CHAPTER 4

AN IMPROVED QoS MULTIPATH ROUTING USING BANDWIDTH ESTIMATION AND RATE ADAPTATION

4.1 INTRODUCTION

In order to effectively adapt the transmission rate, network congestion has to be reliably detected. In particular, among all kinds of packet losses, the congestion loss probability needs to be estimated. Treating all losses as congestion loss leads to undesirable rate adaptations (Fu et al. 2003). To effectively support best-effort multimedia streaming, dramatic rate variations are highly undesirable. To offer bandwidth-guaranteed QoS, the available end-to-end bandwidth along a route from the source to the destination must be known (Chen & Heinzelman 2005).

Available bandwidth is the amount of bandwidth left over after the cross traffic. It can be determined by finding the time period for which the link is not utilized for transmitting data. In recent years, the main focused research area is ad hoc network. In ad hoc network, a host’s available bandwidth refers to the amount of bandwidth available in the node to transmit packets over the network. Whole channel will not be used for packet transmission (Banu 2010).

4.2 METHODOLOGY

As seen in the previous chapter, the performance of network is improved when only rate adaptation and bandwidth estimation is considered during routing. In this chapter, the rate adaptation and bandwidth estimation proposed in the previous chapters are combined to propose a Rate adaptation,
Bandwidth estimation AOMDV Routing. The proposed approach can be applied when the node needs to transmit the data with high capacity as well as dynamic rate adaptation.

The values of rate for transmission and available bandwidth are considered when selecting a path. The route with the maximum value is chosen as the path between source and destination.

QoS parameter estimation is through normalization of the values and final value is computed as follows:

\[ P_{QoS} \times \text{Available Bandwidth} \times \text{Rate} \]

where, \( \alpha \) and \( \beta \) are constants with \( \alpha + \beta = 1 \) and in this study, \( \alpha \) and \( \beta \) are assigned the value of 0.5. The route with the maximum \( P_{QoS} \) is used to transmit the packets.

Figure 4.1 Flowchart of the proposed Methodology
Figure 4.1 shows the flow chart of the proposed investigation. Rate adaptation is computed based on the improved technique implemented in chapter 3 using RREG. Similarly Bandwidth is also estimated using the modified HELLO packet. Larger rate adaptation improves the Packet Delivery Ratio but can also increase the congestion when the number of hops is high which can be identified using Bandwidth estimation. This work uses a combination of the normalized value of Rate adaptation and Bandwidth estimation to achieve better QOS.

### 4.3 RESULTS AND DISCUSSION

In this work, a QoS aware routing for AOMDV is proposed. This QoS is enhanced using Bandwidth estimation and Rate adaptation. Simulations are conducted to evaluate the performance of the proposed AOMDV and are compared with AOMDV with bandwidth estimation. Size of network used in the simulation is 2500 x 2500 m with 50 nodes. Transmission power of each node is 0.005 watt. The results obtained are as shown in Tables 4.1-4.5 and Figure 4.2-4.5.

#### Table 4.1 Packet Delivery Ratio

| Mobility Speed | AOMDV with Bandwidth Estimation (BE-AOMDV) | AOMDV with Bandwidth estimation and rate adaptation |
|----------------|---------------------------------------------|-----------------------------------------------|
| 10.8 Kmph      | 0.9209                                      | 0.944211178                                   |
| 18 Kmph        | 0.9015                                      | 0.895788747                                   |
| 36 Kmph        | 0.8224                                      | 0.85887483                                   |
| 54 Kmph        | 0.8027                                      | 0.805859156                                   |
| 72 Kmph        | 0.6609                                      | 0.738095766                                   |
| 90 Kmph        | 0.6164                                      | 0.706671008                                   |
From the Table 4.1 and Figure 4.2, it is shown that AOMDV with Bandwidth Estimation and Rate Adaptation obtains high packet delivery ratio at mobility speed of 10.8 Kmph of 2.53% when compared to AOMDV with Bandwidth Estimation (BE-AOMDV). At the speed of 90 Kmph, the AOMDV with Bandwidth Estimation and Rate Adaptation obtains high packet delivery ratio of 14.64% when compared to AOMDV with Bandwidth Estimation (BE-AOMDV).

**Table 4.2 Packet Loss Rate**

| Mobility Speed | AOMDV with Bandwidth Estimation (BE-AOMDV) | AOMDV with Bandwidth estimation and rate adaptation |
|----------------|--------------------------------------------|--------------------------------------------------|
| 10.8 Kmph      | 0.0791                                     | 0.055788822                                      |
| 18 Kmph        | 0.0985                                     | 0.104211253                                      |
| 36 Kmph        | 0.1776                                     | 0.14112517                                       |
| 54 Kmph        | 0.1973                                     | 0.194140844                                      |
| 72 Kmph        | 0.3391                                     | 0.261904234                                      |
| 90 Kmph        | 0.3836                                     | 0.293328992                                      |
By using the resultant values of proposed approach exhibits in Table 4.2, the Figure 4.3 depicts that the packet loss rate of proposed approach AOMDV with Rate Adaptation and Bandwidth Estimation is 41.78% less at mobility speed of 10.8Kmph and 30.78% less at 90Kmph when compared to AOMDV with Bandwidth Estimation (BE-AOMDV).

**Table 4.3 End to End Delay**

| Mobility Speed | AOMDV with Bandwidth Estimation (BE-AOMDV) | AOMDV with Bandwidth estimation and rate adaptation |
|----------------|-------------------------------------------|---------------------------------------------------|
| 10.8 Kmph     | 0.0021                                    | 0.007534554                                      |
| 18 Kmph       | 0.0063                                    | 0.006780871                                      |
| 36 Kmph       | 0.0193                                    | 0.010330273                                      |
| 54 Kmph       | 0.0324                                    | 0.012472761                                      |
| 72 Kmph       | 0.1073                                    | 0.059960672                                      |
| 90 Kmph       | 0.1247                                    | 0.089209939                                      |
The performance metric End to End Delay is shown in Table 4.3 and Figure 4.4. It is clear that the delay for end to end transmission of proposed method AOMDV with Bandwidth Estimation and Rate Adaptation is 72% high at the mobility speed of 10.8Kmph when compared to AOMDV with Bandwidth Estimation (BE-AOMDV). But as the mobility speed increases the delay time of the proposed method gets decreased. At the speed of 90Kmph the proposed method obtains 39% of low end to end delay when compared to AOMDV with Bandwidth Estimation (BE-AOMDV).

### Table 4.4 Remaining Energy in joules

| Mobility Speed | AOMDV with Bandwidth Estimation (BE-AOMDV) | AOMDV with Bandwidth estimation and rate Adaptation |
|----------------|--------------------------------------------|---------------------------------------------------|
| 10.8 Kmph      | 372                                        | 374                                               |
| 18 Kmph        | 337                                        | 344                                               |
| 36 Kmph        | 312                                        | 322                                               |
| 54 Kmph        | 269                                        | 281                                               |
| 72 Kmph        | 241                                        | 264                                               |
| 90 Kmph        | 212                                        | 218                                               |
The Table 4.4 gives the remaining energy levels in joules of proposed approach. The Figure 4.5 shows that the remaining energy level of proposed approach AOMDV with Bandwidth Estimation and Rate Adaptation is 0.53% higher than the AOMDV with Bandwidth Estimation at mobility speed of 10.8Kmph. But it increases to 2.83% when the mobility speed increases to 90Kmph.

**4.4 CONCLUSION**

This study proposes a QoS aware routing for AOMDV. QoS routing needs to locate a route from source to destination by considering the QoS constraints bandwidth and rate for transmission. The proposed method is an integration of QoS constraints for routing. Experimental results show that the AOMDV with Bandwidth Estimation and Rate Adaptation obtains high packet delivery ratio. Also the performance of the integrated approach is compared with all metrics and proved that the combination of the two constraints improved the QoS in AOMDV routing.