An Employment of Multi-Hour Ability in Peer-to-Peer Streaming Swarm for U-city

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***Abstract*— Peer-to-Peer(P2P) application change the traditional Network transport method which has been known to Server-Client method. And P2P will replace most communication in U-City(Ubiquitous City). In all Networks are like that, P2P Network also has not enough available bandwidth. At P2P streaming, many bandwidth requirement of users have bring the traffic in the Network. Therefore, each user can not be offered enough bandwidth. This article suggest Multi-Hour Ability which means the bandwidth requirement is different each time at network. By using Multi-hour ability, reduce network traffic and each Peer can provide more bandwidth reliably. In addition, Multi-Hour Ability can effectively use the spare bandwidth, and it can provide more bandwidth to each peer and can improve the quality of peer-to-peer data streaming. we prove it by experiments.**

I. INTRODUCTION

Peer-to-Peer is a new Network method that breaks away from the existing Server-Client Network. Through applications such as instant messengers or downloading programs, Peer-to-Peer (P2P) is already well known. P2P is a technology where a server's handling of various services has been divided and moved to network peers. Today, P2P takes up a considerable amount of Internet traffic.[3] Continuously, P2P will replace many aspects of the current Server-Client Network. It means that P2P will replace most of communication in Ubiquitous City(U-City). In U-City, we can communicate many information which need to our life by P2P method. For these reasons, recent research in the area of P2P is very broad.

The focus of P2P is to have a group of Peers build a Network and communicate. Rather than having just the physical connection, the formation of P2P is more of an applied logical connection. In other words, it uses the Overlay base method to build a Network. These concept is suitable for communication environment of U-City that is complex and varied.

A P2P Network has an allotted bandwidth limit due to each peer's capabilities and various other factors. All Network models, including P2P, have a limit on allotted bandwidth. In addition, if requests are concentrated in one popular area where a lot of peers increase demand, then a Traffic problem could occur. When using such a limited bandwidth, if one Network group (P2P Network) has increase in network connections and each peer's demand for the same desired Source Data increases, then the P2P Network can become very chaotic. Regardless of how powerful each peer's system is or the allowed bandwidth of each peer's network, when a peer connects to a chaotic P2P Network with increased Traffic, the peer cannot receive the expected performance from the P2P Network. In this type of environment, P2P streaming does not work very smoothly.

In a human environment, there is day and night. Humans actively move during the day and sleep during the night. This environment has given humans a pattern in life and this life pattern of humans also affects the Network world of computers. In most cases, people wake up in the morning and go to work. People work during the day and go home at night and sleep. Most of the work occurs during the day, and most facilities shut down at night. When humans use the World Wide Web or computers to do work, the increase in computer and Network usage follow the life pattern of humans. At certain time during the day, when people are up and working, the Network bandwidth usage is much higher than compared to night time.

Therefore, there is a difference in amount of usage of Network bandwidth depending on time of day; this is called Multi-Hour [1]. Using this knowledge of differing bandwidth traffic at different times of day, a technique to increase the entire Network bandwidth during busy times is called Multi-Hour Ability. In Network communication, using limited resources effectively has been an important topic in the past and the present. In P2P, this type of Multi-hour technique has not been applied.

In P2P where Routing can occur freely, if Multi-hour Ability is used, the Traffic created within the P2P Swarm can be eased and bandwidth can be given to each Peer more safely. Since this method uses relatively surplus Network resources, it can effectively use the limited Network resources. In addition, it can help to reduce the expenses associated with increasing Network bandwidth.

This paper, using the theory of Multi-Hour as basis, will present a method to safely and securely gain bandwidth and

relieve network Traffic within P2P Network. In Chapter 2, research related to this paper will be briefly discussed. In Chapter 3, Multi-Hour Ability will be explained. Chapter 4 will prove the communication method using Multi-Hour in P2P is useful and conduct an experiment comparing bandwidth usage. Chapter 5 will conclude the paper.

II. BASE KNOWLEDGE

A. Overlay Network

Overlay networks create a structured virtual topology above the basic transport protocol level that facilitates deterministic search and guarantees convergence. Overlay networks are evolving into a critical component for self-organizing systems. Overlay networks can address flooding -based systems. The bandwidth and processing requirements they place on the network, and they provide no guarantees as to lookup times or content accessibility Overlay networks have a network semantics layer above the basic transport protocol level that organizes the network topology according to the nodes' content, implementing a distributed hash table abstraction that provides load balancing, query forwarding, and bounded lookup times. Overlay networks are evolving into a critical component for self-organizing systems.

B. Peer-to-Peer Structure

Peer-to-peer systems are distributed systems that operate without centralized organization or control. To find a particular piece of data within the network, P2P systems explicitly or implicitly provide a lookup mechanism, or locator function, that matches a given string, or key, to one or more network nodes responsible for the value associated with that key. P2P nodes inter-operate by using the same software or the same set of network-based APIs.

Non-router based architectures push functionality to the network edges, there are several choices in instantiating such an architecture. On the one end of the spectrum is an infrastructure-centric architecture, where an organization that provides value-added services deploys proxies at strategic locations on the Internet. End systems attach themselves to nearby proxies, and receive data using plain unicast. On the other end of the spectrum is a purely application end-point architecture, where functionality is pushed to the users actually participating in the multicast group. Administration, maintenance, responsibility for the operation of such a peer-to-peer system are distributed among the users, instead of being handled by a single entity. The focus of this paper is on simultaneous video broadcast using the application end-point architecture, referred to as peer-to-peer broadcast/multicast. Such similar terms as end system multicast, overlay multicast, application-layer multicast, have also been used in the literature. In the purest form, such architectures rely exclusively on bandwidth resources at application end-points. However, one could also conceive of hybrid architectures that seek to use the bandwidth resources of application end-points to the extent possible, but may leverage infrastructure resources where available. We will include such architectures in our discussion of peer-to-peer broadcast.

1) Unstructured(data-driven)

The Unstructured method which is data-driven overlay designs sharply contrast to tree-based designs in that they do not construct and maintain an explicit structure for delivering data. The underlying argument is that, rather than constantly repair a structure in a highly dynamic peer-to-peer environment, we can use the availability of data to guide the data flow.

A naive approach to distributing data without explicitly maintaining a structure is to use gossip algorithms. In a typical gossip algorithm, a node sends a newly generated message to a set of randomly selected nodes; these nodes do similarly in the next round, and so do other nodes until the message is spread to all. The random choice of gossip targets achieves resilience to random failures and enables decentralized operation. However, gossip cannot be used directly for video broadcast because its random push may cause significant redundancy with the high-bandwidth video. Further, without an explicit structure support, minimizing startup and transmission delays become significant problems.

More explicitly, nodes maintain a set of partners, and periodically exchange data availability information with the partners. A node may then retrieve unavailable data from one or more partners, or supply available data to partners. Redundancy is avoided, as the node pulls data only if it does not already possess it. Further, since any segment may be available at multiple partners, the overlay is robust to failures – departure of a node simply means its partners will use other partners to receive data segments. Finally, the randomized partnerships imply that the potential bandwidth available between the peers can be fully utilized.

The data-driven approach at first sight may appear similar to techniques used in file download solutions like Bit-torrent However, the crucial difference here is that the realtime constraints imply that segments must be obtained in a timely fashion. Thus, an important component of a data-driven broadcast systems is a scheduling algorithm, which strives to schedule the segments that must be downloaded from various partners to meet the playback deadlines.

2) Structured(Tree-based)

In such an approach, peers are organized into structures (typically trees) for delivering data, with each data packet being disseminated using the same structure. Nodes on the structure have well-defined relationships, for example, “parent-child” relationships in trees. Such approaches are typically push-based, that is, when a node receives a data packet, it also forwards copies of the packet to each of its children. Since all data packets follow this structure, it becomes critical to ensure the structure is optimized to offer good performance to all receivers.

Further, the structure must be maintained, as nodes join and leave the group at will – in particular, if a node crashes or otherwise stops performing adequately, all of its offspring in the tree will stop receiving packets, and the tree must be repair.

Finally, when constructing tree-based structures, loop avoidance is an important issue that must be addressed. Tree-based solutions are perhaps the most natural approach, and do not require sophisticated video coding algorithms. However, one concern with tree-based approaches is that the failure of nodes, particularly those higher in the tree may disrupt delivery of data to a large number of users, and potentially result in poor transient performance. Further, a majority of nodes are leaves in the structure, and their outgoing bandwidth is not being utilized. In response to these concerns, researchers have been investigating more resilient structures for data delivery.

C. *Multi-Path Routing*

Multi-path Routing is desirable to allow packets with the same source and destination to take more than one possible path. This facility can be used to ease congestion and overcome node failures. Multi-path routing aims to exploit the resources of the underlying physical network by providing multiple paths between source-destination pairs. Multi-path routing has a potential to aggregate bandwidth on various paths, allowing a network to support data transfer rates higher than what is possible with any one path. Multi-Hour Ability which is the subject covered in this paper, include Multi-path Routing concept.

III. MULTI-HOUR ABILITY & CUSTOMIZE

A. *Multi-Hour*

The concept of Multi-Hour introduce well done in the book 'Routing, Flow, and Capacity Design in Communication and Computer Network'. Introduction mentioned earlier, but also Multi-hour is concept that the telephone network, or the Internet network, other networks that we are used are belong to a different time zone. Moreover, Multi-Hour means that there are different region and different purpose of the network or in most cases there is crowd schedule of time zones.

Multi-hour refers to considering different traffic matrices at different times during the day. Multi-busy-hour behavior of the traffic is observed, especially when the network spans over multiple time zones and has different peaks for different demands at different times, non- coincidence of busy hours. In multi-hour models, network traffic is considered for different hours during the day to reflect within the day load variation; this is done especially to take advantage of non-coincidence of busy hour (peak) loads between different node pairs in the network. Multi-hour network dimensioning (sizing) involves determination of network capacity at minimum cost that can meet the traffic demand at any time during the day by considering multi-hour traffic.

If we apply this multi-hour to P2P streaming, we can get more quality improvement of P2P streaming. If there are many peers of P2P network in heavy traffic, they can transport through the other P2P networks in relativity idle time. Then the peers of P2P network in heavy traffic can be provided more wide and more stable bandwidth. These concepts currently apply to the telephone network services in the United States.

The time difference between the east and west regions because very wide country, such as the United States, there are three time zone as approximately. Eastern is in the morning and the sun rise, at the beginning of the day in eastern, but western is still in the early morning hours, before the sun rise. The usage of the telephone in eastern is rapidly grow up, while the west's phone usage to be a relatively idle. At this time, Congestion use of a telephone in the eastern can be distributed through the idle telephone network of the western. These distributed communication that through the idle telephone network have a few disadvantage of long-distance but can ensure better connectivity then congestion.

Fig. 1 and Fig. 2 shows the network usage is different based on the time zone.

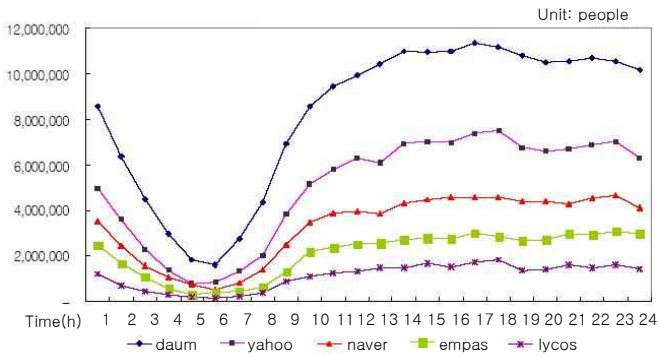
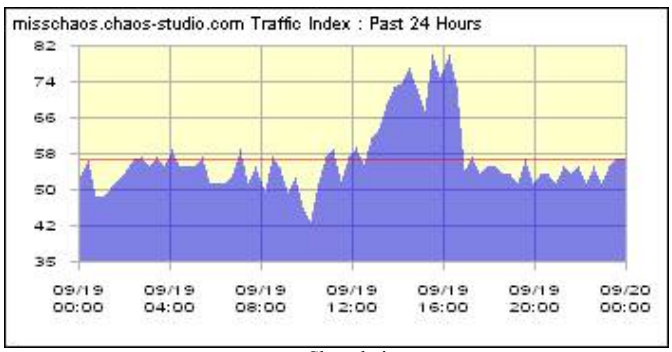


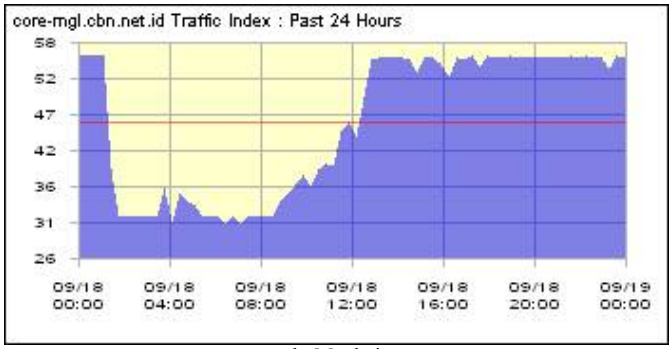
Fig. 1 Domestic Internet portal site behavior analysis

Fig. 1 is a graph that "Domestic Internet portal site behavior analysis" [38] and shows main site entrance by time of day in Korea. Korea has not different time zone by region. The day time and the night time apply to all people. There are most number of traffic at 12:00 p.m. until 8:00 p.m. and the small number of traffic at 2 a.m. to 7 a.m.

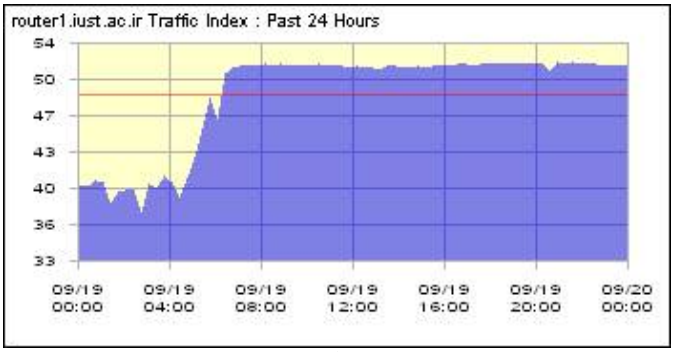
Another example is shown in Fig. 2. Fig. 2 show the fact that is obtained from the site of Internet traffic measurement data[36]. Geographical differences between the world's major cities in the continent, and therefore the congestion time of Internet is different. The network traffic of Shang-hai, Munbayi and Tehran appears relatively clear, because these countries time zone are not widely spread.



a. Shanghai



b. Munbai



c. Teheran

Fig. 2 Network traffic of main city in the world

Similarly, in the P2P Network. Fig. 3 shows the United States P2P Network traffic by the time zone. Fig. 3 shows the traffic of P2P network in USA based on GMT(Greenwich Mean Time). In Fig. 3, P2P is Pure P2P Gnutella model. Pure P2P Gnutella model is second generation of Unstructured P2P which is the model experiments in this paper. The traffic volume is heavy between evening and midnight and tapers down gradually early in the morning. This many be users are likely to join the P2P network after work and keep downloading data at night.

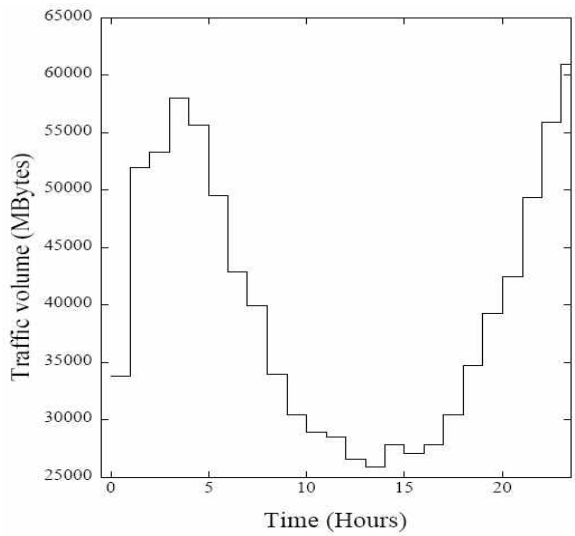


Fig. 3 P2P Network traffic by the time zone (US)

And also observe two peaks 3 hours apart during the heavy traffic period. This is likely due to the time difference between east and west coasts of the continental US[3]. Like this, Each Network in the region of the colony have busy time and idle time by the time zone of geographical characteristics or by any purpose.

B. Multi-Hour Ability

The Multi-Hour Ability is the technique by using Multi-Hour concept. The example of network environment to using Multi-hour Ability is Fig. 4. Fig. 4 show three P2P Networks which have different busy and idle time each other.

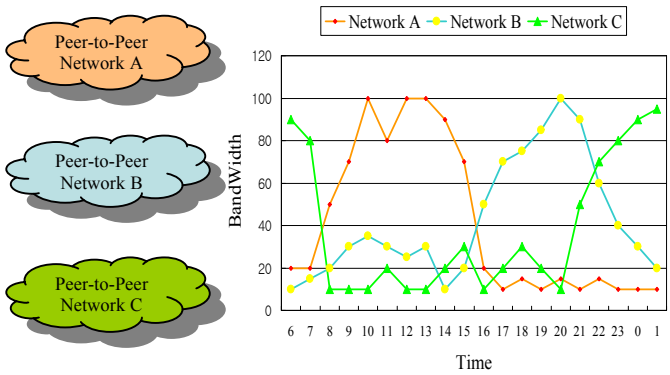


Fig. 4 Example of bandwidth usage by time zone

In this P2P network environment, the Multi-Hour Ability Concept occur at Fig. 5. The P2P Network A is busy and have congestion. But at that time, The P2P Network C is idle. Network C remain bandwidth resources. Then, we can use the idle Network C. Not using the spare is a very large waste of resources. Congestion and traffic of P2P Network A can be distributed by using these spare of bandwidth resources. At Network A specific time periods (11 a.m. to 3 p.m.), the traffic capacity is reached to maximum bandwidth of Network A and if that occurs beyond the maximum bandwidth of Network A, use idle state bandwidth resources of Network C.

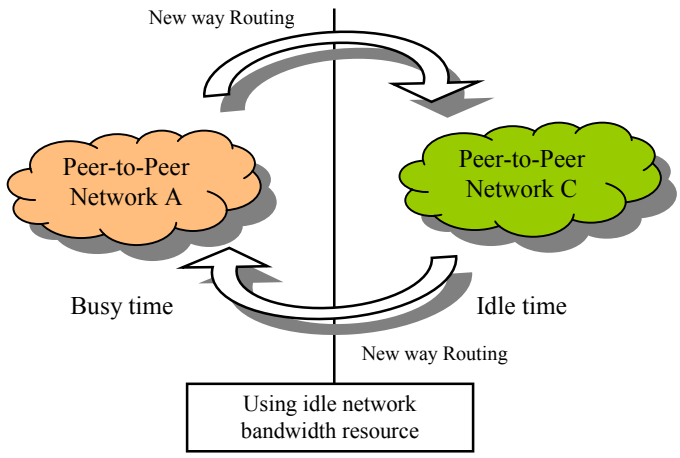


Fig. 5 Concept of Multi-Hour Ability

C. Streaming System Structure

Multi-Hour Ability which is applied Peer-to-Peer Streaming is shown in Fig. 6. Suggested structure of P2P Streaming has time counter and bandwidth checker that can be mounted inside P2P Streaming module. The time counter remember busy time that traffic occur on the network of the day. If the busiest time of P2P Network A is 11 a.m. to 3 p.m,

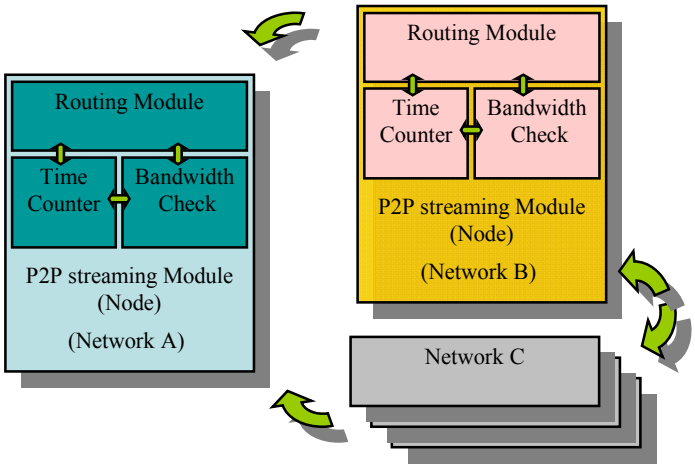


Fig. 6 System structure of Multi-Hour Ability

Then the time Counter remember busy time (traffic time) and tell 'Find another route belong idle periods because it is the time of congestion' to routing module before 11 am. All peers that is in the busy time network will have a similar behavior.

For a more flexible routing we placed bandwidth checker module. Bandwidth Checker check the amount of bandwidth of currently Network. The bandwidth is measured in send Peer to Peer receiver to transmit or receive data, or data packet size of the receiving side of the RTT estimation.

When the Network bandwidth usage reaches maximum, receive side response is very late or receive small size of the data several times. If that happens, sending side knows current network state is overload. In addition, sending side seeks Idle Network relatively. The sending side seek peers which is belong to another Network by method of configure P2P Network. And then find out the Network state which has founded peers is Idle. It can be know that founded peer's Information of Time Counter and Bandwidth Checker.

We will remain detail information of this issue for the future implementation.

D. Application of Multi-Hour Ability

This chapter narrative Multi-Hour Ability to apply P2P communications based on unstructured P2P which is the overlay of the way category of P2P that previously described. As before the example shown in Fig. 4, when the bandwidth usage of each Network is different by timeline, the concept of Multi-Hour Ability is Fig. 7.

In Fig. 7, each peers are consisted by way of unstructured P2P. Left side swarm of peers is P2P network A and right side swarm of peers is P2P network B. Peer R is a source node which has some video data. Peer J wants data communication to peer R. If network A is busy time, then bandwidth usage of network A increase maximum. And congestion caused by bottle-neck appears.

If you would like streaming data from the R to J, must go through bottleneck path. So, unable to stop the degradation of data streaming caused by congestion in network A.

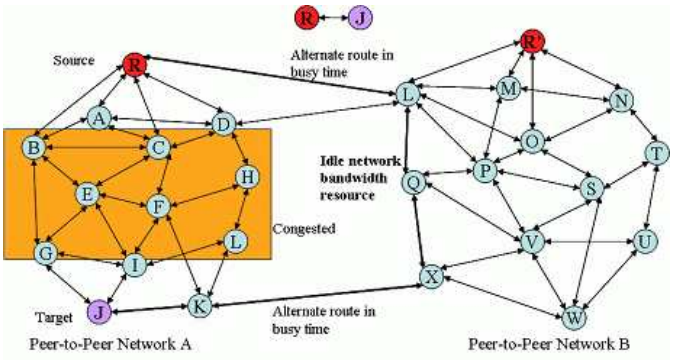


Fig. 7 Application of Multi-Hour Ability

Existing methods of communication like R→C→F→I→J or R→A→B→G→J can not provide enough bandwidth to facilitate of streaming by congestion of middle path. Low bandwidth cause low quality streaming.

In order to solve this problem, we can use Multi-Hour Ability. As shown in Fig. 7, there is a P2P network B which is located in a different time zone. Communication of J and R can escape from bottle-neck by using idle network. Network B placed in idle time and it has spare bandwidth resources. Peers of network B like Q, L, X have secure sufficient bandwidth for better quality of streaming. If network A goes to busy time and congestion occurs, then peers can alternate route at that time. Peer J can be provided data streaming by alternate route like R→L→Q→X→K→J.

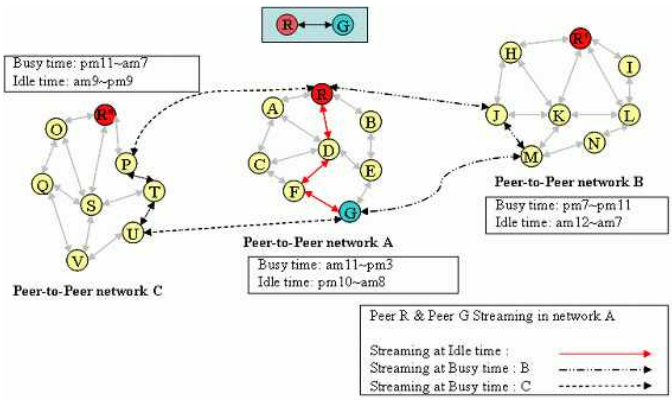


Fig. 8 Behavior scenario of Multi-Hour Ability

Fig. 8 shows the behavior scenario of Multi-Hour Ability. There are three different P2P networks which have different bandwidth usage by time zone. As mentioned before, Peer G

wants to streaming data from peer R. Assume that peer G stream some data during 15 hours from 8 am. to 11 pm. If the current time is 10 pm, Network A which include peer G is idle time. Then, Peer G process streaming data from peer R without change the route. But if the current time is 2 pm, Network A is busy time. Then, Peer G change the route to obtain reliable streaming data. The changing route can be through other peers which is in network B or C.

In contrary, finding other peer which is in idle with spare bandwidth can cause some cost. The cost is a delay that can cause by geographically far apart. However, the actual delay by the regional differences is not big. According to the precedence research, the delay between two regions(sweden - to - UC berkely, US) which apart far from each other is only 199ms.[14] And these costs deserves to be risk compared with be provided row bandwidth by congestion. Because if the new route to the destination is idle network, then network traffic will not occur at least.

IV. EXPERIMENTAL EVALUATION

A. Configuration

The environment of experiment based on Linux-Redhat9.0, and we use NS2(Network Simulator 2) for simulation. Fig. 9 shows the configuration and network settings. Each network includes 100 peers which is connected each other. The connectivity of each peer is partially in each network by particular algorithm. It is not necessarily to connect all peer. All peer have some direct connection with other peer which is nearby. Each peer's hardware ability and bandwidth capability is identical.

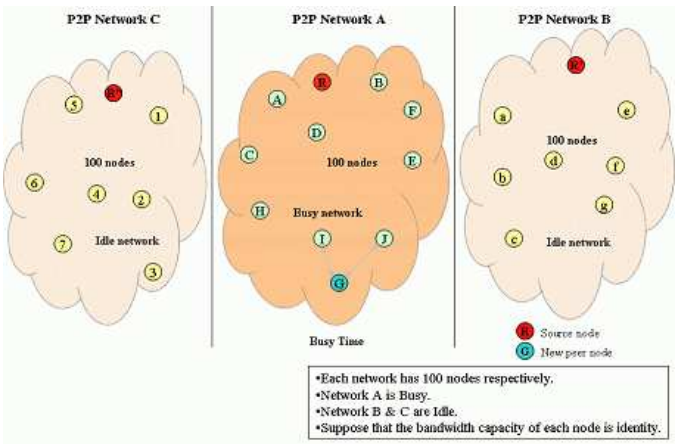


Fig. 9 Experimental configuration

Table 1 shows bandwidth and latency of each peer connection. When each peer has no traffic, the bandwidth of each link is 10Mb and the delay of each link is 20ms. The delay of each network is 200ms.

Because it is according to the precedence research, the delay between two regions(sweden - to - UC berkely, US) which apart far from each other is only 199ms.[14] And assume that the bandwidth of each network is 10Mb at least.

Table 1 Experimental configuration

Attribute	Number of Nodes	Bandwidth of each links	Delay of each links
P2P Network A	100	10Mb	20ms
P2P Network B	100	10Mb	20ms
P2P Network C	100	10Mb	20ms
Connection A-B	-	10Mb	200ms
Connection A-C	-	10Mb	200ms

The traffic of each network is shown in Table 2. Network A is in busy time. So there are many traffic in network A. On the contrary, network B and network C is in idle time. And they have a few traffic in there connection. CBR(Constant Bit Rate)which is supported by NS2 is basically forming a continuous traffic. To set a more realistic situation, there is a traffic at random time.

Table 2 Traffic configuration

Network Swarm	Sender Peer	Receiver Peer	Packet size	Rate	Traffic Type	Busy Time
A	n1~n50	n51~n100	1000byte	1.0~3.0Mbps	CBR	Yes
B	n`1~n`50	n`51~n`100	1000byte	0.1~0.5Mbps	CBR	No
C	n``1~n``50	n``51~n``100	1000byte	0.1~0.5Mbps	CBR	No

Experiment scenario is shown in Fig. 10. Network A has a serious congestion. R is a source peer which has video data. Peer G want to get streaming video data from peer P. In this situation, peer G can not be provided enough bandwidth to quality streaming. In addition, if the communication of peer P and peer G is impossible situation by very heavy congestion, the peer G can not allocate the bandwidth at all. In Fig. 9, ① is a routing way at idle time in network A. And ② is a routing way through network B when network A is in busy time. Similarly ③ is a routing way through network C when network A is busy.

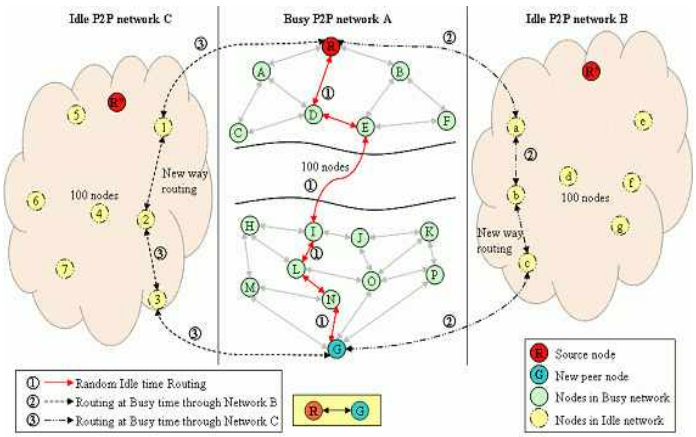


Fig. 10 Routing in busy and idle time

B. Analysis

First, measure that provided bandwidth to peer in each network. For this measurement we use following formula.

- **provided bandwidth to peer in each network = bandwidth capacity(10Mb) - bandwidth usage**

In this formula, bandwidth capacity is physical bandwidth which means the maximum bandwidth of peer and it is numerical value that a data can through out the peer at once. Bandwidth usage is the number of times and the amount of data that passes through one peer at the same time. For example, five traffics which have 1Mb size pass peer k at the same time. Then bandwidth usage of peer k is 5Mb(10Mb - (5 * 1Mb)).

Table 3 Average available bandwidth of each peer

Network Swarm	Busy Time	Using Bandwidth	Average Idle Bandwidth
A	Yes	Over 9Mb	0.89Mb (nearly)
B	No	1.5Mb	8.5Mb
C	No	1.4Mb	8.6Mb

The result is like Table 3. Peers in network B and C can be provided more available bandwidth than peers in network A. In network A, the bandwidth usage is over 9Mb at busy time. Peers in network A have 0.89Mb available bandwidth on average. But Peers in network B and C have 8.5Mb and 8.6Mb available bandwidth on average. A peer which is new peer or existing peer in network A can be provided less than 1Mb. This peer suffers depletion of bandwidth resource. Depletion of bandwidth cause low quality data streaming. But Peers in network B or C can offers a stable and fast path which means can provide more available bandwidth resource. These more available bandwidth can ensure guarantee of streaming quality. Moreover it can distribute the congestion of network A.

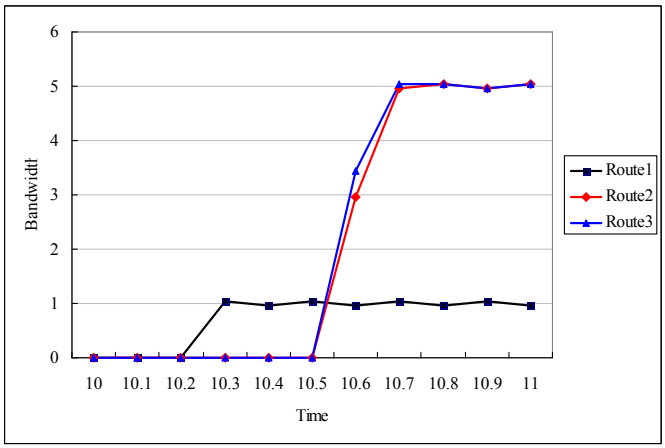


Fig. 11 Available bandwidth of peer G

Fig. 11 shows benefits that compare with using Multi-Hour Ability or not. Route 1 means that the exist routing path through the network A. Route 2 means that the alternate routing path through the network B. And Route 3 also means that the alternate routing path through the network C. Peer G want to get streaming data from source peer R with 5Mbps data rate. Through the network A, data streaming is weak. And can not use bandwidth resource more than 1Mb. But the network B and C have enough bandwidth resource because they exist in idle time. Route 2 and 3 need a little more delay than Route 1. But they can provide more stable bandwidth. Through the network B or C, data streaming use bandwidth fully as 5Mb. In this case if a peer want to transport 1Gb size data to another peer, it takes 137 min through Route 1 but it takes only 27 min through Route 2 and 3. Consequently, more fast communication is possible with idle peers.

The transition of bandwidth is shown in Fig. 12. In this situation peer G and peer P is communicating now in network A. Data streaming is done in 60 seconds. Route 1 is the existing routing path through the network A without change routing. Route 2 means that the alternate routing path through the network B. And Route 3 also means the alternate routing path through the network C.

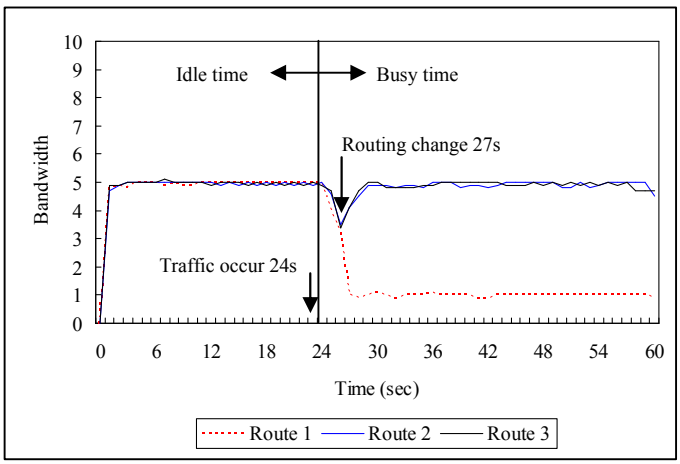


Fig. 12 Transition of bandwidth

The congestion has started appear at 24s. And traffic of network A is increasing by reaching to busy time. Now we compare using Multi-Hour Ability with not using. As we sad before, Route 1 does not using Multi-Hour Ability. So when the traffic occur, peer G is provided a gradual reduction of bandwidth. Conversely, Route 2 and Route 3 use Multi-Hour Ability. In this case, when the traffic occur at 24s then approximately three seconds later, at 27s, Peer G change the routing pass to alternate peer in network B or C. Peer G is already aware alternative routing pass through other peer which is idle time. The bandwidth decline does not retain when using Multi-Hour Ability. Consequently, using Multi-Hour Ability can provide more stable and enough bandwidth than not to use it.

V. Conclusion

Peer-to-Peer (P2P) communication has many advantages than our way of using the traditional Client-Server communication. And expected primarily because of the way many of the next generation of communication studies are underway. Also P2P will be replaced many communication method in U-City as a nest generation communicating method. P2P is a lot of traffic on the Internet is already occupied, and many of the well-known application is being used. These peer-to-peer Network streaming data to be received during the traffic occurs, and reduce the bandwidth is allocated to a peer, streaming quality will be affected accordingly. According to resolve bandwidth degradation caused traffic problems in order to increase the performance of Peer Network, which consists of the expansion of an existing or a lot of time and effort it takes.

In order to solve these problems, this paper provides an introduction to a Multi-Hour Ability. Most Network bandwidth usage is according to the different time. Because, each time zone has each area which is placed in different time zone and the amount of activity is different. Peer-to-peer Network is based on Overlay Network, which formed the foundation for its network even if the available bandwidth is making itself is falling and performance degradation that is the problem, because it is taken for granted.

As this paper says before, there are many bandwidth using time periods and there exist few bandwidth using time zone too in other area at the same time. If we can use this idle bandwidth Network, then we can reduce bottleneck at busy Network which has many bandwidth usage. The model in this paper is that P2P nature of peer-to-peer Network Routing is relatively free. Therefore, considering Multi-Hour Routing, that is, Multi-hour Ability can make Peer-to-peer Network Peer belonging to the data streaming to be better, by securing reliable bandwidth.

In this paper, we configure experiment Network that is one of the current used peer-to-peer streaming protocol. This paper shows 'Multi-hour' applied protocol can increase the bandwidth assigned to Peer, and it is possible to better quality streaming by results of the experiment. Additionally, Multi-Hour Ability P2P network does not require expansion to get additional bandwidth, and only have the bandwidth that the peak point of bandwidth usage.

This algorithm is suggested in the paper that does not considering the situation of varied Network. In fact, our using Network has not always existed in the same state, or the same state, it is not guaranteed. Changed state of Network can be a sudden problem. But, Similarly pattern of the bandwidth changes can predict.

The Multi-Hour Ability, suggested in the paper, is based on a similar pattern in network. That is based on Multi-Hour which means the bandwidth requirement is different each time at network. By using Multi-hour ability, reduce network traffic and each Peer to provide more bandwidth can be reliably. In addition to effectively use the surplus bandwidth, Multi-Hour Ability to improve the performance of the peer-to-peer streaming that it can prove through experiments.

As a future work, suggested algorithm can experiment on real overlay Network. And can get more realistic results.

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References

[1] Michal Pioro, Deepankar Medhi, "Roution, Flow, and Capacity Design in Communication and Computer Networks" , Chapter11. 'Multi-Hour and Multi-Time-Period Network Modeling and Design, pp.455-472, Morgan Kaufmann, 2004

[2] D. Medhi, D. Tipper, "Some Approches to solving a Multi-Hour Broadband Network Capacity Design Problem with Single-Path Routing", Telecommunication Systems, vol.13, pp.269–291, 2000.

[3] Liu, J., et al., "Opportunities and Challenges of Peer-to-Peer Internet Video Broadcast". invited by Proceedings of the IEEE, 2006.

[4] Chen, Y., B. Deng, and X. Li, "Rainbow: A Locality-aware Peer-to-Peer Overlay Multicast System". Grid and Cooperative Computing Workshops, 2006. GCCW'06. Fifth International Conference on, 2006: p. 151-155.

[5] Liao, X., et al., "AnySee: Peer-to-Peer Live Streaming". Proceedings of IEEE INFOCOM, 2006.

[6] Pai, V., et al., "Chainsaw: Eliminating trees from overlay multicast". Proceedings of International Workshop on Peer-to-Peer Systems (IPTPS), 2005.

[7] Venkataraman, V., K. Yoshida, and P. Francis, "Chunkyspread: Heterogeneous Unstructured Tree-Based Peer-to-Peer Multicast". Network Protocols, 2006. ICNP'06. Proceedings of the 2006 14th IEEE International Conference on, 2006: p. 2-11.

[8] Venkataraman, V., P. Francis, and J. Calandrino, "Chunkyspread: Multi-tree Unstructured Peer-to-Peer Multicast". Proceedings of the 5th International Workshop on Peer-to-Peer Systems.

[9] Zhang, X., et al., "CoolStreaming/DONet: A Data-Driven Overlay Network for Efficient Live Media Streaming". Proceedings of IEEE INFOCOM, 2005.

[10] Zhang, M., et al., "Large-scale live media streaming over peer-to-peer networks through global internet". Proceedings of the ACM workshop on Advances in peer-to-peer multimedia streaming, 2005: p. 21-28.

[11] Wu, C. and B. Li, "Diverse: application-layer service differentiation in peer-to-peer communications". Selected Areas in Communications, IEEE Journal on, 2007. 25(1): p. 222-234.

[12] Tran, D.A., K.A. Hua, and T.T. Do, "A peer-to-peer architecture for media streaming". Selected Areas in Communications, IEEE Journal on, 2004. 22(1): p. 121-133.

[13] Hefeeda, M., et al., "PROMISE: peer-to-peer media streaming using CollectCast". Proceedings of the eleventh ACM international conference on Multimedia, 2003: p. 45-54.

[14] Nguyen, T. and A. Zakhor, "Multiple sender distributed video streaming". Multimedia, IEEE Transactions on, 2004. 6(2): p. 315-326.

[15] Frey, P. and R. Wattenhofer, "Master Thesis Swistry: P2P Live Streaming". Dept. of Computer Science Swiss Federal Institute of Technology (ETH) Zurich January-July, 2006

[16] Castro, M., et al., "SplitStream: High-bandwidth content distribution in a cooperative environment". Proceedings of SOSP, 2003.

[17] Jiang, X., et al., "GnuStream: a P2P media streaming system prototype". Proceedings of the 2003 International Conference on Multimedia and Expo-Volume 1, 2003: p. 325-328.

[18] Ganjam, A. and H. Zhang, "Internet multicast video delivery". Proceedings of the IEEE, 2005. 93(1): p. 159-170.

[19] Mills, D.L., "Wiretap: an experimental multiple-path routing algorithm". ACM SIGCOMM Computer Communication Review, 1989. 19(1): p. 85-98.

[20] Tian, R., et al., "Efficient path diversity for application-layer multicast". IEEE Transactions on Circuits and Services for Video Technology. v15 i8: p. 961-972.

[21] Apostolopoulos, J., et al., "Modeling path diversity for multiple description video communication". Acoustics, Speech, and Signal Processing, 2002. Proceedings.(ICASSP'02). IEEE International Conference on, 2002. 3.
[22] Apostolopoulos, J.G. and M.D. Trott, "Path diversity for enhanced media streaming". Communications Magazine, IEEE, 2004. 42(8): p. 80-87.
[23] Nguyen, T., P. Mehra, and A. Zakhor, "Path diversity and bandwidth allocation for multimedia streaming". Multimedia and Expo, 2003. ICME'03. Proceedings. 2003 International Conference on, 2003. 1.
[24] Zhang, M., et al., "A peer-to-peer network for live media streaming using a push-pull approach". Proceedings of the 13th annual ACM international conference on Multimedia, 2005: p. 287-290.
[25] Magharei, N., et al., "Peer-to-peer receiver-driven mesh-based streaming". ACM SigComm (poster session).
[26] Stolarz, D., "Peer-to-Peer Streaming Media Delivery". First International Conference on Peer-to-Peer Computing Proceedings, IEEE Press, New York, 2002.
[27] Annapureddy, S., C. Gkantsidis, and P. Rodriguez, "Providing video-on-demand using peer-to-peer networks". Internet Protocol TeleVision (IPTV) Workshop, WWW. 6.
[28] Padmanabhan, V.N., H.J. Wang, and P.A. Chou, "Resilient peer-to-peer streaming". Network Protocols, 2003. Proceedings. 11th IEEE International Conference on, 2003: p. 16-27.
[29] Liang, J. and K. Nahrstedt, "DagStream: locality aware and failure resilient peer-to-peer streaming". Proceedings of SPIE, 2006. 6071: p. 224-238.
[30] Jurca, D., et al., "Enabling Adaptive Video Streaming in P2P Systems". IEEE COMMUNICATIONS MAGAZINE, 2007. 45(6): p. 108.
[31] Thottan, M., et al., "Distributed network monitoring for evolving IP networks". Distributed Computing Systems, 2004. Proceedings. 24th International Conference on, 2004: p. 712-719.
[32] Li, L., et al., "Distributed network monitoring with bounded link utilization in IP networks". INFOCOM 2003. Twenty-Second Annual Joint Conference of the IEEE Computer and Communications Societies. IEEE. 2.
[33] Guo, L., et al., "Delving into internet streaming media delivery: a quality and resource utilization perspective". Proceedings of the 6th ACM SIGCOMM on Internet measurement, 2006: p. 217-230.
[34] Sripanidkulchai, K., et al., "The feasibility of supporting large-scale live streaming applications with dynamic application end-points". Proceedings of the 2004 conference on Applications, technologies, architectures, and protocols for computer communications, 2004: p. 107-120.
[35] http://www.internettrafficreport.com
[36] H.J. Park, K.R. Park, "P2P Technology Trend and Application to Home Network", TDomestic of trend electronic communications, 21(5). 2006. 10.
[37] KoreanClick, "Domestic Internet portal site behavior analysis", 2002. 6.