Translation Gateway Between IP and NDN Using Dual Channel

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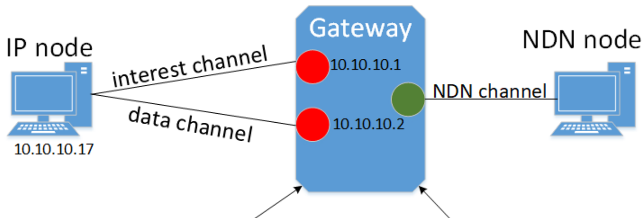
1 Introduction

The migration process from host-based packet to named-based packet, particularly NDN (Named Data Networking) is inevitable in the next decades. However, host-based packet usage is still dominating in a current communication network. Therefore, a clean slate, secure, and gradual network migrations are necessary. Regarding previous research [1], translation is considered as the most practical approach to be implemented in the IP-to-NDN migration process. Therefore, we propose a dual-channel scheme to translate packets between IP and NDN. Using an emulator, we show the numerical results to measure the performance of the translation gateway and compare the proposed dual channel method with the single channel scheme.

2 Dual-channel translation gateway

In this paper, we propose a translation gateway that enables translation between NDN and IP packets. The translation gateway plays a role as an intermediate broker between the two different networks: the IP network and the NDN network. The simple IP-to-NDN translation can be implemented by reading the IP data payload and using a single-channel scheme [2]. However, the single-channel scheme showed a potential threat to security issues because it allowed the gateway to read the IP data payload for naming and translating the packet. Without reading the IP data payload, the gateway can not distinguish the interest packets from data packets. Hence, we propose an IP-to-NDN gateway with a dual-channel that enables the gateway to determine whether each packet is interest or data without reading the IP data payload.



Producer Table

IP:Port	Prefix Name
10.10.10.17:1001	/abc
10.10.10.17:1002	/aaa
10.10.10.17:1003	/bbb
10.10.10.17:1004	/ccc

Consumer Table

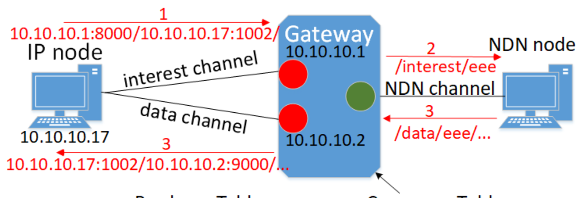
IP:Port	Prefix Name
10.10.10.17:1001	/efg
10.10.10.17:1002	/eee
10.10.10.17:1003	/fff
10.10.10.17:1004	/ggg

Figure 1: Translation gateway with Dual channel

The architecture of the translation gateway is described in Figure 1. The merit of using two IP addresses is to distinguish two different packets existing in NDN, namely interest packet and data packet. One IP address is dedicated to the interest packet, and the other is used for the data packet. A control plane, a table containing information of a combination of IP address and UDP port number that maps to a particular prefix name, is provided in translation gateway to give information about prefix name of interest and data packet. A producer table is used to forward the interest packet from the NDN consumer through an interest channel. The IP producer replies by sending the data through a data channel. Contrary, a consumer table is used to forward an interest-like packet from an IP consumer through an interest channel. The NDN producer replies with a data packet forwarded through the data channel. The connection between those two types of tables is independent of each other.

2.1 IP Consumer and NDN Producer

First, we consider the scenario where the IP node becomes a consumer and NDN acts as a producer using an example shown in Figure 2. We assume the control plane table showing a mapping between prefix name to a combination of IP address and the port number is pre-cached in the translation gateway. The control plane table mechanism is similar to DNS in the IP network. The consumer initiates by sending an interest-liked IP packet. First, the IP node constructs an IP header packet with 10.10.10.1:9000 in the destination part and 10.10.10.17:1002 in the source part with an empty data payload. When receiving this packet, the gateway knows that the packet is an interest packet since it uses IP 10.10.10.1 as the destination address. The gateway converts this packet into an NDN packet with a particular prefix name mapped from the source IP address and port number. The NDN producer receives the interest packet with prefix name /eee and replies directly by sending the data packet to the gateway. The gateway translates the packet by constructing the IP packet with 10.10.10.17:1002 as the destination address and sends it through a data channel.



Producer Table

IP:Port	Prefix Name
10.10.10.17:1001	/abc

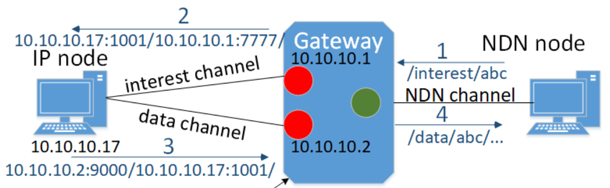
Consumer Table

IP:Port	Prefix Name
10.10.10.17:1002	/eee

Figure 2: IP consumer translation process

2.2 NDN Consumer and IP Producer

Next, we consider the scenario where the NDN node becomes a consumer, and the IP node acts as a producer using an example shown in Figure 3. First, the NDN node emits an interest packet with a particular prefix name, /abc, to the gateway. Next, the gateway tries to translate the NDN interest packet to the IP interest packet by retrieving a combination of IP address and port number for the corresponding prefix name in the producer table. The gateway constructs an IP packet with a destination address header of 10.10.10.17:1001 and a source address header of 10.10.10.1:7777. Afterward, the gateway sends it through the interest channel. IP node replies directly by sending the content with IP packet through data channel with destination address header 10.10.10.2:9000.



Producer Table

IP:Port	Prefix Name
10.10.10.17:1001	/abc

Consumer Table

IP:Port	Prefix Name
10.10.10.17:1002	/eee

Figure 3: NDN consumer translation process

3 Numerical evaluation

An emulator is used to measure the performance of the proposed translation gateway. As for the hardware and software specifications, we used the same values used in [2]. The values set to other major parameters are shown in Table 1. To measure the throughput and forwarding delay at the gateway, a massive amount of interest packets was generated from the NDN/IP consumer to the NDN/IP producer.

Table 1: Setting values of main parameters

Paramater	Value
Number of content items	1000
Cache-size	10
Zipf parameter (α)	0.7 and 1.0

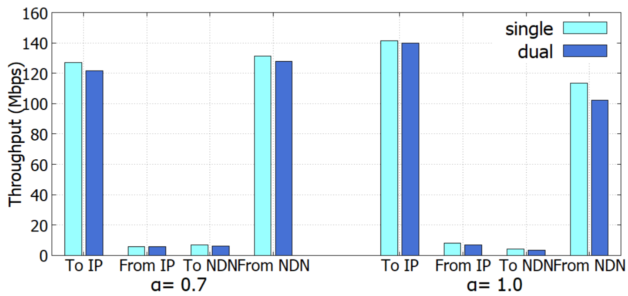


Figure 4: Throughput in case of IP consumer and NDN producer

Figure 4 shows the throughput at the translation gateway with a single or dual-channel when IP node was consumer, and NDN node was the producer. The dual-channel translation gateway achieved slightly smaller throughput compared with the single-channel translation gateway, i.e., about 5% or 7% smaller when $\alpha = 0.7$ and $\alpha = 1$.

Figure 5 shows the throughput when the NDN node was the consumer, and the IP node was the producer. The throughput of the dual-channel translation gateway was about 10% and 15% smaller than that of the single-channel translation gateway when $\alpha = 0.7$ and $\alpha = 1$, respectively.

Figure 6 shows the cumulative distribution of the delay in forwarding packet from/to consumer to/from producer. The cumulative distribution of forwarding delay of the dual-channel translation gateway had been shifted to the right direction about 2 ms from that of

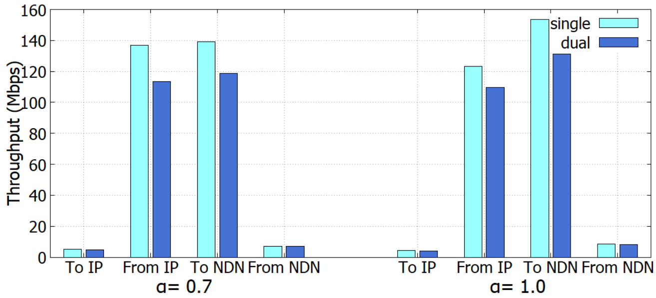


Figure 5: Throughput in case of IP producer and NDN consumer

the single-channel translation gateway when the cumulative probability was greater than about 0.4. This means that the throughput of dual-channel translation was reduced by about 10% on averagely compared with the single-channel translation. However, the dual-channel scheme provides better security than single-channel, which is the upper hand to implement in the real network.

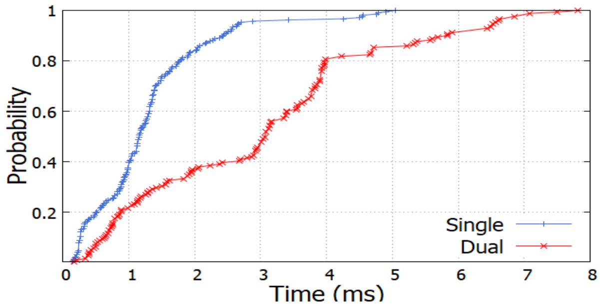


Figure 6: Cumulative distribution of forwarding delay at gateway

4 Conclusion

The dual-channel translation gateway has a lower throughput performance than the single-channel IP-to-NDN translation gateway, about 5-10% because of forwarding time-shifting. However, the security issues for not reading the data payload has been achieved for dual-channel translation gateway that gives additional benefit for this type of translation gateway.

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