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Design a Simulation Model of Multi-radio Mobile Node in MANET

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***Abstract*— In this paper, we present a solution to design a simulation model for mobile node with multiple radio interfaces in mobile ad-hoc wireless networks (MANET). This solution extends the mobile node architecture in NS2 network simulator to allow analysis and evaluation of the performance of multi-channel mobile ad-hoc wireless networks. Simulation results show that the effectiveness of multi-radio mobile node model. Network performance with new mobile node architecture is greatly improved as the number of wireless interfaces increased.**

Keywords— mobile adhoc networks, routing, multichannel, simulation

I. INTRODUCTION

Wireless ad hoc networks or Mobile Ad Hoc Networks (MANET) are one of the wireless access network models that has been widely used in many fields of military, health, education, transportation, aviation, shipping, research expedition [1]. The basic feature of MANET is that the mobile nodes communicate equally with each other through a wireless environment, without a pre-existing infrastructure. Each mobile node can act as both a server and a router. MANET's topology dynamically varies with the movement of the node. Therefore, the routing table at each node must also be updated regularly depending on the network state (Figure 1).

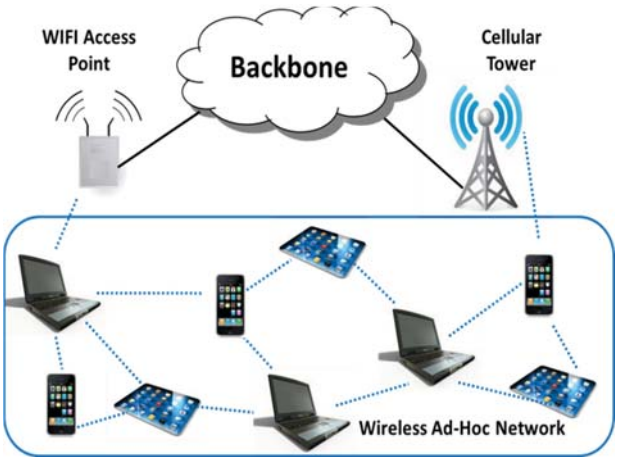
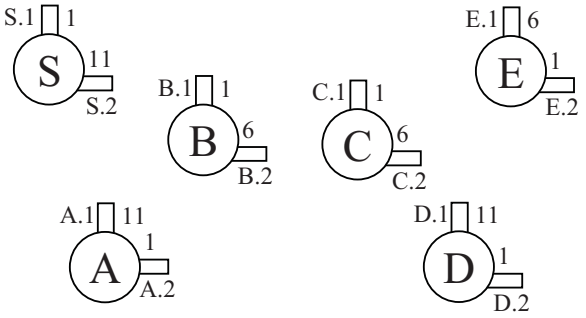
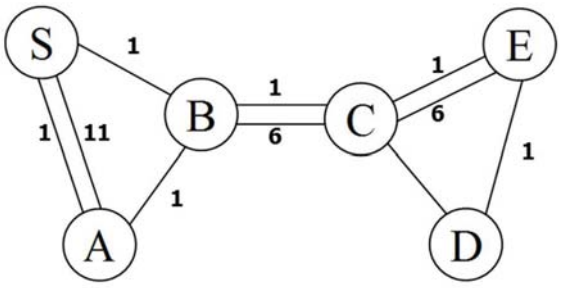


Figure 1. Wireless ad hoc network.

The principle of multi-hop communication in MANET has caused a serious decrease in throughput due to intra-flow interference and inter-flow interference. Accordingly, all mobile nodes have a radio interface that establishes the same frequency channel, because the characteristics of wireless nodes can only communicate with each other on the same frequency channel, which leads to performance of MANET is reduced [2]. To solve this problem, the solution of using multiple radio interfaces at mobile nodes and assigning non-overlapping channels to those interfaces will allow to increase the capacity of the MANET network [3,4]. In practical deployment of MANET networks, the IEEE 802.11 family of standards is widely used. The IEEE 802.11 standard allows non-overlapping channels in the 2.4 GHz and 5 GHz bands. For example, the 802.11b/g standard operates in the 2.4GHz band with 3 non-overlapping channels: 1, 6, 11; The 802.11a standard operates in the 5GHz band with 12 non-overlapping channels. This allows the use of multiple IEEE 802.11 radio interfaces at mobile nodes for MANET to increase network capacity. Figure 2a illustrates a multi-channel MANET network with 02 radio communications at network nodes. These interfaces are assigned with non-overlapping channels 1, 6, 11. The result of this channel assignment creates a new network topology as a multi-graph that is more efficient due to the use of different channels on different links for simultaneous transmission (Figure 2b).



(a) Mobile nodes with 2 radios.



(b)MANET's topology as a multi-graph.
Figure 2. Multi-channel MANET.

Some methods can be applied to evaluate the performance of multi-channel MANET network by using simulation model, mathematical analysis model or empirical measurement. In the method of modeling and simulation of the MANET network, the studies mainly use the current popular network simulation software such as NS2, OMNeT++ or OPNET. Many researchers [1,5,6] used NS2 simulator to

III. Performance Evaluation

A. Simulation parameters

A mobile ad hoc network with nodes randomly deployed on an area of 1000m x 1000m. Mobile nodes have the same number of wireless interfaces established with non-overlapping channels, the channel assignment scheme is the same for all nodes. UDP connections are established between 50 mobile nodes to 01 mobile node acting as a gateway at a rate of 20 packets per second. Radio interfaces follow the IEEE 802.11 b/g standard used in the simulation, these standards have 3 non-overlapping channels 1, 6 and 11, different interfaces are established by different non-overlapping channels. AODV routing protocol is used and improved in the direction that routing broadcast packets are sent on all wireless interfaces. Other simulation parameters are shown as Table 1.

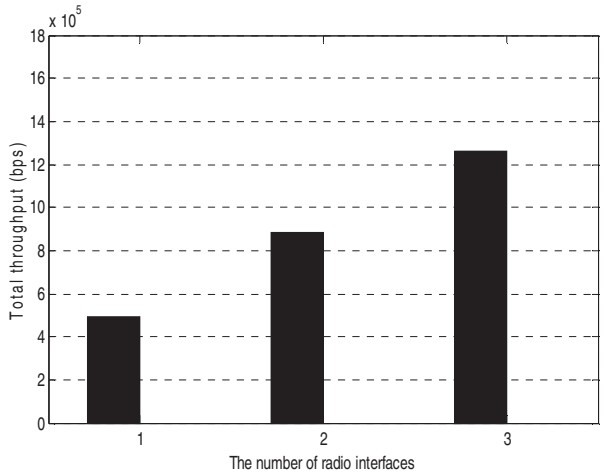


Figure 5. Throughput vs. the number of wireless interface at nodes in MANET

B. Simulation results

In order to evaluate the efficiency of the new mobile node architecture, the network performance parameters used for evaluation including throughput and delay.

- *Throughput*: This is defined as the amount of data that is transmitted through the network per unit time, (i.e., data bytes delivered to their destinations per second).
- *End-to-end delay of data packets*: This is defined as the delay between the time at which the data packet originated at the source and the time it reaches the destination.

The simulation scenario is similarly applied to mobile nodes with the number of wireless interfaces. Figure 5 shows that the network throughput of MANET is improved, when increasing the number of wireless interface at mobile nodes. With 2 radio interfaces assigned to 2 non-overlapping channels, the network throughput is doubled compared to using only one interface.

As shown in Figure 6, the end-to-end delay is significantly improved when increasing the number of wireless interfaces at each mobile node. The main reason is because of more route choices in multi-graph. In addition, the routes with high channel diversity are preferred thereby reducing inter-flow and intra-flow interference.

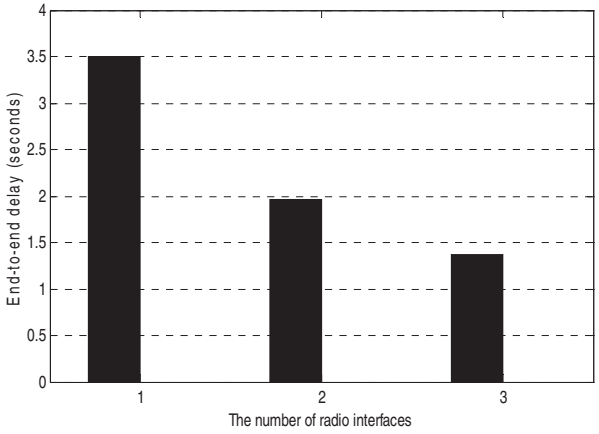


Figure 6. End-to-end delay vs. the number of wireless interface at nodes in MANET

IV. Conclusions

In this paper, we have presented a solution to design multi-radio mobile node for mobile ad hoc network in NS2 simulator. In addition, the paper also presented the solution to improve AODV routing protocol as well as with other routing protocols based on multi-radio mobile node architecture. The simulation results show the effectiveness of the multi-channel mobile ad-hoc networks. The performance of MANET with multi-radio mobile node architecture is significantly improved according to the number of interfaces and the number of non-overlapping channels assigned.

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