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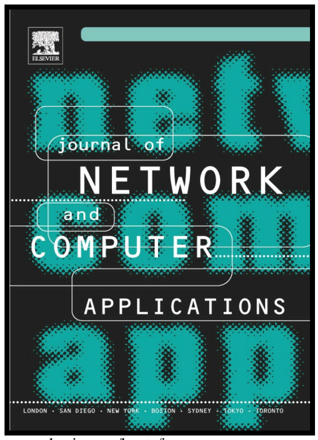

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Muhammad Faran Majeed, Matthew N. Dailey, Riaz Khan, Apinun Tunpan

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Pre-caching: a proactive scheme for caching video traffic in named data mesh networks

Muhammad Faran Majeed[a,*], Matthew N. Dailey[a], Riaz Khan[b], Apinun Tunpan[c]

[a] *Computer Science & Information Management, School of Engineering & Technology, Asian Institute of Technology, Thailand*
[b] *School of Engineering & Technology, Asian Institute of Technology, Thailand*
[c] *Internet Education & Research Lab (intERLab), Asian Institute of Technology, Thailand*

Abstract

Information-centric networking (ICN) is a future Internet architecture with the potential to solve myriad issues arising from traditional Internet architecture. By providing in-network caching of content, ICN provides for efficient delivery of content, such as streaming video, that occupies most of the bandwidth and resources of the Internet. Named data network (NDN) is a promising ICN architecture that supports video streaming (both live and on-demand) but does not fully exploit the full potential of in-network caching. In this paper, we propose a mechanism for pre-caching, based on the popularity, chunks of large content objects, such as videos, once they are requested by a consumer. We provide for collaboration in caching between neighboring content routers (CRs) in mesh networks, keeping the cache capacity constraints of CRs in mind. We characterize pre-caching as an optimization problem in which the goal is to jointly minimize the number of hops from the caching node to the consumer and the number of replicas, while observing the cache capacity of each CR. We implement and empirically evaluate each of the schemes and find substantially better than the existing NDN-based schemes.

Keywords: pre-caching; video streaming; named data networking; future Internet architecture; wireless mesh network.

1. Introduction

The communication network that was devised in the 1970s, now known as the Internet, started as an "Internet of Hosts," where the main focus was sharing of resources between hosts. With evolution, it became an "Internet of Services" to provide online services, an "Internet of People" to connect people through social media, an "Internet of Things" to connect devices around us to one another, and now an "Internet of Media" [1]. Today, the colossal expansion of media on the Internet has made content the first-class citizen of the Internet rather than the host. Information-centric networking (ICN) has proven to be a paradigm that can handle such enormous content efficiently [2]. In ICN, each router, or to be more exact, each content router (CR), caches content and then forwards it. This enables other requesters or consumers[1] to get a content object directly from the nearest CR that has it cached.

*Corresponding author.
Email addresses: muhammad.faran.majeed@ait.asia (Muhammad Faran Majeed), mdailey@ait.asia (Matthew N. Dailey), riaz17@gmail.com (Riaz Khan), atunpan@ait.asia (Apinun Tunpan)

[1] In this paper, the words "consumer" and "requester" are used interchangeably.

1.1. Named data networking (NDN)

Among the existing approaches for ICN, as outlined in several well-known research papers [3, 4, 5, 6], the named data networking (NDN) [7] is the dominant architecture. NDN emphasizes delivery of content rather than communication between hosts. The main benefits of NDN are avoiding delays and network congestion and improving the performance of networks in unreliable and dynamic environments.

In NDN, two types of packets, interest packets and content packets, are exchanged during communication to support forwarding and routing. Three main data structures are used: the content store (CS), the interest table or pending interest table (PIT) and the forwarding information base (FIB). The CS has records of content cached by a CR. The PIT keeps track of interests arriving on faces and guides content back to the interested party. The FIB contains entries for interests forwarded on outgoing faces. In NDN, the (hardware) interfaces of CRs for communication are called faces, to emphasize that these interfaces are not only for communication but more importantly for exchange of content with applications within a machine. The three data structures and a set of faces in a NDN CR are shown in Figure 1. When a CR receives an interest, it first checks its CS to determine whether it has the chunk already cached. The chunk is sent back if it is found in the cache; otherwise, the CR checks its PIT. If an existing entry is found for the requested chunk in the