Information-Centric Networking

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INTRODUCTION

Over the years, the Internet not only has increased in size in terms of the number of devices, users and applications but also in the type of usage. The original Internet was designed for remote host access along with transferring emails from one host to the other (Almagor, 2011). These applications made the Internet architecture predominantly to be host centric where each and every accessible device on the Internet was assigned a globally unique IP address. The invention of world wide web along with the connected invention of the multimedia browser in the 1990s started pushing the Internet towards an information store. With this transformation, users started searching for the device, where the required information is stored and downloading that information onto his or her computer for viewing. This is commonly known as browsing and still based on the host-centric architecture of the Internet.

Over the years, the information dissemination has shifted from the host centric browsing paradigm to a data (content) centric paradigm, where the information is given the prominence over the device that holds it (Hassan, Elbreiki, Firdhous & Habbal, 2015). This new paradigm of information dissemination has led to the popularity of one-to-many and many-to-many distribution and retrieval of information to increase over the host-to-host communication in the Internet (Katsaros, Chai, Wang, Pavlou, Bontius & Paolone, 2014). Presently users are more interested in retrieving information faster from anywhere on demand rather than knowing where it was originally stored or currently retrieved from. This shift has prompted the storing of information in intermediate nodes with better support for mobility.

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For supporting this paradigm shift in information retrieval, many incremental solutions in terms of overlay networks have been proposed and implemented over time (Pandey, Garg & Gore, 2012). Though these solutions could meet the requirement of the time, they did not alter the host centric nature of the Internet architecture. Hence they could not overcome the inherent shortcomings of the host centric architecture resulting in issues with scalability, security, mobility and manageability. The continuous minor modifications in terms of patches and incremental solutions has made the Internet architecture more complex and vulnerable leading to a less-flexible architecture with limited manageability. All these has led to the demand for a design for totally new clean slate architecture that can meet the current as well as the future requirements of an information intensive world. In this regard, many independent projects have been initiated by researchers throughout the world. Though the names and finer implementation details of many of these projects differ from each other, many of the important attributes are either common or shared including assumptions, objectives and architectural properties (Hassan et al, 2015; Ahlgren, Dannewitz, Imbrenda, Kutscher & Ohlman, 2012). Paul, Pan and Jain (2011) have discussed many of the projects in detail highlighting the salient features of them along with the experimentations carried out for validating the claims put forward by the researchers.

In this chapter, the author takes a critical look at emerging networking paradigm of Information Centric Networking (ICN) that has been proposed for overcoming the shortcomings of the current Internet architecture. The main focus of the chapter will be features of the proposed ICN architecture with special emphasis on naming,

addressing and routing along with the challenges and requirements that need to be addressed for the development of ICN.

BACKGROUND

The information-centric networking (ICN) is a term coined for identifying the multiple projects carried out by several researchers all over the world for coming up with the future safe Internet architecture while serving the current demand for seamless distribution of information on demand. The architecture of the proposed networking paradigm is to overcome the shortcomings of the present day Internet including security of information and hosts, support for mobility multicast delivery of information, scalability and quality of service guarantees demanded by different users (Ghodsi, Shenker, Koponen, Singla, Raghavan & Wilcox, 2011). The proposed architecture leverages in-network caching, i.e., replication of information in networking devices such as routers, multiparty distribution of information through replication and user interaction models decoupling senders and receivers ultimately achieving a networking architecture that is more resilient to disruptions, failures flash-crowd effects happening in the networks. The some of the prominent projects carried out with the above mentioned objectives include Data-Oriented Network Architecture (DONA), Publish-Subscribe Internet Routing Paradigm (PSIRP) currently known as the Publish-Subscribe Internet Technology (PURSUIT), Network of Information (NetInf) designed as part of the Design for the Future Internet (4WARD) project and currently known as the Scalable and Adaptable Internet Solutions (SAIL), Content-Centric Networking (CCN) currently absorbed into the Named Data Networking (NDN) project, Content Mediator Architecture for Content-aware Networks (COMET) and Delay Tolerant Networking (DTN) (Koponen, Chawla, Chun, Ermolinskiy, Kim, Shenker, Stoica,, 2007; Dimitrov & Koptchev, 2010; Dannewitz, Kutscher, Ohlman, Farrell, Ahlgren, & Karl, 2013; Jacobson, Smetters, Thornton, Plass, Briggs & Braynard, 2009; García, Beben, Ramon, Maeso, Psaras, Pavlou, Wang, Sliwinski, Spirou, Soursos, Hadjioannou, 2011; Fall, 2003). The DTN has been based on a message oriented architecture used along with information-centric addressing and routing concepts.

Concepts of Information-Centric Networking

The ICN paradigm is founded on the idea of production and consumption of information based on user interest. Under ICN, the principle objective of the network is to expose, find and deliver information rather than the reachability of end-hosts and the maintenance of conversations between them (Almeida & Lourenco, 2012). The ICN paradigm mainly consists of two functional parts. They are namely the information dissemination or exposure and information retrieval. Thus the network is assumed to consist of interconnected pieces of information commonly known as content, information or data objects. The content can be of any type including an email, static or user generated data, real time media steams, online videos and music, more complex interactive multimedia communications, or even devices used for for network management. Objects can be organized into clusters depending on the requirements to define social relationships or some ontology between them. They can also be mutable, combined or aggregated to form new objects. All these objects are addressed using names for the purpose of identification and routing while managed by applications or services at a upper middleware level. The object names are globally unique and independent of the location where they are stored.

Figure 1 shows the content advertisement and retrieval process in the information centric networks. The creator of any information who is commonly known as the publisher starts the process by advertising the availability of the content in the network without knowing who may be interested