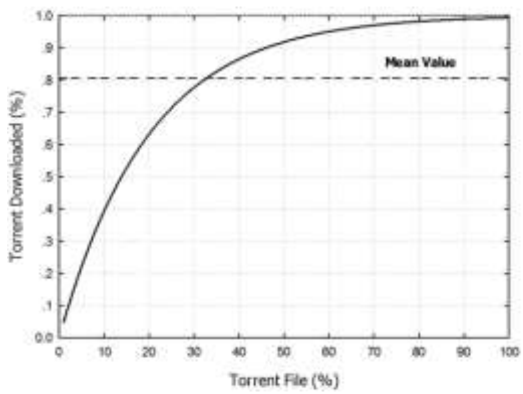
Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

3.2 Measurement Results

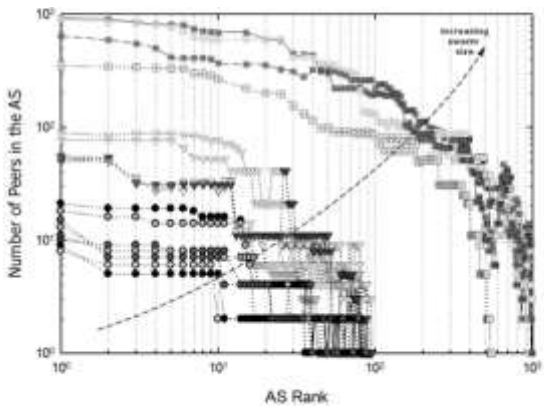
Figure 4 (a) shows that the online time of seeders and leechers in the BT network is not as predicted above. That is, actions such as "going offline immediately after completing file download" will result in scarcity of download resources. The cumulative probability distributions of the two types of BT users indicate that the average seeding time is 1.7 to 2.2 times of the download time, and many BT users remain online after they complete downloading all the content. This greatly enriches the file download resources in the BT network. Figure 4 (b) shows that over 80% of BT network activities are concentrated in 10% or fewer BT seed files, most BT seeds are not popular for a long time, and the higher popularity of a BT seed file indicates the larger size of the formed BT swarm. Figure 4 (c) shows that the size of the BT swarm is directly proportional to the size of the ISP AS. The larger the ISP AS scale, the more BT user nodes in the BT swarm. Due to the two factors, 80% of inter-AS network traffic is produced by fewer than 10% of the ultra-large BT swarms. This is beneficial to the traffic optimization policy that seeks for the nearest BT neighbor node. However, Figure 4 (d) shows that over 70% of the BT swarms have no more than nine user nodes in the same ISP AS. Except for a few top ISP ASes, BT users in most ISP ASes do not download the same file. This means that the BT nodes in the BT network have low peer clustering.



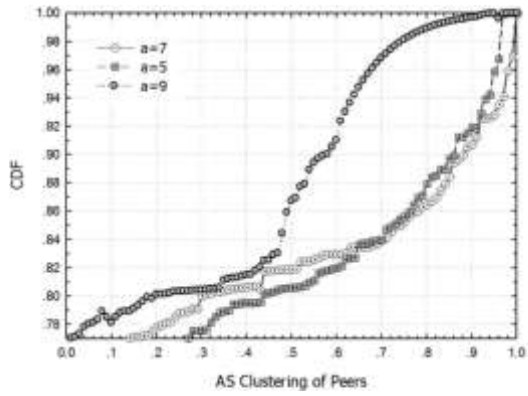
(a) Online duration of BT user nodes



(b) Popularity of BT seed files



(c) Number of BT users in a BT swarm



(d) Number of BT users in the BT swarm of the local ISP AS

Figure 4 Measurement results

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

IV. FILE CONTENT REPLICATION ALGORITHM BASED ON STATISTICAL MEASUREMENT

As you can see from the network measurement results in Section 3, the BT file sharing network is highly dispersed in terms of the BT user behavior characteristics, BT swarm distribution, BT file download model, and inter-AS network traffic. The results also show that the factors affecting the overall performance of the BT network are highly concentrated, which provides high possibility for implementing BT traffic localization through file content replication.

Due to the complexity of the BT file sharing network (see Section 3.2), simple file content replication is obviously not advisable. If there are only a limited number of BT users and no more than five nodes in each ISP AS participate to form a BT swarm, as shown in Figure 4 (d) in Section 3.2, searching BT users with high upload resource potential in the local ISP AS and replicating file content for them cannot significantly reduce the inter-AS network traffic. The effect of such operations will be significant if there are a huge number of BT users and hundreds of nodes in each ISP AS participate to form a BT swarm. For this reason, before implementing file content replication, it is necessary to conduct statistical measurement and analysis in advance to find out the peer clustering of BT user nodes in an ISP AS in the BT file sharing network.

4.1 Calculating the Peer Clustering of BT Nodes in an ISP AS

Symbol conventions in this paper are as follows:

$\aleph$: Indicates the collection of all ISP ASes in the worldwide Internet.

$\Re$: Indicates the collection of all BT swarms in the BT system.

A : Indicates the random variable of a specific ISP AS. $P(\mathrm{A}=\alpha)$ indicates the probability that the value of A is α $(\alpha \in \aleph)$.

S : Indicates the random variable of a specific BT swarm.

T : Indicates the frequency table of random variables A and S. In this table, $\mathrm{T}(\delta,\alpha)$ indicates the number of users in the BT swarm δ that belong to the ISP AS α.

$P(\delta \mid \alpha)$: Indicates the probability that the BT user in the ISP AS α belongs to the BT swarm δ.

$P(\alpha \mid \delta)$: Indicates the probability that the BT user in the BT swarm δ belongs to the ISP AS α.

With the frequency table T, it is easy to calculate and compare $P(\delta \mid \alpha)$ and $P(\alpha \mid \delta)$ by using the following formulas:

$$P(\delta \mid \alpha)=\mathrm{T}(\delta,\alpha) \Big/ \sum_{\alpha\in\aleph} \mathrm{T}(\delta,\alpha) \tag{1}$$

$$P(\alpha \mid \delta)=\mathrm{T}(\delta,\alpha) \Big/ \sum_{\delta\in\Re} \mathrm{T}(\delta,\alpha) \tag{2}$$

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

In formula (1), $\sum_{\delta\in\Re}\mathrm{T}(\delta,\alpha)$ indicates the distribution of the BT swarm δ in all ISP ASes. In formula (2), indicates the $\sum_{\alpha\in\aleph}\mathrm{T}(\delta,\alpha)$ distribution of the ISP AS α in all BT swarms. $P(\mathrm{A}|\alpha)$ indicates the relationship between a specific ISP AS α and another AS A in all BT swarms, and it is calculated as follows:

$$P(\mathrm{A}|\alpha)=P(\mathrm{A}|\delta_1)P(\delta_1|\alpha)+P(\mathrm{A}|\delta_2)P(\delta_2|\alpha)+\cdots\cdots=\sum_{\delta\in\Re}P(\mathrm{A}|\delta)P(\delta|\alpha) \quad (3)$$

The value of $P(\mathrm{A}|\alpha)$ shows the intimacy of the relationship between the ISP AS α and another AS A, and this relationship is established based on the BT swarm. The wide distribution of the ISP AS α over $\Re$ indicates a narrow distribution of the BT swarm δ over another AS A and the high randomness of BT nodes in the ISP AS α. Here, we use $Entropy(\alpha)$ of $P(\mathrm{A}|\alpha)$ to reflect the random change degree.

$$Entropy(\alpha)=\mathrm{H}\left(P(\mathrm{A}|\alpha)\right)=\sum_{\bar{\alpha}\in\mathrm{A}}P(\bar{\alpha}|\alpha)\log\left(P(\bar{\alpha}|\alpha)\right) \quad (4)$$

The higher entropy value of the ISP AS α, the more BT swarms to which BT nodes in this AS are distributed. (Without doubt, the number of nodes in this AS is large.) This indicates a higher probability of forming a larger intra-AS node swarm, with high peer clustering. File content replication can be applied in the ISP AS α to copy most required files to BT nodes with high upload bandwidth potential in the AS α to increase the number of seeders. Then, an unchoke message is sent to other BT user nodes, and the newly added nodes obtain identity information of new seeders (with complete file resources) through the handshake message. After that, BT users have more chances to download files from seeders in the local ISP AS, thus smoothly lowering the overall inter-AS BT traffic.

4.2 File Content Replication Algorithm

In our BT network measurement system (see Section 3.1), the scheduler is responsible for file content replication between BT nodes. The file content replication algorithm contains the following steps:

Step 1: Use the frequency table T obtained by network measurement to calculate the entropy values E of the ISP ASes and sort the ASes. Then, select the top 10 ISP ASes.
Step 2: Search for BT nodes with upload bandwidth greater than download bandwidth in each ISP AS. If multiple nodes meet this criteria and they belong to the same BT swarm, randomly select one as the new seeder candidate. Create a new seeder node list $candidate-list$. The list contains elements $(swarm-id, seeding-peer-id)$.
Step 3: Sort BT seeds by popularity and select top 100 BT seeds. Find user nodes with complete file content from the corresponding BT swarm of each BT seed on the tracker. Create a list of BT seed file source nodes $seeder-list$. The list contains elements $(swarm-id, seeder-id)$.
Step 4: Compare $candidate-list$ with $seeder-list$. If they contain the same $swarm-id$, a file replication

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

relationship is established between $seeder-id$ and $seeding-peer-id$. Then, file content replication can be implemented.

For user nodes newly added to the BT network, we perform the following steps to modify the tracker protocol:

Step 1: Add the new BT user node X to the BT network, specify the BT swarm $swarm-id$ that the node belongs, and send a whois request message to obtain the ISP AS $AS-id$ to which the node belongs.
Step 2: If the ISP AS ranks top 10 according to the entropy E and the BT seed corresponding to $swarm-id$ ranks top 100 according to popularity, the nearest designated seeder node $seeding-peer-id$ must exist in the AS.
Step 3: Report on the tracker that the $seeding-peer-id$ node has been added to the neighbor node list of the user node X.

4.3 Lab Verification

We designed a simulator based on the real operating state to verify the proposed file content replication algorithm by using the BT traffic data sets obtained during network measurement as input and simulating the actual running of the BT network. To ensure the pertinence and validity of the test data, we randomly selected 691 BT seeds from the ByrBT site for monitoring and observed nearly 19,245 independent IP addresses from 1,355 management agencies over 17 provinces. We designed four algorithms in the simulator: (1) Baseline algorithm: selecting neighbor nodes strictly in accordance with the BT protocol specifications; (2) Locality-aware algorithm: selecting neighbor nodes from the local ISP AS as many as possible[14,18,19]; (3) ISP-friendly algorithm: considering as many ISP needs as possible for P2P overlay network construction[2,5,6]; (4) Replicative algorithm: selecting proper ISP AS and BT swarm according the network measurement and analysis results, finding potential seeders, and replicating file content.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

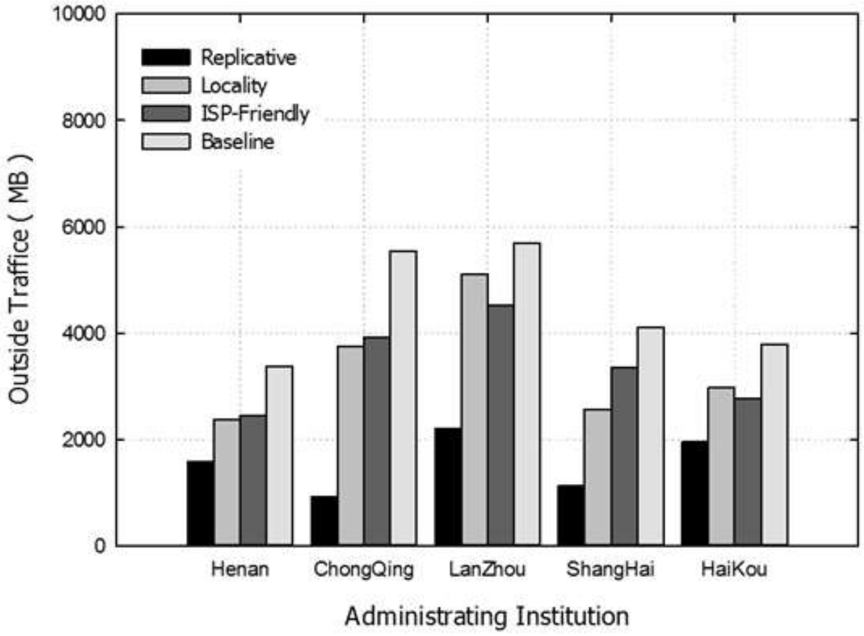


Figure 5 Advantage of file replication policy

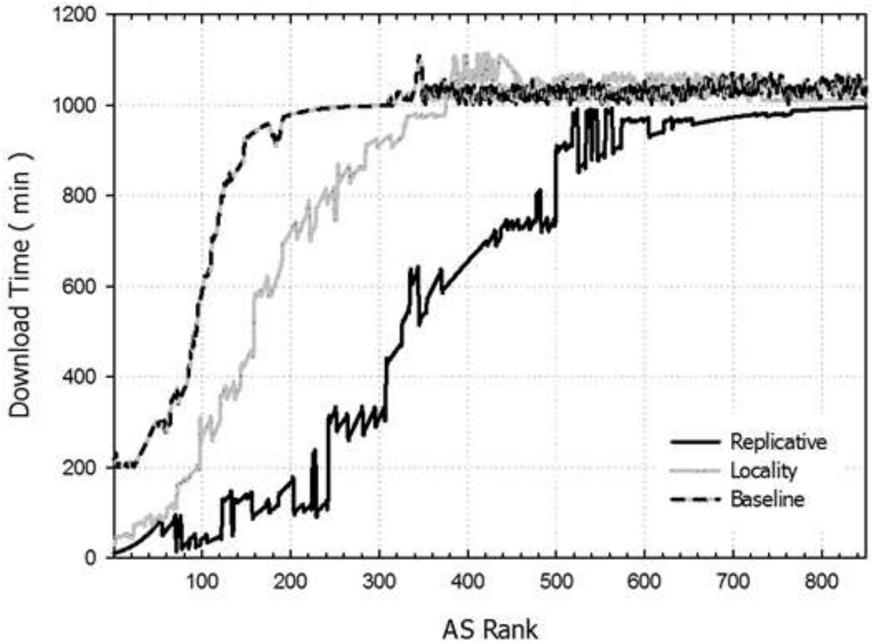


Figure 6 No significance in small AS scale

We randomly selected five ISP ASes from the test data sets, namely the provincial nodes on the education network of Henan, Chongqing, Lanzhou, Shanghai, and Haikou. The data statistics of inter-AS network traffic in Figure 5 show that the file content replication policy has the most significant effect, which can suppress 50% to 70% of the BT traffic outside the ISP, and the effect of the locality-aware peer selection policy is not good enough. However, the file content replication algorithm proposed in Section 4 is aimed at a small number of large-scale ISP ASes and does not cover the entire BT network. Figure 6 shows that this algorithm is not competitive when the ISP AS has a small scale. In

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

fact, BT traffic optimization is not necessary when no more than 10 BT nodes in an ISP AS form a BT swarm.

V. CONCLUSION

We conducted a large-scale network measurement and research and found that the BT file sharing network is highly dispersed, but the measurement results showed that the factors affecting the overall performance of the BT network are highly concentrated. This paper proposed a BT network service model using the file content replication policy. This model monitors the BT network in real time to find the ISP AS with the highest BT node peer clustering and the BT seed file with the highest popularity. Then, the file content replication policy is applied to convert more common BT users in an ISP AS into seeders, so that BT users preferentially download files from the local ISP AS. This model eliminates the need for deploying a complex cooperation mechanism between ISP ASes and reduces inter-AS BT connections and backbone network traffic. The simulated lab verification results showed that, compared with the locality-aware algorithm and the ISP-friendly design, the file content replication policy can reduce 50% to 70% of the inter-AS network traffic in average.

ACKNOWLEDGEMENTS

This work was supported by 2021 Jiangsu new perception technology and intelligent scene Application Engineering Research Center and 2021 Yangzhou science and technology plan project(yz2021132) -Yangzhou new wide band gap semiconductor material and device technology application public service platform.

REFERENCES

[1] Jie Dai, Liu Fang-ming, Bo Li. The disparity between P2P overlays and ISP underlays: issues, existing solutions, and challenges. Network, IEEE, 2010, 24(6): 36-41.

[2] Magharei N, Rejaie R, Rimac I, et al. ISP-Friendly live P2P streaming. Networking, IEEE/ACM Transactions on, 2014, 22(1): 244-256.

[3] Wang Hai-yang, Liu Jiang-chuan, Ke Xu. Understand traffic locality of peer-to-peer video file swarming. Computer Communications, 2012, 35(15): 1 193-1930.

[4] Dischinger M, Mislove A, Haeberlen A, et al. Detecting bittorrent blocking//Proceedings of the 8th ACM SIGCOMM conference on Internet measuremen (IMC '08), 2008: 3-8.

[5] Masoud M Z, Xiaojun Hei, Cheng Wen-qing. Constructing a locality-aware ISP-friendly peer-to-peer live streaming architecture//Information Science and Technology (ICIST), 2012 International Conference on, 2012: 368-376.

[6] Fernando T, Keppetiyagama C. ISP friendly peer selection in bittorrent//Advances in ICT for Emerging Regions (ICTer), 2013 International Conference on, 2013: 160-167.

[7] Zhen Ma, Ke Xu, Liu Jiang-chuan, et al. Measurement, modeling and enhancement of BitTorrent-based VoD system. Computer Networks, 2012, 56(3): 1103 -1 111.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1914-1926
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

[8] Zhang Guo-qiang, Zhang Guo-qing, CHENG Su-qi. Lanc: Locality-aware network coding for better P2P traffic localization. Computer Networks, 2011, 55(6): 1 125-1242.
[9] Tobias H, Lehrieder F, HOCK D, et al. Characterization of BitTorrent swarms and their distribution in the Internet. Computer Networks, 2011, 55(5): 1 121-1197.
[10] Matteo V, Steiner M, Laevens K. Understanding BitTorrent: A reality check from the ISP's perspective. Computer Networks, 2012, 56(3): 1054 -1 106.
[11] Silverston T, Jakab L, Cabellos-Aparicio A, et al. Large-scale measurement experiments of P2P-TV systems insights on fairness and locality. Signal Processing: Image Communication, 2011, 26(7): 327 - 338.
[12] Yang Xiang-ying, De Veciana G. Service capacity of peer to peer networks//INFOCOM 2004. Twenty-third AnnualJoint Conference of the IEEE Computer and Communications Societies, 4, 2004: 2242-2252 vol.4.
[13] Neglia G, Reina G, Zhang Hong-gang, et al. Availability in bittorrent systems//INFOCOM 2007. 26th IEEE International Conference on Computer Communications. IEEE, 2007: 2216-2224.
[14] Blond S L, Arnaud L, Dabbous W. Pushing BitTorrent locality to the limit. Computer Networks, 2011, 55(3): 541 - 557.
[15] Dan G. Cache-to-Cache: could ISPS cooperate to decrease Peer-to-Peer content distribution costs?.Parallel and Distributed Systems, IEEE Transaction, 2011, 22(9): 1469-1482.
[16] Byun H, Lee M. A P4P-integrated Data-driven P2P System for the Live Multimedia Streaming Service. Comput. Commun, Issue_Date = November, 2013, 2013, 36(17-18): 1698-1707.
[17] Kouvatsos D D. Traffic and performance engineering for heterogeneous networkss, chapter bittorrent session characteristics and models. [S.l.]: River Publishers, 2009.
[18] Bo Liu, YI Cui, Lu Yan-sheng, et al. Locality-Awareness in BitTorrent-Like P2P applications. Multimedia, IEEE Transactions on, 2009, 11(3): 361-371.
[19] Bindal R, PEI Cao, Chan W, et al. Improving traffic locality in bittorrent via biased neighbor selection//Distributed Computing Systems, 2006. ICDCS 2006. 2, 2006: 66-66.