Design and simulation of Dynamic Source Routing with bandwidth awareness

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***Abstract*—An ad-hoc network is a wireless network without fixed infrastructure. The nodes are free to move around and this makes it a challenge for routing protocols to manage the data transfer on networks. The nodes can be various devices ranging from laptops to cell phones that use the IEEE 802.11 standard protocol to communicate with each other. In this paper we investigate the need that exists for efficient routing protocols for wireless networks, more specifically ad-hoc networks. Most of the current reactive routing protocols use hop count to determine the shortest path from source to destination. We proposed to implement bandwidth as an additional metric in the DSR protocol.**

***Index Terms*—Ad-Hoc network, Bandwidth estimation, Dynamic Source Routing.**

I. Introduction

In recent years the use of wireless technology has become increasing popular. This may be because of the ease of use of this kind of connection and that the devices forming the network are not limited to computers. When a wireless network is formed between devices, data transfer needs to be reliable and efficient, this is why a routing protocol is used. The protocol tells the node or device what to do with received data, whether to accept, ignore or simply forward it to the next node in a multi-hop environment. Ad-hoc networks make it possible to interconnect devices without existing infrastructure which makes the implementation thereof cost effective.

A Mobile Ad-Hoc Network (MANET) [1] is a specific type of ad-hoc network, where the nodes are mobile and use the IEEE 802.11 standard. This means that every node has the ability to act as a router. Nodes are free to move randomly and join or leave the network. The dynamic nature and lack of infrastructure of this network makes it challenging for routing protocols.

The rest of this paper will be organised as follow: Section II gives a background on routing and bandwidth estimation. Section III describes the proposed research and in Section IV the methodology to complete the research is discussed.

II. Background

A. The Routing Protocol

Routing protocols ensure reliable and efficient data transfer from source to destination in a single- or multi-hop wireless network. The protocol handles all received data from the wireless spectrum via the physical layer and it decides whether to allow, deny or send the data to the next node. There are currently 3 types of routing protocols that are commonly used [1]:

- **Proactive Routing:** Each node has a routing table of the entire network and therefore route discovery is quick. It is also known as table driven routing. The routing table is updated constantly with information of new nodes and routes. The constant updating causes large unwanted network overhead. This type of routing protocol is not ideal for use in MANETs but can be useful in static mesh networks.
- **Reactive Routing:** Routes are created on demand and only the current route is stored in the routing table. It is also known as on demand routing, because none of the previous routes are stored in memory. The nodes don't have to update their routing table constantly, which results in lower network overhead. Reactive protocols react well in the dynamic node environments.
- **Hybrid Routing:** This protocol uses proactive and reactive components to minimize the total overhead of the network. The network is divided into zones. Proactive routing is used within the zone and reactive routing is used outside the zone.

The Dynamic Source Routing (DSR) [2] protocol was selected as a good reactive protocol to implement in MANETs. DSR records multiple paths and then select the best route based on the hop count of the stored paths.

A source node stores a complete route from the source node to destination node in its routing cache and the intermediate nodes don't have to update the state of their neighbouring nodes as is the case with AODV, which results in a lower network overhead. The route setup is performed by using ROUTE REQUEST (RREQ) and ROUTE REPLY (RREP) messages or packets. The source needs the bandwidth status of the nodes that form the path and the bandwidth information can be send to the source via the RREP messages.

Apart from hop-count information of a route, we propose to collect information on the available bandwidth of a specific path. This can then be used as a further metric to determine the most favourable path along which to send information.

B. Bandwidth estimation

Wireless technology strives to improve quality of service (QoS) [3] and ensure low end-to-end delay with high throughput and low packet loss. This is why the bandwidth factor was selected as route selection metric which may be used together with the current hop count metric in DSR.

Four sources sources were found where the authors aimed to estimate bandwidth: Munaretto [4] proposed the QOLSR protocol where the extra data used for end-to-end delay and the bandwidth metric are incorporated into *HELLO* messages used to flood the network for status updates of their neighbours. The bandwidth metric calculation is performed using medium access control (MAC) as described in the IEEE 802.11b standard.

Chen [5] estimated bandwidth using two techniques. The first is to *"listen"* on the wireless channel for traffic and then record the time that the channel is quiet. This is then used to calculate the available bandwidth with the times measured for quiet and busy intervals. The second is to piggyback the available bandwidth information received from the MAC onto the *HELLO* messages to update the bandwidth availability status of the node to its neighbours.

Guimarães [6] used a carrier sense multiple access (CSMA) protocol where the available bandwidth is derived from the MAC layer. The content of the packet is used to estimate the bandwidth required for the route and then reserve the route from source to destination. This protocol also support multirate transmissions in the network.

Ivascu [7] proposed the QMRB-AODV which distribute the traffic over the network and reduce the amount of control messages compared to the standard AODV. This also means that the total bandwidth is shared among nodes in the network and this makes the available bandwidth of a node higher than it normally would be.

All above mentioned have the same goal in mind and that is to deliver a higher end-to-end throughput channel. They rely on the status or update messages of the routing protocol to distribute the bandwidth status, causing a lager network overhead.

III. Proposed Research

The shortest path doesn't always describe the best available path from the source node to the destination node in the ad-hoc environment. The metric of route selection in the DSR protocol will be changed from hop count (or the shortest path) to the shortest path with the highest available bandwidth. The bandwidth estimation technique will be derived from the previous work done and described in Section II subsection B. This criteria will ensure a better path is selected and not simply the shortest path. A tradeoff can be made between the available bandwidth and the hop count from source to destination.

The bandwidth of the node will be calculated using data received from the MAC of the node and a running average may be used. This will give a better understanding of the available bandwidth of a node over time or the congestion in general.

The enhanced DSR protocol with bandwidth awareness will be simulated within the OPNET environment to see if there is an improvement on the standard DSR protocol that only use shortest path as route selection criteria.

IV. Methodology

The following methodology is proposed in order to complete the proposed research:

Literature Study: At first the routing protocol will be studied to fully understand how it works. Bandwidth estimation techniques will then be investigated to determine how it can be integrated with the DSR protocol.

Simulate DSR protocol: The standard DSR protocol will be simulated in the OPNET modeller. These simulation results will be used for baseline comparison and evaluation.

Develop enhanced DSR: The DSR protocol will be changed to accommodate the bandwidth awareness metric.

Verification and Validation: The developed enhanced DSR protocol will first be verified to ensure the correct procedure was followed in designing and operation of the protocol. Finally, the validation of the new designed protocol will be done.

Simulate enhanced DSR: The OPNET modeller will be used to simulate the standard and enhanced DSR protocols with the same configuration. The simulation results will reflect the effectiveness and performance of the enhanced protocol.

V. Conclusion

Previous work have shown that there is an aspect of the routing protocol that needs attention, namely QoS. The QoS metric focused on in this paper is bandwidth estimation which is a key factor for improving end-to-end throughput in ad-hoc networks. Future work will include bandwidth estimation for route selection within the DSR protocol. The simulation of the new developed protocol in OPNET will reflect the performance of the new protocol against the standard protocol.

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