Testbed Evaluation of QoS Routing Enhancements for Mobile Ad Hoc Networks

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(Work-in-Progress Paper)

***Abstract*—Mobile Ad hoc Networks (MANETs) are a specific type of wireless network that is infrastructure-less, dynamic and self-organising. There is a growing need for MANETs to support real-time multimedia applications. Most current MANET routing protocols only support best-effort routing. By improving the QoS on MANETs, we can extend the set of multimedia services that can run on the MANET.**

We propose to practically implement enhancements to the AODV routing protocol and quantify the effect of these enhancements on the QoS achieved in a wireless grid testbed. The work will then be extended by comparing relative performance with the DYMO routing protocol.

First, the routing metric will be changed from hop count to measured end-to-end delay. This will allow AODV to take the requirements of delay-sensitive applications such as voice and video services into account when selecting a route. The hypothesis is that this simple enhancement will greatly improve the level of QoS achieved.

***Index Terms*—Ad Hoc Networks, Implementation, QoS, Routing Protocols, Testbed, Wireless Grid.**

I. Introduction

MOBILE Ad hoc Networks (MANETs) are a specific type of wireless network that is infrastructure-less, dynamic and self-organising. Nodes in a MANET are connected via single- or multi-hop paths. Nodes are mobile and can therefore join or leave the network at any time. Mobility of nodes also attribute to the dynamic nature of these networks.

The absence of infrastructure in the network implies that there is no centralised form of control. Effectively, every node in a MANET therefore acts as a host and a router. Routing takes place in a fully distributed manner and determines the overall performance and efficiency of the MANET.

However, MANETS are becoming more and more popular as these networks require minimal cost and time to deploy. This opens up new possibilities in low-cost last-mile connectivity solutions [1]. There is a growing trend for multimedia applications over IP with QoS support in the wireless networking environment [2]. Naturally, this trend also brings the need for MANETs to facilitate better QoS support.

The rest of the paper is organised as follows: Section II gives an brief background. Section III details the proposed research and Section IV describes the methodology.

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II. Background

A. QoS provisioning in MANETs

QoS provisioning in a MANET is a difficult task due to the following reasons [2],[3]:

- The wireless channel is error-prone.
- The wireless channel is shared between all nodes within the broadcast region of each other.
- Mobility of nodes causes frequent link failures.

To facilitate QoS support in MANETs is therefore a challenging and envolving task.

B. Physical Implementation

The majority of the research work done in the MANET field, with relation to routing and Medium Access Control (MAC) schemes, has been done using simulation only. One of the motivations for using simulations is the difficulty in creating a physical implementation. It is also more cost and time effective to make use of simulations. [3]

However, a statement is made in [4] :

> An opinion is spreading that one cannot rely on the majority of the published results on performance evaluation studies of telecommunication networks based on stochastic simulation, since they lack credibility.

The above mentioned statement is supported by the results of a survey [4] of 2200 network simulation publications in the field of telecommunication networks. In [5] it is shown that discrepancies between real-life and simulation results can be attributed to the use of overly simplified simulation models.

A number of experimental radio grid testbeds have been established in recent years to aid in the research and development of MANETs, mesh networks and other wireless technologies [6]. The most renowned international facility is the ORBIT testbed with 400 nodes arranged in a 20 X 20 grid [7]. In South Africa, the Meraka institute has 49 nodes arranged in a 7 x 7 grid [8]. Experimental evaluation on these testbeds gives researchers a better understanding of how wireless technologies function in a real world scenario.

C. Ad Hoc Routing Protocols

Ad Hoc Routing Protocols can be categorised into pro-active routing protocols, reactive routing protocols and hybrid routing protocols. Pro-active protocols are also referred to as table-driven protocols as each node maintains a list of destinations and their routes. The list at each node is periodically updated by routing tables that are exchanged through the network.

Reactive protocols are also known as on-demand protocols as a route to a destination is only discovered once a node specifically requests it. Only the routes needed by nodes in the network are therefore present in the routing tables. Hybrid protocols exhibit characteristics of both protocol categories mentioned above. This paper is only concerned with reactive routing protocols. [1]

The AODV (Ad Hoc On-demand Distance Vector) and DYMO (Dynamic MANET On-demand) routing protocols are both reactive routing protocols that are listed by the Internet Engineering Task Force (IETF) MANET working group. AODV is considered mature and is described in RFC3561. DYMO is still in draft phase and actively worked on by the working group.

This has the effect that more mature and stable physical implementations of AODV are available, making AODV a better candidate protocol for the QoS enhancements that will be presented in this research.

III. Proposed Research

The focus of this research is to make a meaningful contribution to the improvement of QoS in MANETs via a physical implementation on the routing layer.

Our research work follows on the work presented in [9]: The effectiveness of changing the AODV routing metric from hop count to measured end-to-end delay is presented through simulation in the OPNET environment. The effect that the change of metric has on the level of QoS achieved is also presented. It is shown that the enhanced protocol's superiority is especially noted in delay sensitive applications such as Voice over IP and Video over IP.

A physical implementation will serve to validate the enhanced protocol's performance. Experimental evaluation in a wireless grid testbed will quantify the effect of the protocol enhancements on the QoS achieved in a real-life network. The enhanced protocol's performance will be compared with AODV and DYMO to compare relative performance.

IV. Methodology

Experimental baseline measurement: It is necessary to establish experimental baseline measurements. This is done by subjecting the unmodified AODV protocol to all the intended experiments in a radio grid testbed. The baseline measurements will be used to compare future measurements with and evaluate differences in performance.

Protocol Design and Implementation: The implementation of the QoS enhancements poses certain challenges not encountered in the simulation environment. Most notably is the assumption of a synchronised environment in the simulations. To measure end-to-end delay, nodes in the MANET need to be synchronised. Current plans are to preliminary use Network Time Protocol (NTP) to achieve synchronisation in the MANET. This will however not hold in a real-life environment as the mobile nature of MANETs makes it impractical to elect a NTP server. In a controlled experimental setup it however holds some merit. A distributed synchronisation algorithm that is incorporated with the routing protocol will be implemented at a later stage, this will eliminate the need to use NTP.

Experimental Evaluation: Experimental evaluation will commence on the ORBIT radio grid testbed. The testbed results will reflect a more accurate picture of the real-life protocol performance. The effect of the QoS enhancements will be easily notable, as the results for these experiments can be directly compared with the baseline measurements. This will also provide the platform from which additional comparison with the DYMO routing protocol can be done.

V. Conclusion

The preliminary work regarding QoS improvements in a real-life MANET through the change of a routing metric have been presented. Future work will include the effect on QoS when multipath extensions are added to the AODV routing protocol.

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