An Optimized Congestion Control Scheme for Mice Flows in Named Data Networking

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ABSTRACT

The transmission performance of flows in NDN is greatly dependent on congestion control algorithms. However, current congestion control schemes for NDN are not designed to distinguish flows of different type, and they are relatively conservative for mice flows. This poster proposes a Packet-Pair based startup for NDN congestion control schemes, by exploiting the available bandwidth estimation during the flow startup, to approach the maximum throughput faster. Thus, this technique can improve the transmission efficiency of mice flows without harming elephant flows. We evaluate our proposal on ndnSIM and prove its effectiveness.

CCS CONCEPTS

• **Networks** → Network protocol design; Transport protocols.

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1 INTRODUCTION

Named Data Networking (NDN) [5] has attracted much attention as a promising network design. The congestion control mechanism is an essential factor in ensuring the transmission performance of the NDN network. Efficiency is one of the most important goals of congestion control scheme design. Window-based congestion control schemes are popular in both TCP/IP and NDN networks.

However, existing window-based congestion control schemes in NDN are relatively conservative for mice flows especially in the long fat network (LFN), since the startup phase such as slow-start is designed to fill the pipe to approach the available bandwidth. Therefore, it is likely that the transmission of the mice flow has been finished before reaching the maximum throughput. In addition, emerging services with small-size flows, e.g., short video applications, are developing more rapidly, which need to ensure QoS and QoE.

Window-based congestion control schemes generally employ the Additive Increase and Multiplicative Decrease (AIMD) model to control the Interest sending rate at receivers. With this model, the congestion window (*cwnd*) increases by one per Round-Trip Time (RTT). We found that $cwnd = cwnd + 1$ is triggered by the last Data returns per round as well slides backward. Thus, subsequent two Interests will be sent out in back-to-back way (Packet-Pair), which can be used to estimate the available bandwidth [1, 2].

In this poster, we propose an optimized congestion control scheme for the mice flow, and we exploit the Packet-Pair based available bandwidth estimation technology during the startup of the congestion control scheme, to approach the maximum throughput faster.

2 SCHEME DESIGN

Our scheme is implemented at receivers, which is an optimization of existing window-based congestion control schemes. It is based on: (1) the window; (2) the bandwidth probing. We found that Packet-Pair will always appear at $cwnd$+1. Thus, the scheme focuses on controlling window size and sampling Packet-Pair for bandwidth estimation. The key idea of our proposal is optimizing the startup of the congestion control scheme. The scheme process is illustrated in Fig. 1.

2.1 Window-based Congestion Control Scheme

We employ AIMD and PCON [4] at receivers to control the Interest sending rate. PCON also marks queuing Data

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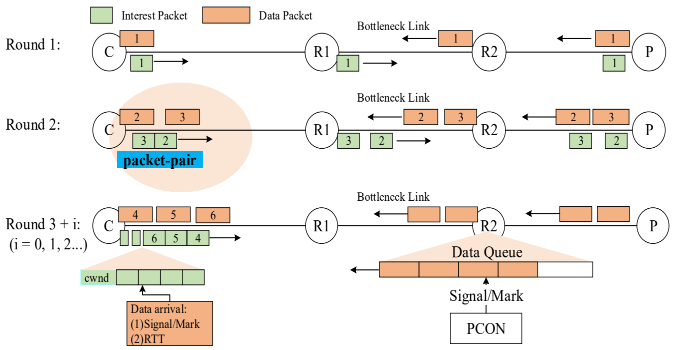

Figure 1: Scheme Process

at intermediate nodes and informs the receiver to decrease *cwnd*. We set the initial congestion window *cwnd* to 1, then the Packet-Pair will be triggered by the first returned Data.

2.2 Sample the Packet-Pair to Update *cwnd*

At the receiver, we added a simple logic to sample the first Packet-Pair (when $cwnd = 2$) during the startup of the congestion control scheme. Data packet size is denoted as S. The sending time of both two Interest packets is t_0. The arrival time of the two Data packets is t_1 and t_2, respectively. The available bandwidth of the bottleneck link is b.

At the optimal transmission performance point, the relationship between these variables is presented in Eq. 1. According to the Packet-Pair scheme[2], the available bandwidth of the bottleneck link can be estimated as Eq. 2. Then *cwnd* can be updated by Eq. 3. Thus, subsequent Interest packets will be sent using the new *cwnd*.

$$RTT/cwnd = 1/b \tag{1}$$

$$b = S/(t_2 - t_1) \tag{2}$$

$$cwnd = S/(t_2 - t_1) * (t_1 - t_0) \tag{3}$$

Noted that, the estimated available bandwidth using this Packet-Pair method is less than the actual available bandwidth. Therefore, the updated *cwnd* will not cause congestions when the available bandwidth changes smoothly.

3 EVALUATION

We implement our Packet-Pair based scheme on ndnSIM2.6[3] and compare it with other three typical schemes, AIMD, CUBIC and BIC. These four methods are based on PCON.

We use a 6-node linear topology with one bottleneck link. The bottleneck link bandwidth is 40Mbps, and the sum of all link delay is 20ms. The payload size of Data packet is 1024 Bytes. We simulate a mice flow containing 10000~20000 Data packets, and an elephant flow containing 200000 Data packets. And these two flows share the same bottleneck link. The performance indicator is the flow completion time.

In the single-flow scenario (Fig.2), mice flow with Packet-Pair based scheme takes the shortest time, since *cwnd* reaches

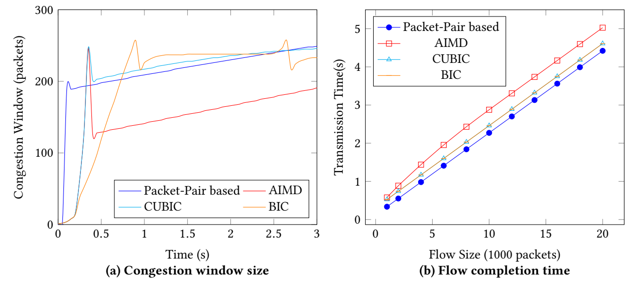

Figure 2: Single flow (mice flow) performance

the available bandwidth more fast and more steadily. In the double-flow scenario (Table 1), both mice and elephant flow with Packet-Pair based scheme take the shortest time.

Table 1: Two flows performance: completion time (s)

Flow type	Packet-Pair based	AIMD	CUBIC	BIC
mice flow	**8.71**	14.82	19.58	11.27
elephant flow	47.53	50.55	47.65	47.73

4 CONCLUSION

In this poster, we exploit the Packet-Pair technology to optimize the startup phase of window-based congestion control schemes to approach the maximum throughput more quickly. Mice flows can dramatically benefit from our proposal without affecting elephant flows. Based on simulations, we demonstrate the efficiency of our proposal. We will extend our proposal to multi-path and multi-source scenario in our future work.

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