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Chunk Replacement Design for QoS Control in CCN

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Abstract: Content Centric Networks (CCN) is one of the future internet technologies. The Quality of Service (QoS) is also important issue in CCN. However, the current CCN chunk replacement method is not suitable for QoS. Therefore, this study propose a new chunk replacement design to support QoS efficiently. The proposed method manages the average of packet arrival time in CCN node and classifying packet separately for QoS service in CCN. This study also simulates the proposed new chunk replacement design in congested topology. This study proposes chunk replacement mechanism on the CCN. Even if the chunk request time of flow number 1 and 2 is same, the throughput on request node can be different. If the transmission rate of flow is faster than other flows, the flow can occupy the total current bandwidth. Therefore, the other flows cannot use current bandwidth sufficiently. In the simulation, the proposed method set the same start time of each flow and changed the transmission rate of each flow so that the proposed method can check the throughput of each flow. The most of the previous method still have the problem of different throughput. In this study, the consumer node is using the proposed chunk replacement algorithm. The flow that arrives later is using the same bandwidth compared to other flows in the limited network circumstance. Therefore, the throughput is not different according to the transmission rate. The proposed method will be also an efficient method for QoS. To demonstrate chuck replacement algorithm, topology is composed of linked 6 nodes with 3 consumer nodes and 3 producer nodes to prove its performance.

Key words: CCN, cache, future internet, congestion, queue management

INTRODUCTION

The data transmission rate is gradually increasing due to development of high-bandwidth networks. One of the reasons is the use of devices such as a remote planes, smart watches is increasing and requires high-speed networking. There is a decrease in the transfer rate due to the interference between the flows as the data transmission rate increases (Christo and Meenakshi, 2016; Chic and Sandhu, 2016). It also causes the CCN fairness decrease between flows in the intermediate node. This study evaluates the fairness issue at the CCN which is one of the next-generation technologies that is emerging as the future internet. It supports to provide the required content to the users in wired and wireless networks. The basic unit to transmit in CCN is interest packet and data the packet as a pair. The user requires data packet by sending interest packet. It is an automatically adjusted flow balance (Oueslati *et al*., 2012) mechanism. Because of this end-to-end flow control is not required (Udugama *et al*., 2013). CCN is working on the basis of hop by hop (Lee *et al*., 2013; Mastorakis *et al*., 2015) method, unlike the previousend-to-end method. Once user sends interest packet, data packet will be sent to consumer passed by intermediate cache of CCN node. The each CCN node can save the content in cache. Therefore, it can send the content instead of the producer. CCN needs forwarding strategy in this mechanism. If some node is down because of overflow or blackout, the other node will be alternative, so it has the flexibility (Lim *et al*., 2014). This is because the consumer can receive the data packet from the alternative a node with changing PIT (Pending Information Table) path. If the data size is bigger, data packet can be handled by the unit chunk even though it sends interest and data packet as a pair (Lee *et al*., 2013). There are various studies related to the data chunk and fairness control in CCN. The research about reduction of the receiving time of data from the consumer by adjusting the index of data chunk in the intermediate routers (Chib and Sandhu, 2016) and the

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research that suggested a routing scheme based on selective cache caching or pre-allowable range based on the acceptable range for the medium cached (Chib and Sandhu, 2016). In addition, there is a study for improving throughput through the flow control in order to improve fairness (Tanaka *et al*., 2012; Rozhnova and Fdida, 2012; Zhang *et al*., 2014).

MATERIALS AND METHODS

The structure of CCN: Content Centric Network (CCN) is a new mechanism for future internet such as ICN, NDN. CCN node is composed of CS (Content Store), PIT (Pending Information Table) and FIB (Forwarding Information Base). Cache (CS) is the repository that stores Data packet that the user requested by sending Interest packet. PIT table is matching table to transmit the data packet to the requested user. FIB table decides the direction to forward Interest packet. As shown in Fig. 1, once interest packet is received by CCN node, the CCN node checks prefix and then does duplicate data check by confirming nonce record. If it is not duplicate data, it will search for the data in the cache and if it exists, data packet will be sent to the consumer after that the related record will be deleted from the PIT table. If there is no related data in the cache, the information of the Interest packet will be saved in PIT table. Forwarding strategy to transmit the interest packet will be decided through FIB table. If the data packet is received from CCN node, CCN node will check whether the information from data packet matches to interest record in PIT table after checking the prefix. If it matches, the information will be saved in the cache, after that the data packet will be sent to consumer node.

Chunk replacement design: When the network is unstable and congested, the classification of a fast flow and slow flow rate is needed for fairness between the flows. The slow flow packet affects transmission rate of fast flow packet in the bottleneck bandwidth of the high-speed network. The transmission rate of fast flow packet is higher than that of slow flow packet that is stored in the CS of bottlenecks per time unit. That is why, the packet loss rate of fast flow is higher than the one of slow flow when congestion occurs in bottleneck CCN node. If the proposed emthod separate the flow by checking transmission rate and handle them separately in CCN node, the total throughput can be increased based on QoS by reducing delay in CCN node.

The proposed algorithm checks the arrival time of data packet after reading prefix of the packet in CCN node in order to classify between fast flow and slow flow. The proportion of transmission between the slow flow packet and fast flow packet is set to 1:1.

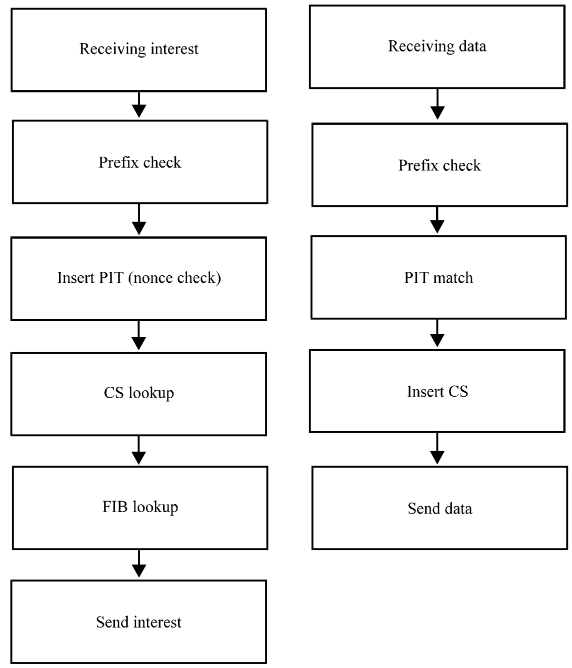

Fig. 1: Receiving interest and data packet on CCN node

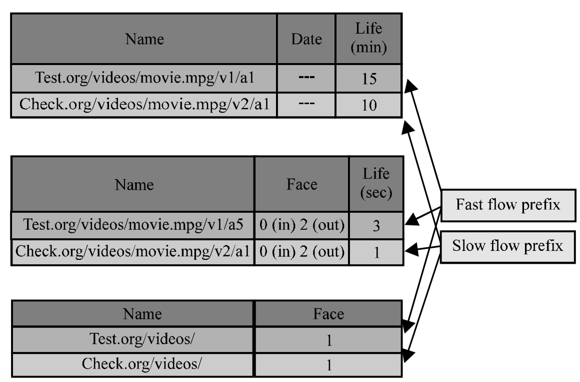

Fig. 2: Classifying packet separately on CCN node

When the packet arrives in the intermediate CCN node, the node will check whether the arrived packet is fast flow packet or slow flow packet by inspecting packet arrival time per time unit. If the arrived packet is fast flow packet, it will be assigned to the front of the table. If the arrived packet is slow flow packet, it will be assigned to the back of the table. If the number of the packet in the table is full, fast flow packet will go out first.

Figure 2 shows a table field in the CCN node. CS which represents cache in CCN node is composed of data prefix and lifetime. PIT table is composed of nonce for duplicate packet check in and out face that is interest path and prefix, lifetime. FIB table is composed of prefix

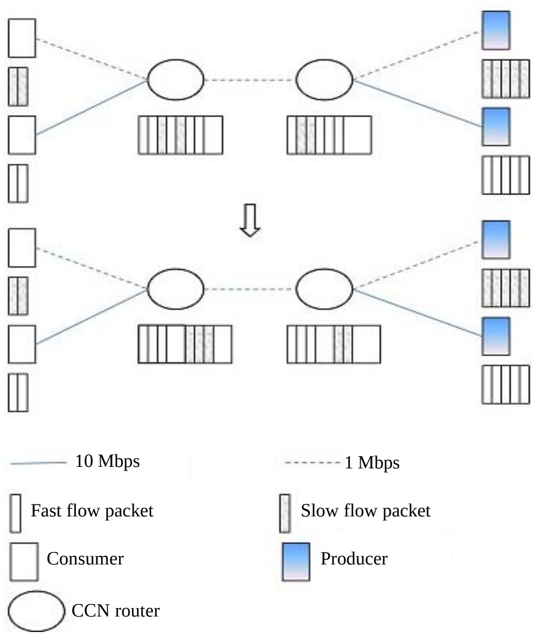

Fig. 3: The usage of chunk data

name and face. It decides the forward direction for the packet. The standard of classifying between fast flow prefix and slow flow prefix is the arrival time of the packet.

Figure 3 shows the sequence of stacked chunks of in the bottleneck interval. When the consumer sends interest packet for chunk to the producer, the intermediate node will store the information of interest packet. The CCN node will classify the slow flow and fast flow packets packet when they are saved in the node. One of the reasons is to reduce searching time in PIT table. Data packet size is more than the interest packet size, therefore, it may cause the congested environment. Furthermore, the data throughput between fast flow and slow flow is similar because they are congested in bottleneck CCN node. The proposed method to solve fairness is that classifying packets in the tables of CCN node. The slow flow and fast flow will be divided in the table. Chunk processing is processing to control the ratio of the fast flow and slow flow. It will maintain the fairness by this improved throughput, based on QoS.

Figure 4 shows how the chuck is managed in the CCN router. If the interest packet arrived on CCN router, fast flow packet in the PIT table will be separated from the slow flow packet. When the data packet is received from the producer, the CCN node will store in CS table by classifying fast flow packet and slow flow packet.

Algorithm 1 and 2 describe the proposed technique. When the interest packet is received in CCN router, the

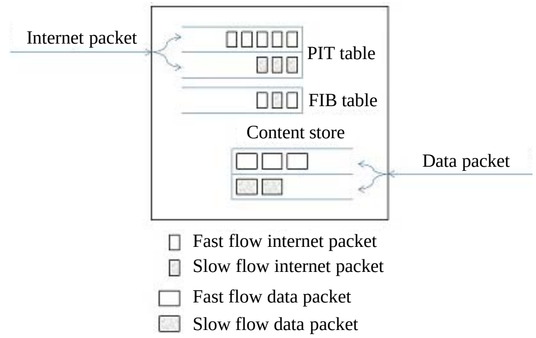

Fig. 4: Chunk classification in CCN router

node will check whether it is in IT table or not. If it is not, the CCN node will check the interest packet arrival time (it) and the average value of arrival time (avgIt). If theit is left the side of avgiT, the packet will be a fast flow packet so it will be assigned the front of PIT table. If the it is not, the packet will be assigned the right side of PIT table. If the data packet is received in the CCN node, the CCN node will check the data packet arrival time (dt) and the average value of arrival time (avgDt). If the dt value is the left side of avgDt, the Data packet will be assigned the left side of CS table. If it is not, it will be assigned the right side of CS table. The separate processing of the packets in the CCN node will improve the total throughput and the fairness of the receiving consumer.

Algorithm 1 (for interest packet):

```
Ensure: Incoming packet is not dummy packet
If it< avgIt then
Push Interest packet to the front of PIT
End if
If it> avgIt then
Push Interest packet to the back of PIT
End if
```

Algorithm 2 (for data packet):

```
Ensure: Incoming packet is not dummy packet
If dt< avgDt then
Push Data packet to the front of CS
End if
If dt> avgDt then
Push Data packet to the back of CS
End if
Ensure: Outgoing packet is not dummy packet
If fast flow packet then
Pop Data packet from the front of CS
End if
If slow flow packet then
Pop Data packet from the back of CS
End if
```

RESULTS AND DISCUSSION

Performance evaluation: To demonstrate chuck replacement algorithm, ndnSIM 2.0 (Mastorakis *et al*., 2015) based on NS-3 (http://www.nsnam.org/) is used.

Table 1: Configuration for simulation

Parameters	Values
Request chunk size per second	100 pieces
Simulation time	100 sec
Payload size	1040 byte
Bandwidth	10 Mbps
Bottleneck bandwidth	1 Mbps
Cache size	1000 packets
The minimum threshold of RED	50 packets
The maximum threshold of RED	80 packets
Transmission rate of C1	10 Mbps
Transmission rate of C2	1 Mbps
Link delay	20 msec

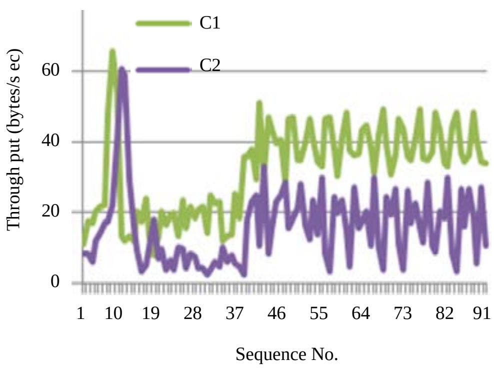

Fig. 5: Result for the previous method

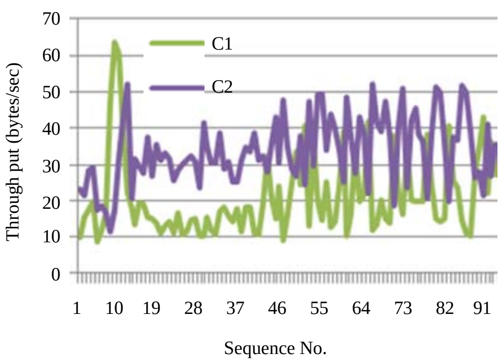

Fig. 6: Result for the proposed method

The topology is composed of linked 6 nodes with 3 consumer nodes and 3 producer nodes. The consumer nodes will send the Interest packet at the same time to compare the reception time of the data packets for Interest. Table 1 shows the configuration for the simulation. Consumer requests the movie streaming data to the producer. Cache algorithm was used LRU. The RED method was used, the minimum threshold is 50 packets and the maximum threshold value was set to 80 packets. The one of Consumer1 (C1) and Consumer2 (C2) was set to 1 Mbps.

Figure 5 graph illustrates the data packet throughput requested by the Consumer 1 and 2 using conventional methods. The chunk request time of C1 and C2 are the same but throughput was different. The throughput of C1 and C2 did not make a significant difference. Figure 6 graph illustrates the throughput for each consumer using the proposed chunk replacement algorithm. The flow that arrives in the network later is using the less bandwidth in the limited network circumstance. The proposed method will be an efficient method in this case. It will improve the throughput of each flow without affecting QoS policy C1, C2 of Fig. 6 is similar throughput.

CONCLUSION

In this study, a chunk replacement mechanism is proposed to increase the transmission rate of each consumer and fairness in the CCN router. By keeping the transfer rate on the basis of QoS and making efficient use of the network to improve the fairness, the throughput of each flow was increased using chunk replacement mechanism. The simulation results show the improved throughput and fairness based on QoS. The following study will investigate the proposed method in various scenarios and traffic usage patterns to make satisfactory progress of the communication network by controlling the content size studies.

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REFERENCES

Chib, R. and A.S. Sandhu, 2016. A design and analysis of EOM for energy saving and effective routing protocol: AODV and AOMDV. Indian J. Sci. Technol., Vol. 9, 10.17485/ijst/2016/v9i19/92831

Christo, M.S. and S. Meenakshi, 2016. Reliable and authenticated rumor riding protocol for unstructured peer-to-peer network. Indian J. Sci. Technol., Vol. 9, 10.17485/ijst/2016/v9i21/95161

Lee, S.W., D. Kim, Y.B. Ko, J.H. Kim and M.W. Jang, 2013. Cache capacity-aware CCN: Selective caching and cache-aware routing. Proceedings of the 2013 IEEE International Conference on Global Communications (GLOBECOM), December 9-13, 2013, IEEE, Atlanta, Georgia, ISBN:978-1-4799-1353-4, pp: 2114-2119.

Lim, S.H., Y.B. Ko, G.H. Jung, J. Kim and M.W. Jang, 2014. Inter-chunk popularity-based edge-first caching in content-centric networking. IEEE. Commun. Lett., 18: 1331-1334.

Mastorakis, S., A. Afanasyev, I. Moiseenko and L. Zhang, 2015. NDNSIM 2.0: A new version of the NDN simulator for NS-3. Master Thesis, University of California, Los Angeles, California.

Oueslati, S., J. Roberts and N. Sbihi, 2012. Flow-aware traffic control for a content-centric network. Proceedings of the IEEE International Conference on INFOCOM, March 25-30, 2012, IEEE, Orlando, Florida, USA., ISBN:978-1-4673-0775-8, pp: 2417-2425.

Rozhnova, N. and S. Fdida, 2012. An effective hop-by-hop interest shaping mechanism for CCN communications. Proceedings of the 2012 IEEE International Conference on Computer Communications Workshops (INFOCOM WKSHPS), March 25-30, 2012, IEEE, Orlando, Florida, USA., ISBN:978-1-4673-1017-8, pp: 322-327.

Tanaka, K., N. Gajendran, H. Asaoku, T. Kyo and N. Kamada, 2012. Higher involvement of subtelomere regions for chromosome rearrangements in leukemia and lymphoma and in irradiated leukemic cell line. Indian J. Sci. Technol., 5: 1801-1811.

Udugama, A., J. Cai and C. Goerg, 2013. Adaptation and evaluation of widely used TCP flavours in CCN. Proceedings of the 5th International Conference on Mobile Networks and Management, September 23-25, 2013, Springer, Cork, Republic of Ireland, pp: 29-44.

Zhang, F., Y. Zhang, A. Reznik, H. Liu, C. Qian and C. Xu, 2014. A transport protocol for content-centric networking with explicit congestion control. Proceedings of the 2014 23rd International Conference on Computer Communication and Networks (ICCCN), August 4-7, 2014, IEEE, Shanghai, China, ISBN:978-1-4799-3572-7, pp: 1-8.