Addressed Query Gossip Resource Discovery Protocol for Mobile P2P Networks and Its Performance in Diverse Mobility Models

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ABSTRACT

This article describes how P2P resource discovery protocols perform poorly over mobile ad hoc networks mainly due to the frequent network dynamics. Peer-to-Peer search techniques including structured and unstructured can be employed over MANETs. Empirical studies indicate that searching in such resultant networks are not efficient and effective due to peer discovery, connectivity and mobility issues. The author proposes Addressed Query Gossip Resource Discovery algorithm, a lightweight resource discovery designed to suit the mobility requirements of ad hoc networks to optimize the search performance while at the same time minimize the extra usage of mobile and network resources. Mobility models represent the movements of mobile nodes. Such models are used to represent how the location, velocity and acceleration change over time. The author conducts performance analyses of the proposed protocol and widely used unstructured search techniques over MANET under 2 realistic mobility models, i.e., Random Waypoint and Reference Point Group Mobility models. The results show that the proposed protocol has the best performance in almost every measured metrics. In addition, the protocol consumes less energy, has less message overhead and good success ratio for random waypoint movement as compared to the reference group mobility model. After extensive evaluations, the simulation results clarify that the mobility models have a significant impact on the performance of peer-to-peer content discovery protocols over mobile ad hoc networks.

KEYWORDS
Flooding, Gossip, MANET, Mobility Models, P2P Resource Discovery Protocols, Random Walk

1. INTRODUCTION

Mobile Ad hoc Networks (MANETs) are multi-hop dynamic network which are characterized by wireless links, mobile nodes and multi-hop routing. In such network the nodes that are not directly connected at Layer 2 can communicate through Layer 3 routing. Due to continuous movement of nodes, resource discovery in such networks become more challenging and tedious. Most of the existing unstructured peer-to-peer protocols resolve search query by flooding and random walk mechanisms. Flooding and Random walk (Gkantsidis, Mihail and Saberi, 2004) are two typical search techniques. Flooding is simple and widely accepted method wherein the query is flooded to every node in the network. While in Random walk the query is forwarded randomly to some nodes in the network. Even though flooding and random walk have their own limitations, but then these methods have to

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be eventually considered to suit such self-organizing multi-hop networks. Performance of peer-to-peer resource discovery in wired networks have been well researched in the past. Different content searching techniques were evaluated over a wired network like the Internet. But, their results are not feasible to be validated against MANETs, due to deficiency of infrastructure, mobility, energy consumption issues and churn. (Mian, Beraldi and Baldoni, 2010) summarizes the problems related to service discovery protocols in MANETs. They study random walk protocol over such multi-hop network. Further, they list out several issues pertaining to random walk with major of those being next-hop selection criteria, valid termination check parameter, multiple walker, unicast transmission disadvantages, etc. Peer-to-Peer networks are popular and such systems constitute majority of internet traffic (Schollmeier, Gruber and Niethammer, 2003) due to its flexible and distributed network characteristics.

Over the past decades P2P architecture based systems have been deployed over Internet to provide services mainly including file sharing, telephony, information retrieval system, torrent and video conferencing applications, etc. P2P networks are broadly classified based on its design as structured and unstructured architecture. In structured P2P networks, the peers strictly are well-organized with each peer maintaining a DHT index. The famous examples include CAN, Chord, Pastry, Tapestry, etc. Since, in these systems participating peers position is structured so the query search is more efficient. But, these systems have limitations in mobile environment, increase the complexity and overhead as continuous modification of index pointer is needed to be done because of the rapid continuous mobility. On the contrary, in unstructured networks there is no strict regulation for formation of topology and peer’s positioning. Further, there is no need of any central indexing for placement of the contents. Nodes can join and leave randomly. Among unstructured P2P protocols the most referred ones are Gnutella, Fastrack, Kazaa, Freenet etc. When we say P2P it simply means that each peer has equal role in the network for a fully distributed system. Even today major mobile communication architectures are mainly centralized. One of the best possibilities to overcome the bottleneck caused due to this centralized architecture is to setup a P2P platform. This communication pattern can suit any network including wired, wireless and MANET. Incorporating peer-to-peer network characteristics in mobile ad hoc networks is coined as P2P MANETs or Mobile P2P (MP2P) network. Due to similarities in P2P and MANET, a P2P Overlay can run over Mobile Ad hoc Network. But, at the same time their combination also poses difficulties due to differences in the operating layers, transmission mechanisms and frequent topology changes in MANETs (Choi, Park and Woo, 2006; Gerla, Lindermann and Roston, 2005).

We have briefly discussed about MANET and P2P networks. An overview on the general difficulties in adopting P2P systems over MANET is outlined. The rest of the paper is organized as follows. In section 2, we review the related work. Section 3 describes the P2P content discovery protocols. Section 4 presents a brief about the mobility models in MANET. In Section 5, simulation environment and experimental evaluations are described, and the results are discussed, and finally Section 6 concludes with the observations.

2. RELATED WORKS

Peer-to-Peer networks are popular and such systems constitute majority of internet traffic share. Such P2P services have been widely used to implement file sharing systems. The resource discovery protocols are classified in two broad categories, i.e., Structured and Unstructured protocols. In unstructured protocols there is no strict rule to define the location of the content stored, and its network topology formation. These systems use query flooding to locate the object. Gnutella and Random Walk are two significant protocols of this type. While in structured protocols, the neighborhood connection between nodes and location of the content stored are well-defined. Chord is a well-known example of this type. MANETs on the other hand are a multi-hop dynamic topology network that
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