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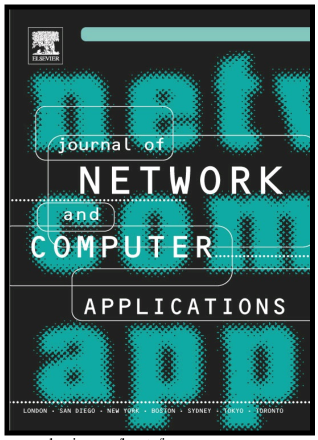

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Social-based energy-aware multicasting in delay tolerant networks

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Abstract

In a post-disaster environment, traditional network infrastructure is mostly unavailable due to incidental destruction and damages. In such scenarios, delay/disruption tolerant networking may be considered as an alternative approach to meet the quintessential communication needs between the victims, field workers and centralized authority. In such applications, multicast communication is imperative because rescue and relief messages may often need to be shared among many volunteers. In this paper, we address the problem of relay selection for multicasting single and multiple data items in DTNs considering the application in disaster management. Both the single-data and multiple-data multicast problems are formulated as bi-objective optimization problems under the constraints of target delivery time, buffer space and residual energy levels of relay nodes. Both the problems are shown to be NP-hard. Hence, we propose two heuristic relay selection schemes exploiting social properties in DTNs. Theoretical analysis is performed for energy consumption and exhaustive simulation is carried out to evaluate performance of our proposed schemes in ONE simulator considering real-life data in post-disaster scenarios. Results show that our schemes are energy-saving thereby ensure longer network lifetime compared to other prominent schemes.

Keywords: Delay/disruption tolerant networks, relay selection, social-based multicast, energy awareness

1. Introduction

Delay/Disruption Tolerant Networks (DTNs) are primarily characterized by intermittent connectivity and opportunistic contacts among nodes in the networks. In addition, short communication range, sparseness, node mobility and short communication duration are also some of the key features of such networks. A DTN may also be viewed as a special class of mobile ad hoc network (MANET), where an end-to-end path between any source-destination pair rarely exists. Such networks are especially suitable for applications in challenging environments, such as battlefield communications, wildlife monitoring, space communications [1]. Besides, in post-disaster situations, volunteers/relief workers, engaged in any devastated region, face a huge problem of connectivity among themselves, as well as with the relief coordination center, due to complete or partial collapse of the existing voice/data network infrastructure. In such cases, necessity of a flexible, fast-deployable low-cost temporary communication network is paramount. DTN is being considered as an important communication paradigm in post-disaster rescue and relief management operations, because of its potential to meet most of the said requirements [2, 3].

Popular routing schemes for MANETs are not suitable in DTNs, because all of them are based on the common assumption of the existence of several end-to-end paths between any source-destination pair. On the other hand, frequent network partitions due to unpredictable node mobility, result in rare existence of static path(s) between an arbitrary source-destination pair in DTNs. A data is typically delivered in DTNs following ”store-carry-and-forward” principle. However, routing in such networks has been investigated for more than a decade. Consequently, various unicast as well as multicast schemes can be found [4, 5]. In unicast communication, a message is sent from a source to another destination. Multicast is the term used to describe communication where a message is sent to a set of destinations. In DTNs, conventional routing schemes (e.g. PROPHET [6], data delivery using message ferries [7]) exploit the mobility of the DTN nodes to select the same as relays which forward data opportunistically.

As node mobility is unpredictable and volatile in nature, there arises the need of new routing schemes based on more stable characteristics of the nodes. To make forwarding decisions based on the knowledge of long-term and less volatile characteristics of the nodes, of late, researchers are leveraging social network concepts in the design of efficient DTN routing schemes [8, 9]. Social-based opportunistic schemes consider dynamic nature of the nodes' interactions for having a better representation of social structures. In [10], Moreira et al. propose dLife, a routing scheme that captures the dynamic social structures by time-evolving social ties between pair of nodes in the network. In [11], an algorithm is proposed that leverages online social relations (on Facebook or Google+), interests and contact history of a node. In [12], it is shown that a regular pattern