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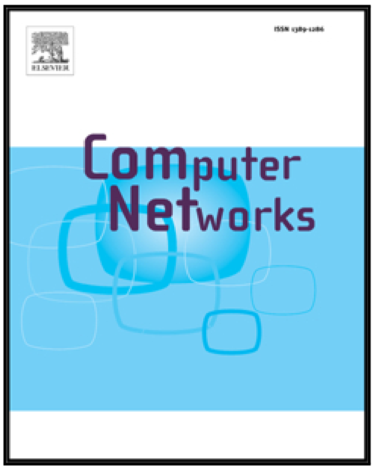

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Design and Evaluation of Coordinated In-network Caching Model for Content Centric Networking

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***Abstract*—In-network caching has been widely adopted in Content Centric Networking (CCN) to accelerate data delivery, mitigate server load and reduce network traffic. However, the line-speed requirement makes the in-network caching space very limited. With the rapid growth of network traffic, it is significant challenging to decide content placement in such limited cache space. To conquer this conflict, coordinated in-network caching schemes are needed so as to maximize the profit of ubiquitous caching capacities. In particular, in-network caching in CCN is deployed as an arbitrary network topology and naturally supports dynamic request routing. Therefore, content placement scheme and dynamic request routing are tightly coupled and should be addressed together. In this paper, we propose a coordinated in-network caching model to decide the optimal content placement and the shortest request routing path under constraints of cache space and link bandwidth in a systematic fashion. Via extensive simulations, the effectiveness and efficiency of our proposed model has been validated.**

I. Introduction

As an emerging predominant next-generation network architecture, Content Centric Networking (CCN) [1] leverages ubiquitous `in-network caching`, where each router is equipped with a content store (CS) module, to accelerate data delivery, mitigate server load and improve user experience. Furthermore, CCN identifies each piece of content chunk with a globally unique name. As these name-based content chunk can be addressed, stored and transported independently, in-network caching allows every cache enable node (e.g., router, proxy cache and end-user machine) of the network to opportunistically cache the named-chunks and use them to serve the subsequent requests, avoiding going all the way to the original server.

Despite many benefits are expected by in-network caching, there are a number of challenges to be addressed. First, with current technologies, line-speed requirement limits the capacity of in-network caching and suggests the cache size of each router should not exceed 10-GByte DRAM memory size [2]. It is significant challenging to decide content placement in such limited cache space. Second, the increasing demand of network traffic, such as user-generated content, time-shift TV and high definition video, overwhelms link bandwidth capacities. The scarcity of bandwidth of Internet links is becoming a bottleneck of accessing huge amount of data. We therefore argue that designing an effective in-network caching scheme in consideration of cache space and link bandwidth constraints is critical for CCN. This problem has been studied extensively in traditional Web caching or content distribution network (CDN) systems, which, however, are not fit for CCN due to the following two reasons.

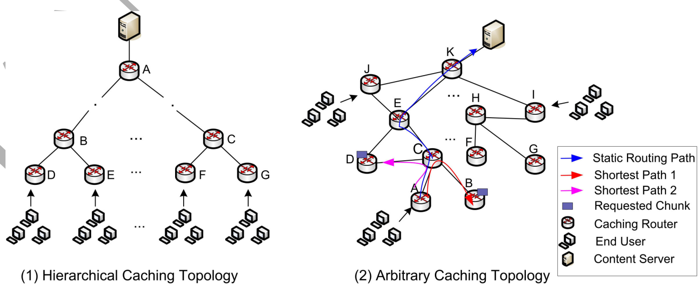

Fig. 1. Hierarchical and Arbitrary Caching Network Topologies Comparison, and Static and Dynamic Request Routing Paths Comparison in CCN.

First, unlike content caching deployed as an *overlay* capacity in CDN, in-network caching is deployed as an *underlay* network capacity in CCN. Therefore, caching nodes in CCN may cover the whole Internet scale and are arranged as an *arbitrary* network topology (see Fig. 1(b)), rather than the hierarchical tree structure in CDN (see Fig. 1(a)). Second, in-network caching naturally supports *dynamic request routing*, which can locate content replicas based on current caching statuses in the network and selects a more benefit path for the request. Fig. 1(b)) illustrates an example of dynamic request routing in an arbitrary network topology. When router A receives a request from an end user, dynamic request routing strategy will send it in path 1 or 2 (A-C-B or A-C-D), both of which are much better than the one (A-C-E-K-Server) selected by static routing strategy, sending the request to the original server.

Existing works [2]-[7] have been conducted on designing in-network caching strategies in CCN, such as the optimal content placement locations [3], explicit cooperative caching scheme [4], implicit cooperative caching scheme [5], name-

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