Journal of Network and Computer Applications 67 (2016) 128–146

Contents lists available at ScienceDirect

Journal of Network and Computer Applications

journal homepage: www.elsevier.com/locate/jnca

Review

A survey of routing and data dissemination in Delay Tolerant Networks

Sobin CC [a], Vaskar Raychoudhury [a], Gustavo Marfia [b], Ankita Singla [a]

[a] IIT Roorkee, India
[b] University of Bologna, Italy

ARTICLE INFO

Article history:
Received 25 September 2015
Received in revised form
6 December 2015
Accepted 11 January 2016
Available online 18 January 2016

Keywords:
Delay Tolerant Networks
Routing
Data dissemination
MANET

ABSTRACT

Delay Tolerant Networks (DTNs) have practical applications in various fields. DTNs have been studied in-depth by many researchers and multiple high quality survey papers have been produced which analyzes DTN features, taxonomies, and applications. In recent years, interest in DTN research has rekindled as there are several emerging network-based application domains that require delay tolerance support and thus can use DTN specific routing and data dissemination techniques. Examples of such novel areas are Information Centric Network (ICN), Mobile ICN, Named Data Network (NDN), Internet of Things (IoT), etc. In this paper, we have surveyed those applications briefly and have proposed an alternate taxonomy for classifying existing DTN routing algorithms. The objective of this survey is to help future researchers to identify DTN specific properties in the new applications and to apply appropriate routing protocols whenever necessary. We have studied the relation between message replication and individual or group communication semantics of DTN routing protocols considering both social-based and opportunistic message forwarding techniques. We have also introduced an in-depth coverage of data dissemination protocols in DTN which can be adapted to content-centric networking domains. We conclude our survey by identifying a set of open challenges for future researchers.

Contents

E-mail addresses: sobincc@gmail.com (S. CC), vaskar@ieee.org (V. Raychoudhury), gustavo.marfia@unibo.it (G. Marfia), ankitajnd@gmail.com (A. Singla).

http://dx.doi.org/10.1016/j.jnca.2016.01.002
1084-8045/

1. Introduction

Delay tolerant networks (DTNs) or opportunistic networks (Boldrini et al., 2008) are sparse mobile networks in which an end-to-end path may not exist. The underlying principle behind DTN to route data is *store-carry and forward*, in which intermediate mobile nodes store data to be transmitted till it finds an appropriate relay node (to forward the message) in the path towards the destination. DTNs have applications in several ad hoc networking and data dissemination operations, like crisis management, battlefield, wildlife monitoring (Juang et al., 2002), transportation engineering (UMassDieselNet, 2015), Pocket Switched Networks (Hui et al., 2005), etc. Recently, several emerging and novel network-based application domains are coming up that also require delay tolerance support. Examples of such novel areas are Mobile Information Centric Network (M-ICN), Named Data Network (NDN) (*a class of ICN*), Internet of Things (IoT), Mobile Social Networks (MoSoN), etc. In this paper, we have looked into DTN specific routing and data dissemination techniques which can be adapted for the aforementioned application domains.

DTN evolved from the Mobile Ad hoc Networks (MANET) by relaxing some of the requirements of MANET and by allowing a high degree of mobility to the participating nodes (Fig. 1). MANET and DTN share many common aspects, such as, lack of infrastructure, resource constrains, node mobility resulting in frequent network partitioning, etc. However, they have multiple differences as well. While MANET nodes communicate using standard TCP/IP protocol suite, DTN nodes use application-layer Bundle protocols, designed to support the store-carry-forward communication paradigm of DTN, to communicate with peers. Bundle layer protocol span across transport and network layers: storing limited bundles inside the network and facilitating late binding of DTN address to subnet address (Franck, 2015). Network partition caused by node mobility results in packet loss in MANET whereas, it stretches the span of DTN as routing through frequent disconnection is an inherent property of DTN routing protocols. Finding the appropriate relay node may take long time in DTN which requires message carriers to store the message in their buffers for considerably long time.

Routing in DTNs is non-trivial due to the following challenges. Firstly, DTNs has no pre-existing infrastructure like wired and wireless infrastructure-based networks. Even infrastructure-less MANETs computes end-to-end routing paths which are, instead, inherently non-existent in DTNs. So, traditional MANET protocols like AODV (Perkins et al., 2003), DSR (Johnson et al., 1996), etc. cannot be directly applied to DTN because they require the