The Impact of Interest Traffic Generation on NDN Forwarding

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Abstract

With the increase of the number of Internet applications, which require different Quality of Service (QoS), network traffic generation and Flow Completion Time (FCT) play important roles in both consumer and operator sides. As Network traffic is generated differently with variable size, behavior, and priority; operators need to know how consumers generate traffic, in order to provide them better service. On the other side, consumers need to get their transactions completed within a possible shortest period of time. The Named Data Networking (NDN) proposed as Future Internet architecture needs to meet both operators and consumers' requirements. In the presence of heterogeneous traffic generation applications and forwarding strategies, it becomes difficult to select the best application and forwarding strategy to use, and to identify the relationship between them. In this paper, we analyze the impact of Interest traffic generation on NDN Forwarding Strategies in terms of Flow Completion Time. The simulation results show that the forwarding strategies do not depend on how consumer generates the traffic. On the other side, an application that consumer uses to generate Interest traffic plays an important role in Flow Completing Time variation.

1. Introduction

NDN architecture has got many researchers' attention due to name based forwarding, in which content is requested by name. In additional to that, it has caching capabilities, where node in transmission path can cache the content for serving similar requests of other consumers. Interest traffic generation and forwarding play important roles in retrieving content. With the increase of number of heterogeneous Internet applications, which require different Quality of Service (QoS), the operators need to share network resources based on demands of users [1]. Furthermore, they want to know how consumers generate traffic, in order to provide them better service. On the other side, consumers want to get their transactions completed within a possible shortest period of time [2].

NDN forwarding differs from IP; In IP, the router uses the source and destination IP addresses to forward the packets. On the other hand, NDN forwarding is based on content name lookup, where the router uses name to request and forward the content. All in all, forwarding strategy deals with fast name lookup, intelligent forwarding and effective caching [3]. In [4], the authors carried-out performance evaluation of NDN Forwarding Strategies: Flooding, SmartFlooding and BestRoute in terms of Flow Completion Time (FCT). FCT was defined as a time duration from the first Interest request is sent, until to the reception of the last data chunk as a response to the last submitted interest. Their simulation results show that Flooding performs well than others. On the other side, BestRoute and Smartflooding have almost the same performance. ConsumerCbr was used as the only one application for generating Interest traffic. In view of the above, and in consideration of the existence of heterogeneous applications for generating Interest traffic, we find important to extend [4].

In this paper, we analyze the impact of Interest traffic generation on NDN Forwarding Strategies in terms of Flow Completion Time, through the use of existing ndnSIM traffic generation applications, namely ConsumerZipfMandelbrot, ConsumerBastches, ConsumerWindow, and ConsumerCbr [5]. The simulation results show that the forwarding strategies do not depend on how consumer generates the traffic, on the other side, the way Interest traffic is generated has an impact on Flow Completing Time. The rest of the paper is organized as follows, Section 2 describes in detail Interest traffic generation, while section 3 describes NDN Forwarding strategies. Section 4 provides evaluation details, while the section 5 describes our future scope and conclusion.

2. Interest traffic generation

The NDN proposed as the Future Internet architecture works in one-to-one fashion, in which one Interest retrieves one data chunk. In NDN, there are many consumer applications in which generate Interest traffic based on pre-defined patterns. In this section, we discuss on existing traffic generation applications in ndnSIM, namely ConsumerZipfMandelbrot, ConsumerCbr, ConsumerBatches, ConsumerWindow.

In ConsumerCbr, the Interest traffic is generated based on pre-defined parameters such as frequency, traffic rate, etc. ConsumerZipfMandelbrot works as ConsumerCbr, in which Interest traffic is generated based only on ZipfMandelbrot distribution. In ConsumerBatches, at a simulation point, the Interest traffic is generated with a specific number of Interests to be sent within a specific time period. In Consumer Window, the traffic is generated with variable rate, and based on a sliding window. Sliding window defines the number of Interests that will be sent out without waiting the returning chunks; i.e. outstanding number of Interests.

3. NDN Forwarding strategies

In NDN, there are two types of packets identified by a unique name, Interest packet is used for requesting the content and the data packet is transmitted in response to the Interest packet on the reverse path. Incoming packet is forwarded based on its name; i.e. on every incoming packet, the node performs its name lookup, and decides on how to forward the packet through the use of forwarding strategy. Forwarding strategy uses Forwarding Information Base (FIB) table, in which maintains forwarding rules, to forward the packets. There are many forwarding strategies, and based on [4], in this paper, we used only top two forwarding strategies in terms of FCT, namely Broadcasting (Flooding) and BestRoute. In Broadcasting, CCN node, after checking the FIB entries, forwards every Interest to eligible upstream node(s). The next hop face becomes eligible when it does not belong to the downstream node. On the other side, BestRoute forwards every Interest to the lowest routing cost upstream node(s) [6].

4. Performance evaluation

In this section, we analyze the impact of Interest traffic generation on NDN Forwarding Strategies, we used 4 existing ndnSIM reference applications: ConsumerZipfMandelbrot, ConsumerCbr, ConsumerBatches, and ConsumerWindow for generating Interest traffic. On the other side, Flooding (Broadcasting) and BestRoute were used as forwarding strategies. All our simulations were performed using the ndnSIM, an NS-3 based NDN 2.0 simulator [7].

4.1 Simulation Scenarios

In scenario 1 presented in Figure 1, we have two consumers, two intermediate routers, and two content providers. Content provider 1 serves consumer 1 with content /Dest1, and Content Provider 2 serves consumer 2 with content /Dest2. All links have 10 Mbps bandwidth, except the link between Router 1 and Router 2, which is 20 Mbps. The propagation delay is 10 milliseconds. The queue size is 100 packets, and maximum cache size is 10000 chunks.

In scenario 2 presented in figure 2, we have 4 consumers, one content provider and 2 intermediate routers. Each link has a bandwidth of 5 Mbps, except the link between router 1 and router 2 which is 10Mbps, and 20 Mbps between router 2 and content provider. The Content provider replies all consumers' requests with prefix /Dist 1 for consumer 1, prefix /Dist 2 for consumer 2, prefix /Dist 3 for consumer 3, and prefix /Dist 4 for consumer 4.

In both scenarios, the payload size is 1024 bytes. BestRoute and Broadcasting were used as forwarding strategies. For Interest traffic generations, in consumerCbr, consumer nodes generate traffic with the frequency of 100 Interests per second. In ConsumerZipfMandelbrot, consumer nodes generate traffic with the frequency of 100 Interests per second, 0.7 as rank parameter and 0.7 as power parameter. In ConsumerWindow, consumer nodes start sending one Interest per second, on every received chunk, the sliding window gets incremented one Interest. The initial window timeout was set to true; i.e. on timeout node restarts with initial window. For the ConsumerBatches, consumer nodes generate 100 Interests per one second, 500 Interests per five seconds and 1000 Interests per ten seconds.

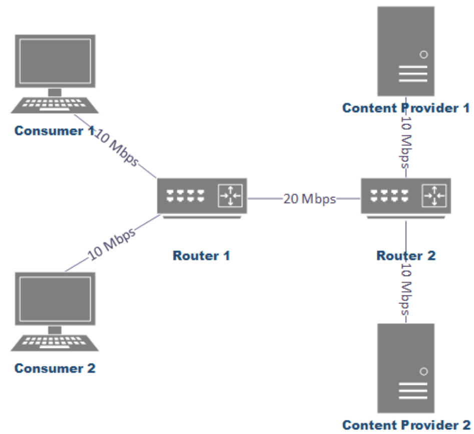

Figure 1: Scenario 1

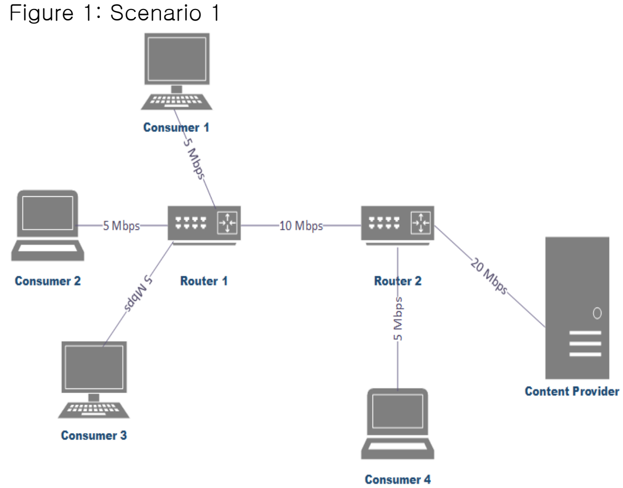

Figure 2: Scenario 2

4.2 Simulation Results

In both scenarios, we generate Interest traffic to retrieve 2 MB of chunks in each flow. Our simulation results in figure 3, 4 show that the FCT (milliseconds) for Broadcasting and BestRoute are almost the same through the use of different Interest traffic generation applications. This motives us to confirm that the forwarding strategies do not depend on traffic generation applications. For every incoming traffic, the forwarding strategies are able to decide on how to forward the packets.

During 20 seconds of simulation, the simulation results show that the traffic generated by ConsumerZipfMandelbrot and ConsumerCbr experienced larger FCT than the traffic generated by ConsumerWindow and ConsumerBatches. ConsumerBatches application is characterized by unclear behaviors, in which the change of number of Interests to be sent within a specific time period produces the same simulation results (lower). Even if ConsumerBatches has the lowest FCT than others, we consider it as an unstable application for generating Interest traffic. In figure 4, FCT for ConsumerZipfMandelbrot goes down due to the utilization of one content provider to serve four contents with prefixes /Dist 1, /Dist 2, /Dist 3 and /Dist 4 in 4 flows. Cache size was 10000 chunks in all nodes. These settings contribute in making content more popular, and as well as in reducing the time for name lookup. In view of the above, Flow completing Time depends on how the consumer generates the traffic, i.e. an application that consumer uses to generate Interest traffic plays an important role in Flow Completing Time variation.

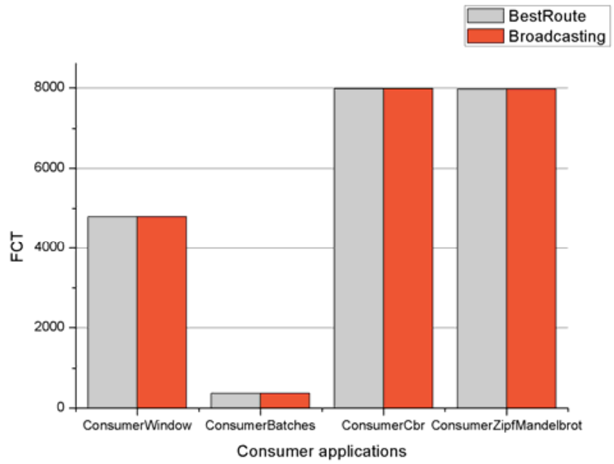

Figure 3: Traffic forwarding for scenario 1

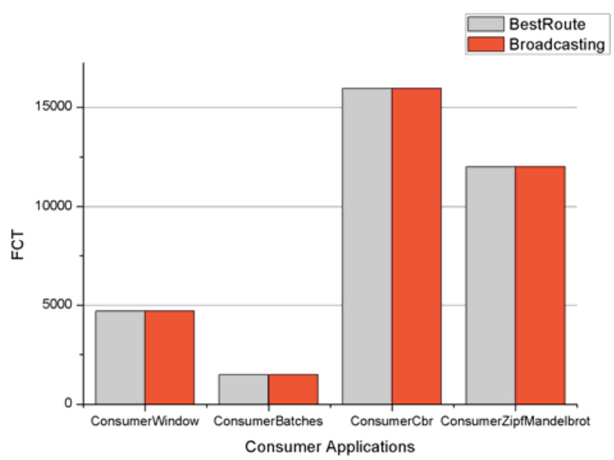

Figure 4: Traffic forwarding for scenario 2

5. Future Scope and Conclusion

In this paper, we analyzed the Impact of Interest traffic generation on NDN Forwarding Strategies. Four existing Interest traffic generation applications, namely ConsumerBatches, ConsumerZipfMandelbrot, ConsumerCbr and ConsumerWindow were used. The simulation results show that the forwarding strategies do not depend on Interest traffic generation. For every incoming packet, the forwarding strategies are able to decide on how to forward the packet. On the other side, Flow completing Time depends on how consumer generates Interest traffic. ConsumerWindow and ConsumerZipfMandelbrot perform well than others in terms of FCT. In ConsumerBatches, the changes of number of Interests to be sent within a specific time period does not affect simulation results, and this makes ConsumerBatches unrecommendable.

In the future works, we aim to extend our research on NDN differentiated services by proposing new traffic generation application, forwarding strategy and PIT structure, in order to provide an improved Quality of Service (QoS).

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7. References

[1]. Bouch, Anna, and M. Angela Sasse. “Network quality of service: What do users need?" Proceedings of the 4th International Distributed Conference. Vol. 22. 1999.

[2]. Dukkipati, Nandita, and Nick McKeown. "Why flow-completion time is the right metric for congestion control." ACM SIGCOMM Computer Communication Review 36.1 (2006): 59-62).

[3]. Yuan, Haowei, Tian Song, and Patrick Crowley. "Scalable NDN forwarding: Concepts, issues and principles." Computer Communications and Networks (ICCCN), 2012 21st International Conference on. IEEE, 2012.

[4]. Anselme NDIKUMANA, Ashis Talukder, Rossi Kamal, Kyi Thar, Saeed Ullah, Rim Haw and Choong Seon Hong*. “Performance Evaluation of NDN Forwarding Strategies."http://networking.khu.ac.kr/publications/data/KIISE2014-12-Anselme.pdf visited on April 8, 2015, 10:21 AM

[5]. http://ndnsim.net/2.0/applications.html. Visited on April 29, 2015 at 8:09 PM

[6]. Afanasyev, Alexander, Junxiao Shi, Beichuan Zhang, Lixia Zhang, Ilya Moiseenko, Yingdi Yu, Wentao Shang et al. NFD developer's guide. Technical Report NDN-0021, NDN, 2014.

[7]. Afanasyev, Alexander, IlyaMoiseenko, and Lixia Zhang. ndnSIM: NDN simulator for NS-3. Named Data Networking (NDN) Project, Tech. Rep. NDN-005, Rev 2 (2012)

[8]. Tsilopoulos, Christos, and George Xylomenos. "Supporting diverse traffic types in information centric networks." Proceedings of the ACM SIGCOMM workshop on Information-centric networking. ACM, 2011.

[9]. Carofiglio, Giovanna, et al.”Multipath congestion control in content centric networks.” IEEE NOMEN 13 (2013).