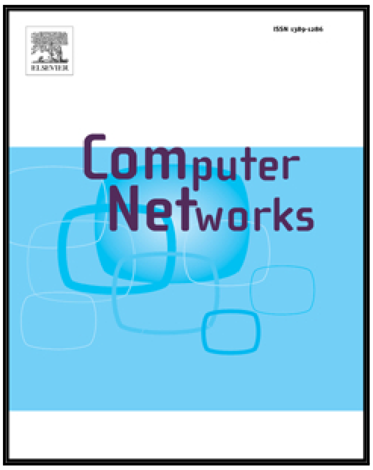

A Framework for Experimenting ICN over SDN Solutions using Physical and Virtual Testbeds

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Information Centric Networking; Software Defined Networking; Testbed; OpenFlow; Open Source; Emulation.

ABSTRACT

Information Centric Networking (ICN) is a paradigm in which the network layer provides users with access to content by names, instead of providing communication channels between hosts. The ICN paradigm promises to offer a set of advantages with respect to existing (IP) networks for the support of the large majority of current traffic. In this paper, we consider the deployment of ICN by exploiting the Software Defined Networking (SDN) architecture. SDN is characterized by a logically centralized control plane and a well-defined separation between data and control planes. An SDN-enabled network facilitates the introduction of ICN functionality, without requiring a complex transition strategy and the re-deployment of new ICN capable hardware. More in details, in this paper we provide: i) a solution to support ICN by exploiting SDN, extending a previous work of ours; ii) design and implement an open reference environment to deploy and test the ICN over SDN solutions over local and distributed testbeds; iii) design and implementation of a set of Caching policies that leverage on the ICN over SDN approach; iv) performance evaluation of key aspects of the ICN over SDN architecture and of the designed caching policies. All the source code and the monitoring suite are publicly available. To the best of our knowledge, there are no other similar solutions available in Open Source, nor similar emulation platforms, including also a comprehensive set of monitoring tools.

1. Introduction

Information Centric Networking (ICN) is a paradigm emerged to overcome some intrinsic limitations of the IP protocol [1][2]. In ICN, the network provides users with access to content by names, instead of providing communication channels between hosts. The idea is to provide "access to named data" as the fundamental network service. This means that all content (e.g. a document, a picture) is given a name; then, users request for the named content, the network forwards the requests toward the "closest" copy of such a content, which is delivered to the requesting user. With ICN, the communication network becomes aware of the name of the content that it provides and the routing decisions are made based on the content name. As a result, ICN [3]: i) improves network efficiency; ii) naturally supports mobility of users and servers and multicast communications; iii) eases the operation of fragmented networks, or sets of devices disconnected from the rest of the network; iv) offers simpler application programming interfaces; v) provides a content-oriented security and access control model.

The capabilities of ICN are particularly valuable as we move to an increasingly mobile connected world, where information, end-points and people are continually connecting to a different point, requiring in-built mobility support from the network. The Internet's coupling of the IP address for both identifying a device (and related content) and for determining where it is topologically located in the network resulted in conflicting goals. On one hand, for routing to be efficient, the address must be assigned topologically; on the other hand in order to manage collections of devices, without the need for renumbering in response to topological change or mobility events, the address must not be explicitly tied to the topology [4]. ICN offers a clean solution, by logically separating network locators from identifiers, not only of devices but also of content and potentially of users and functions.

Despite the widespread attention that ICN has received from researchers in the past decade, both in terms of papers and research projects (see the section 9 on related work), the area is still facing significant research and innovation challenges, including innovative applications, interplay with cloud and virtualization concepts, name to location resolution, routing/forwarding table scalability.

One of the open issues is the deployment of an ICN infrastructure in the current networks, based on the IP protocol, as it may require the replacement or update of existing running equipment. In this regard, we believe that Software Defined Networking (SDN) [5][6][7][8] can be an important enabler of ICN, as it promises to facilitate the continuous evolution of networking architectures. The SDN architecture is characterized by a logically centralized control plane and a well-defined separation between data and control planes. Forwarding devices execute packet forwarding actions following rules installed by an SDN Controller. The logical interface between the Controller and the forwarding devices is called *southbound* interface. An SDN-enabled network could facilitate the introduction of ICN functionality, without requiring a complex transition strategy and the re-deployment of new ICN capable hardware.

In [9] we introduced an ICN over SDN network architecture to deploy ICN in IP networks. Here we build on and extend that work, providing the following main novel contributions:

1. Enhancements in the design of the ICN over SDN forwarding mechanisms to support mesh topology and to scale with the size of the topology.
2. Design and implementation of an open reference environment to deploy and test the ICN over SDN infrastructure and the related network service over local and distributed testbeds.
3. Design and implementation of a set of Caching policies that leverage on the ICN over SDN approach.
4. Performance evaluation of key aspects of the ICN over SDN architecture and of the designed caching policies.