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Improving the Transmission Control Efficiency in Content Centric Networks

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Abstract

The current Internet is facing a lot of challenges, including the transmission inefficiency due to the popularity of content-delivery applications. Content-Centric Networking (CCN) solves this problem by name-oriented routing and in-network caching. However, the existing transmission control approaches are not applicable in CCN.

In this paper, we propose Flow-Aware Congestion Estimation (FACE) for congestion control in CCN. FACE predicts the future occupancy of the forwarding queue of the CCN router by historical flow information. Based on the current queue utilization, FACE estimates whether the congestion occurs more accurately. The Pending Interest Table (PIT), as a core component of the CCN router, is also crucial for the transmission control efficiency. Therefore, we then propose RTT-Aware PIT (RAPIT) for more precise transmission control. RAPIT measures the Round-Trip Time (RTT) between a CCN router and a content publisher, and sets PIT entry residence time dynamically based on the measured RTT. The evaluations show that FACE and RAPIT improve the PIT utilization and transmission control efficiency of CCN greatly.

Keywords: Content Centric Network, Transmission Control Efficiency, Congestion Control, Pending Interest Table

1. Introduction

The current Internet, designed 40 years ago, is facing a lot of challenges, including the transmission inefficiency due to the popularity of content-delivery applications (*e.g.*, Youtube, Netflix). Therefore, many brand-new Information Centric Networking (ICN) architectures are proposed, *e.g.*, Data-Oriented Network Architecture (DONA) [1], Network of Information (NetInf) [2], Content Centric Network (CCN) [3] and Publish/Subscribe Internet Routing Paradigm (PSIRP) [4]. As a widely-accepted ICN architecture, CCN solves this problem by name-oriented routing and in-network caching. In CCN, contents are requested and forwarded by names; routers can identify and cache the forwarded contents. In this way, the redundant transmission along the same path can be avoided, thus the transmission control efficiency is greatly improved.

The new features of CCN bring not only advantages, but also challenges to the Internet content transmission. Based on the feature of in-network caching, a request can be replied by a caching node along the path to the content provider. Hence, a CCN flow may have multiple sources and paths. Due to these reasons, consumers cannot estimate congestion accurately based on a single RTT value as they do in the traditional TCP transport protocol. **Therefore, it is very important to design a congestion control approach based on CCN features.**

Besides, as a core component of the CCN router, the Pending Interest Table (PIT) is crucial for the forwarding performance. PIT records the content requests (Interest) from users. Then the corresponding content packets (Data) trace the recorded Interests back to the consumer. Thus PIT is involved in the forwarding of both Request and Data packets. As packet arrival rate increases, PIT requires larger capacity and higher access rate. Actually, in 2012, an evaluation on a 20Gbps gateway trace indicates that at such a link rate, the PIT needs 1.5M entries, and there are 1.4M lookups, 0.9M inserts and 0.9M deletions per second [5]. When the PIT gets fully filled but the requests keep arriving, the router has to discard new coming requests. This *PIT congestion* may lead to a mass of request retransmissions. **Therefore, it is of great significance to control PIT congestion in CCN.**

In this paper, we propose an intergraded solution to improve the transmission control efficiency in CCN. Our scheme includes two main elements:

1) A Flow-Aware Congestion Estimation (FACE) for transport congestion control. First, we design a monitoring mechanism for data packet sending queue on the router. Based on the information collected from the transmitted flows and the queue utilization, the router is able to estimate whether a Data packet queue will get congested, thus it notifies the congestion at the best time.

2) A PIT congestion control approach: RTT-Aware Pending Interest Table (RAPIT). RAPIT inhibits PIT congestion by reducing the residence time of non-satisfied

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