Efficient Multicasting for Conferences Using MANETs

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Abstract - This paper mainly presents a motivation for research to be done on multicast protocols for Mobile Ad hoc NETworks (MANETs). In particular, the paper argues why the existing multicast protocols are too robust and less efficient to serve workshop (or conference) related environments. A new multicast routing protocol called a Polymorphic Multicast Routing Protocol (PMRP) is proposed. Compared to the current protocols, PMRP is envisaged to be more efficient due to its extra intelligence resulting from a polymorphic design and exploitation of the characteristics of the underlying network environment.

Index Terms — mobile ad hoc networks, multicasting, efficiency, and robustness.

I. INTRODUCTION

A MANET is a self-organising and rapidly deployable network, which does not have a fixed infrastructure. Nodes in MANETs cooperate to form the necessary infrastructure which makes multi-hop communication possible. MANETs are useful in many situations where deployment of fixed wire networks is hindered by factors such as terrain, time, and economic viability. Examples of such situations include military operations, emergency rescue operations, conferences, classrooms, multiplayer computer games, construction sites and vehicular communication.

Most applications in MANETs involve group communication. Research has shown that group communication can efficiently be served by multicast routing rather than unicast routing. The benefit for using multicast routing is that it saves bandwidth and other network resources by transmitting the same data packet to multiple receivers simultaneously [1].

Multicast routing faces a myriad of challenges which hinder its wide spread adoption in MANET applications. The challenges include rapid and unpredictable mobility of nodes, limited bandwidth capacity, limited battery life and memory, quality of service, scalability and security.

A number of multicast routing protocols have been developed. The protocols are classified in various ways. Common classes of multicast protocols are tree-based and mesh-based protocols. AMRoute [2] and MAODV [3] are examples of tree-based protocols. Mesh-based protocols include CAMP [4] and ODMRP [5].

A literature review has revealed that most of the available multicast routing protocols are multipurpose in nature. Performance of the protocols in terms of efficiency and reliability varies from one networking environment to another. The design of a multipurpose protocol takes into consideration a whole spectrum of possible topology changes, resulting in protocols which are imperatively robust.

This research considers application of multicasting in workshop (or conference) related environments using MANETs. Workshop networking environments are characterised by minimal topology changes and fairly predictable topologies, which make the application of the current protocols in such environments less efficient and too robust.

The rest of this paper is organised as follows. Section II covers application of MANETs in conferences. Challenges associated with the design of multicast routing protocols are presented in section III. Section IV explains efficient multicasting for topology changes. The paper ends with a conclusion in section V.

II. APPLICATION OF MANETs IN CONFERENCES

In today's conference (or workshop) related environments, the use of Information Communication Technology (ICT) devices is inevitable. The self-configuring and portable nature of MANET devices offer a convenient ICT solution to workshop activities mainly in terms of economic viability and setup time. Typical services delivered through MANETs include file and slide sharing, electronic voting, video streaming, and database and Internet access.

The aforementioned services can be part of collaborative work or group communication in which participants work together to achieve a common goal. At the network layer, the services can be delivered efficiently by multicasting.

From a protocol design point of view, the network topology changes resulting from the conference participants can be predicted and therefore exploited for a more efficient design of a multicast protocol to serve the environment.

III. CHALLENGES IN MULTICAST MANETs

The design of a multicast routing protocol for MANETs faces a number of technical challenges which arise from the unique characteristics of MANETs in relation to wired network environments. Some of the major challenges in addition to efficiency and robustness are outlined as follows:

A. Resource Management

MANETs consist of portable devices which have limited battery life and memory. Multicast protocols should minimise usage of power by reducing the number of packet transmissions. One possible way to minimise transmissions is by reducing the total number of nodes that participate in transmissions, and this makes protocols strive to minimise the forwarding node set. Protocols are also required to reduce memory usage by minimising state information.

B. Support for Quality of Service

The need to deliver multimedia traffic in MANETs requires that multicast routing protocols should have the capabilities for QoS provisioning.

C. Scalability

A multicast routing protocol is required to provide an acceptable level of service to packets even when a network is large. A major design issue to be considered under scalability is to minimise the amount of control overhead as the size of the network increases.

D. Security

Existence of a wireless medium, the broadcast nature of transmissions, and lack of a centralised administration makes security an important issue in MANETs. A MANET is vulnerable to eavesdropping, interference, spoofing and many other security threats.

IV. EFFICIENT MULTICASTING FOR TOPOLOGY CHANGES

"Multicast efficiency" is defined as the ratio of the total number of data packets received to the total number of data and control packets transmitted in the network [6]. The challenge is to design an efficient multicast protocol which takes into consideration the limitations of the available bandwidth in MANETS.

Nodes in a MANET are free to move anytime, anywhere and at any speed. In a highly dynamic network, data packets may be dropped during a multicast session resulting in a low packet delivery ratio. Hence, a multicast routing protocol must be robust enough to cope with node mobility and topology changes so as to achieve a high packet delivery ratio. Therefore a protocol is required to be both efficient and robust.

The literature review reveals a trend in the development of protocols which starts with conventional protocols followed by hybrid ones and finally adaptive protocols. The development trend reflects progressive addition of intelligence to protocols so as to make them cope with the dynamics of the networking environments of MANETs.

Even though researchers have reached the stage of developing intelligent (or adaptive) multicast protocols, most of their protocols are multipurpose (or application independent) in nature, and thus the protocol performance differs significantly from one network environment to another.

In particular, this research argues that current multicast protocols are too robust and less efficient to serve workshop (or conference) related networking environments in which network topology changes are minimal and fairly predictable. The existence of excessive robustness and inefficiency in the current protocols in relation to workshop related environments is due to the fact that the protocols are designed with a whole spectrum of topology changes, including topologies for military operations, in mind.

As a solution, a new multicast routing protocol, called a Polymorphic Multicast Routing Protocol (PMRP), is proposed primarily to serve workshop related environments. PMRP is envisaged to be more efficient and robust enough for its recommended environment.

PMRP will have the ability to dynamically transition between three forms, namely matrix, cluster-based, and random form depending on the physical topology of nodes. The rationale behind the proposal is that the new protocol will have the ability at any instant of time to exploit the characteristics of a dynamically changing network topology for optimum efficiency, reliability and other QoS related constraints.

V. CONCLUSION

The proposed PMRP, which is envisaged to be more efficient than the existing ones, will provide more efficient delivery of MANET services including multimedia ones. PMRP will have the potential to trigger mass deployment of MANET applications for workshop (or conference) related environments due to its envisaged significant improvement in efficiency over the existing protocols. PMRP will also have the ability to operate in any other MANET environment with acceptable performance.

REFERENCES

[1] S. K. Soni and T. C. Aseri, "A Review of Current Multicast Routing Protocol of Mobile Ad Hoc Network", *2nd IEEE International Conference on Computer Modeling and Simulation ICCMS'10*, Vol.3, pp. 207 – 211, 2010.

[2] J. Xie, R. R. Talpade, A. McAuley and M. Liu, "AMRoute: Ad Hoc Multicast Routing Protocol", *Journal of Mobile Networks and Applications (Springer)*, Vol.7, No.6, pp. 429 – 439, 2002.

[3] E. M. Royer and C. E. Perkins, "Multicast Ad hoc On-demand Distance Vector (MAODV) Routing", *IETF Internet Draft:* draft-ietf-manet-maodv-00.txt, July 2000.

[4] J. J. Garcia-Luna-Aceves and E. L. Madruga, "The Core-Assited Mesh Protocol", *IEEE Journal on Selected Areas in Communications*, Vol. 17, Issue 8, pp. 1380 – 1394, 1999.

[5] Y. Yi, S. Lee, W. Su and M. Gerla, "On-Demand Multicast Routing Protocol (ODMRP) for Ad Hoc Networks", *IETF Internet Draft:* draft-ietf-manet-odmrp-04.txt, February 2003.

[6] S. K. Sarkar, T. G. Basavaraju and C. Puttamadappa, "Ad Hoc Mobile Wireless Networks", *Auerbach Publications – Taylor & Francis Group*, Chapter 4, ISBN 13: 978-1-4200-6221-2, 2008.

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