

Performance Comparison of Unstructured Peer-to-peer Content Discovery Techniques over Mobile Ad Hoc Networks

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Abstract—The performance of several unstructured peer-to-peer (P2P) content discovery techniques over MANETs was analyzed in this work. They include: query flooding, expanding ring search, random walk and Bloom filter(BF)-based probabilistic routing. The chosen performance metrics are the query success rate, the route stretch and the search cost. Mathematic analysis is conducted to predict their behavior in static networks. Besides, the overhead introduced by the BF-based probabilistic routing is modeled using a $M/G/\infty$ queue. Finally, extensive computer simulations is performed to validate our analytical results in a static environment, and to shed light on the behavior of these schemes in a mobile environment. It is concluded that the BF-based probabilistic routing outperforms flooding-based and random walk schemes in finding a good balance among various performance metrics. Its only potential disadvantage is that the control packet size increases as the number of shared objects increases, which may not impose a severe constraint on a middle-sized MANET.

I. INTRODUCTION

Mobile devices communicate with one another without the support of a fixed network infrastructure in mobile ad hoc networks (MANETs). MANETs have been primarily developed for special application scenarios such as the battlefield or the disaster area. Another potential application of MANETs is in hybrid form, i.e. with the support of fix infrastructure; for example, the mesh networks and the vehicular ad hoc networks (VANETs). Nevertheless, there have been very few commercialization examples of MANETs in our daily life.

There are several obstacles in popularizing MANETs in the commercial world. One is their poor performance in multihop communications. Another is the lack of proper applications from user's perspective. While deploying a distributed file system on a large-scale MANET is not foreseeable in the near future, a moderate-scale MANET supporting peer-to-peer (P2P) file sharing among a group of end users appears to be practical and meaningful [1]. Several conceivable scenarios include: 1) P2P gaming among mobile devices, 2) sharing multimedia files in a conference room among laptops and PDAs, 3) exchanging contact information, ringing tones and audio/video clips among smart phones, and 4) auto collision avoidance signal transmission in VANETs.

Comprehensive performance comparison of several unstructured P2P content discovery techniques for MANETs is conducted through mathematical analysis and computer

simulation in this work. The P2P content discovery techniques under study include: query flooding, expanding ring search, random walk and Bloom filter(BF)-based probabilistic routing. Each technique is evaluated by its query success rate, route stretch and search cost. Our research objective is to provide a thorough understanding of the impact of the wireless ad hoc environment on the behavior of P2P content discovery techniques. This knowledge will benefit the development of proper end-user applications in MANETs.

Some of our main research results are summarized below.

- The path probability, which is the probability for two randomly selected nodes in an ad hoc network to be connected by at least a path, serves as an upper bound of the query success rate for all content discovery techniques.
- The BF-based probabilistic routing scheme outperforms flooding-based and random walk schemes. The only disadvantage with the BF-based probabilistic routing is that the control packet size is much larger, and it increases as the number of nodes or sharing objects increases.
- The node density has a great impact on the route stretch of flooding-based and random walk schemes, but little impact on the BF-based probabilistic routing.
- Node mobility has very limit impact on the query route stretch and the search cost.
- Random walk is not resilient to node mobility as compared with flooding-based and BF-based probabilistic routing schemes.
- Node mobility facilitates the propagation of content updates in the BF-based probabilistic routing.
- Our theoretical analysis is well corroborated by computer simulation in most cases.

REFERENCES

- [1] M. Conti and S. Giordano, "Multihop ad hoc networking: the theory," *Communications Magazine, IEEE*, vol. 45, pp. 78–86, April 2007.