

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING, BUET

NS2 Project Report

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MY STUDENT ID IS 1805091.91%8 = 3. So, I HAVE SIMULATED WIRELESS 802.15.4 (STATIC) (SECTION-1) AND WIRELESS 802.11 (MOBILE) (SECTION-2) NETWORK.IN THE SECTION-3, I HAVE SIMULATED MODIFIED AODV ROUTING PROTOCOL IN WIRELESS 802.11 (MOBILE) NETWORK.

1 WIRELESS 802.15.4 (STATIC)

1.1 Description of the simulation

The simulation is based on the IEEE 802.15.4(static) standard. Routing is based on the dsdv protocol. The simulation is based on the ns-2 simulator. The simulation is based on the following parameters:

- Channel: Wireless channel
- Propagation: Two-ray ground
- Antenna: Omnidirectional
- Link: 802.15.4
- Queue: Drop-tail
- Routing: DSDV
- Mobility: Static
- Position: Grid
- Area: $2*(tx_range)m \times 2*(tx_range)m$
- Flow: Random source to random destination
- Packet size: 64 bytes
- Number of nodes: Variable
- Number of flows: Variable
- Packet rate: Variable
- Tx Coverage: Variable
- Simulation time: 60 seconds

1.2 Results

1.2.1 *Varying Number of Nodes*

Baseline parameters are as follows:

- Number of flows: 20
- Packet rate: 100 packets per second
- Tx Coverage: 300m

The number of nodes is varied from 20 to 100 in steps of 20. See Figure 1.1a ,1.1b , 1.1c , 1.1d, 1.1e , 1.1f and 1.2 for the result.

1.2.2 *Varying Number of Flows*

Baseline parameters are as follows:

- Number of nodes: 40

- Packet rate: 100 packets per second
- Tx Coverage: 300m

The number of flows is varied from 10 to 50 in steps of 10. See Figure 1.3a ,1.3b , 1.3c , 1.3d, 1.3e , 1.3f and 1.4 for the result.

1.2.3 Varying Packet per Second

Baseline parameters are as follows:

- Number of nodes: 40
- Number of flows: 10
- Tx Coverage: 300m

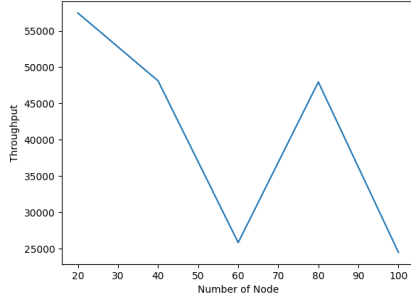
The packet rate is varied from 100 to 500 packets per second in steps of 100. See Figure 1.5a ,1.5b , 1.5c , 1.5d, 1.5e , 1.5f and 1.6 for the result.

1.2.4 Varying Transmission Range

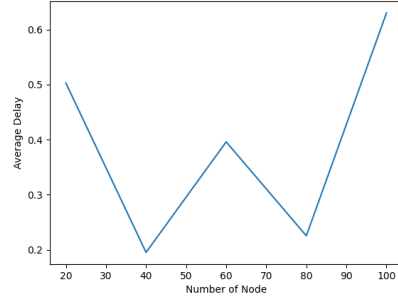
Baseline parameters are as follows:

- Number of nodes: 40
- Number of flows: 10
- Packet Rate: 100 packets per second

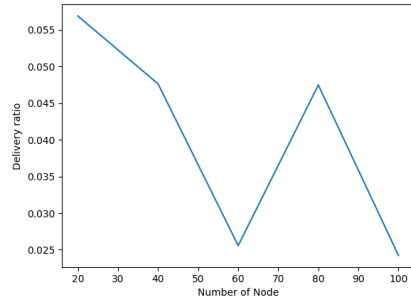
The transmission range is varied from 100 to 500 meters in steps of 100. See Figure 1.7a ,1.7b , 1.7c , 1.7d, 1.7e , 1.7f and 1.8 for the result.



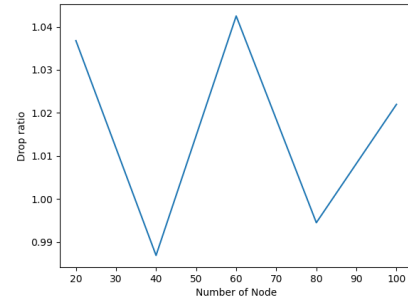
(a) Number of Nodes Vs Throughput



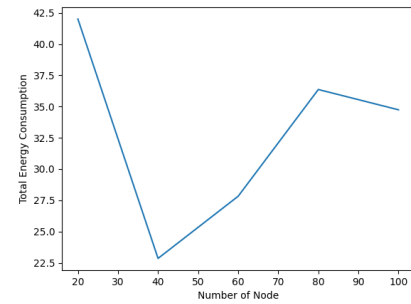
(b) Number of Nodes Vs Average Delay



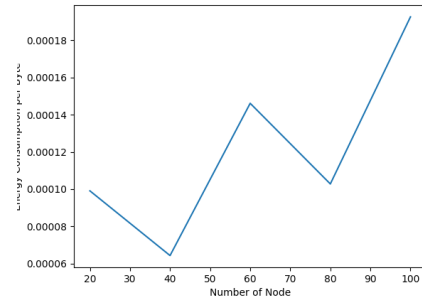
(c) Number of Nodes Vs Delivery Ratio



(d) Number of Nodes Vs Drop Ratio

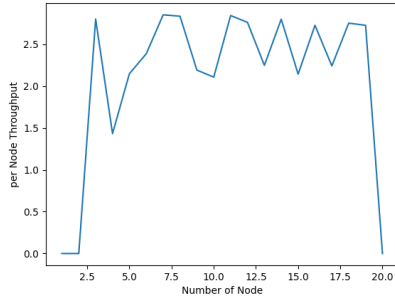


(e) Number of Nodes Vs Energy Consumption

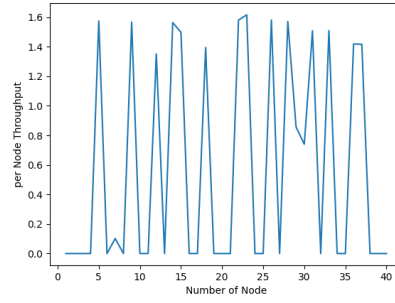


(f) Number of Nodes Vs Energy Per Byte

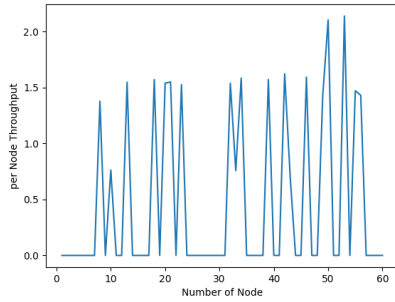
Figure 1.1: Varying Number of Nodes



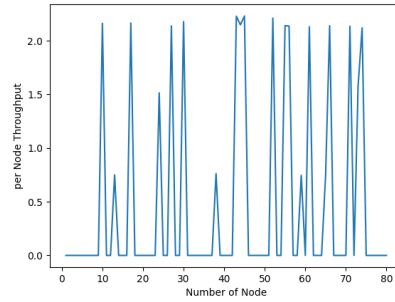
(a) Number of Nodes(20) Vs Throughput per Node



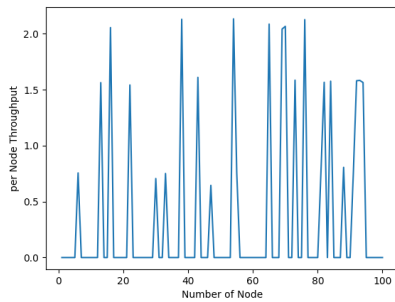
(b) Number of Nodes(40) Vs Throughput per Node



(c) Number of Nodes(60) Vs Throughput per Node

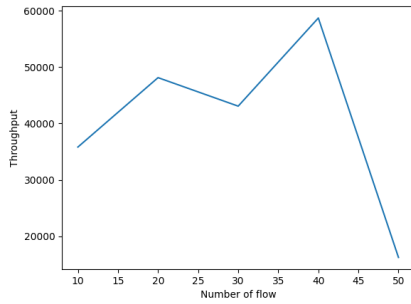


(d) Number of Nodes(80) Vs Throughput per Node

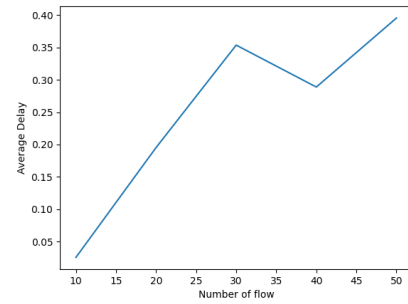


(e) Number of Nodes(100) Vs Throughput per Node

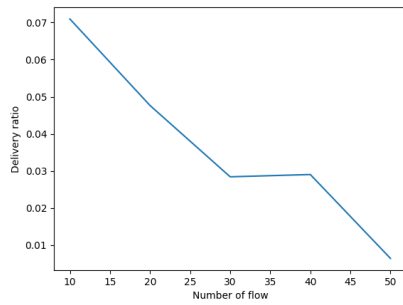
Figure 1.2: Varying Number of Nodes (Throughput per Node)



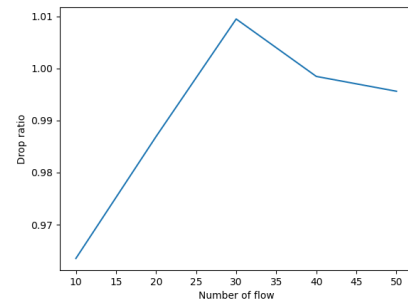
(a) Number of Flows Vs Throughput



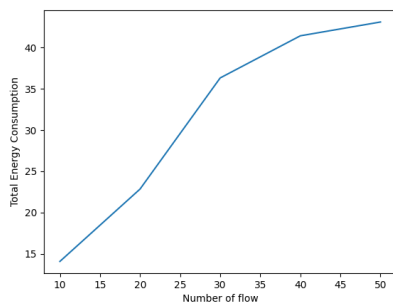
(b) Number of Flows Vs Average Delay



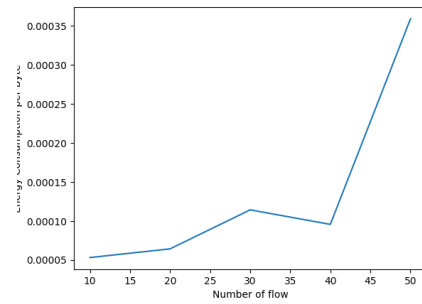
(c) Number of Flows Vs Delivery Ratio



(d) Number of Flows Vs Drop Ratio

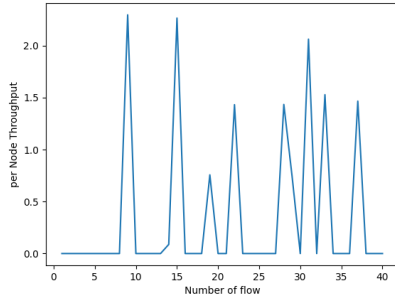


(e) Number of Flows Vs Energy Consumption

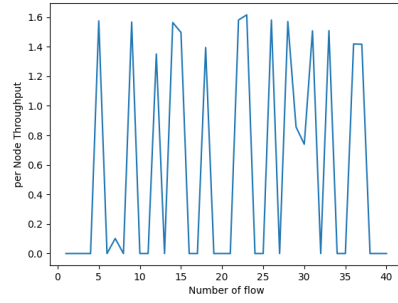


(f) Number of Flows Vs Energy Per Byte

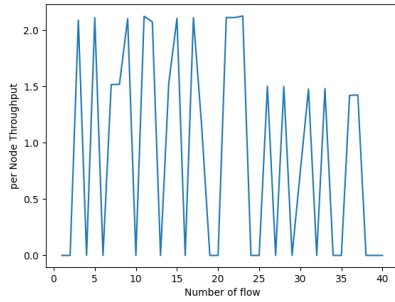
Figure 1.3: Varying Number of Flows



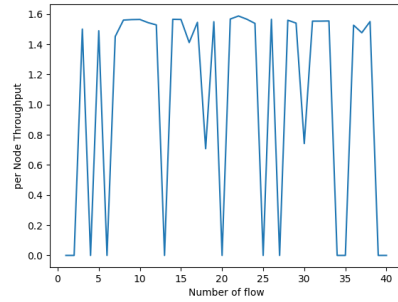
(a) Number of Flows(10) Vs Throughput per Node



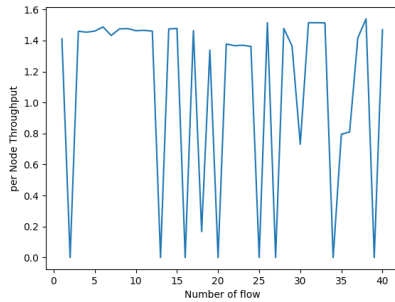
(b) Number of Flows(20) Vs Throughput per Node



(c) Number of Flows(30) Vs Throughput per Node

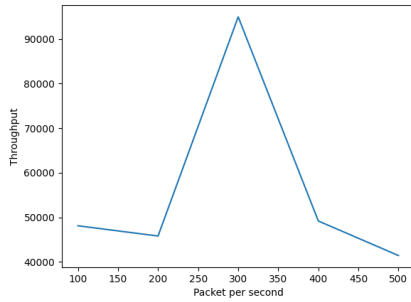


(d) Number of Flows(40) Vs Throughput per Node

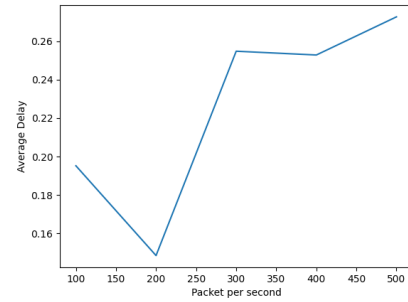


(e) Number of Flows(50) Vs Throughput per Node

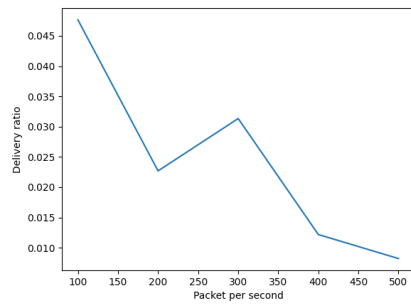
Figure 1.4: Varying Number of Flows (Throughput per Node)



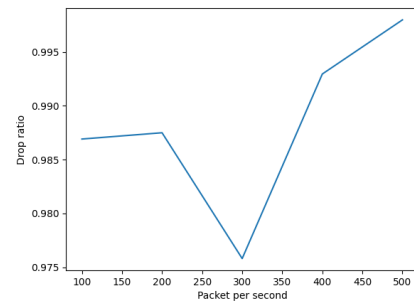
(a) Packet Rate Vs Throughput



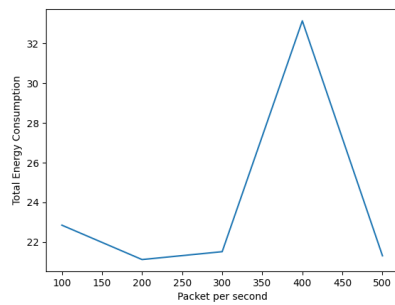
(b) Packet Rate Vs Average Delay



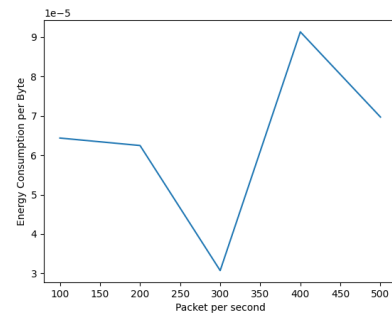
(c) Packet Rate Vs Delivery Ratio



(d) Packet Rate Vs Drop Ratio

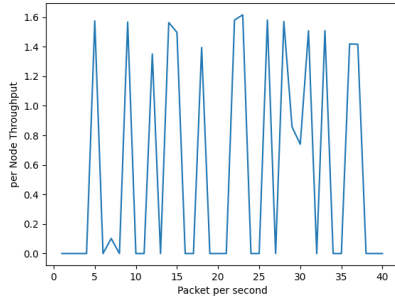


(e) Packet Rate Vs Energy Consumption

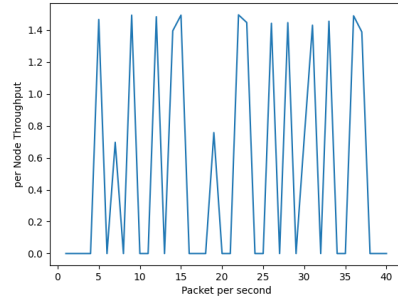


(f) Packet Rate Vs Energy Per Byte

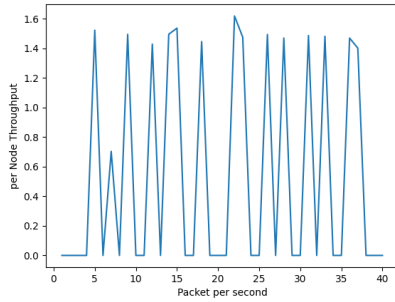
Figure 1.5: Varying Packet Rate



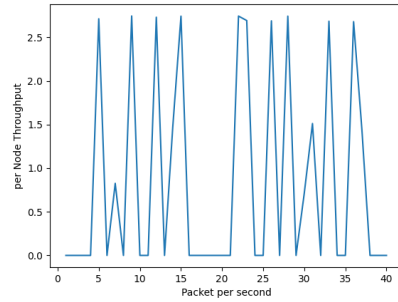
(a) Packet Rate(100) Vs Throughput per Node



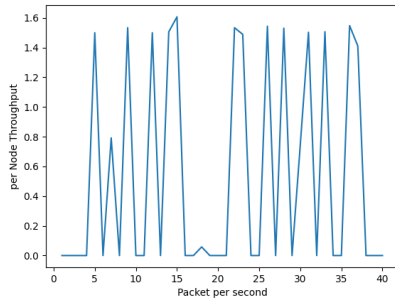
(b) Packet Rate(200) Vs Throughput per Node



(c) Packet Rate(300) Vs Throughput per Node

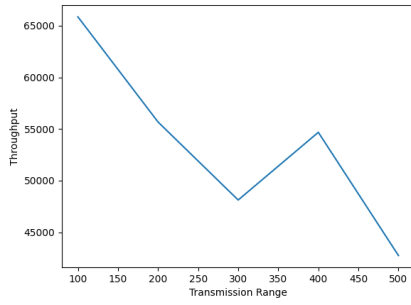


(d) Packet Rate(400) Vs Throughput per Node

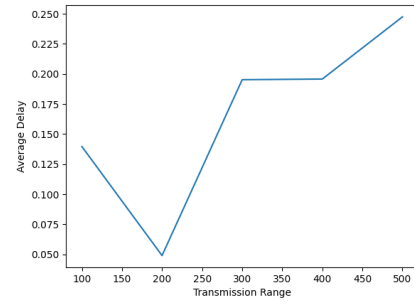


(e) Packet Rate(500) Vs Throughput per Node

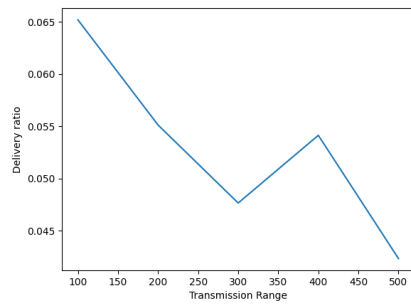
Figure 1.6: Varying Packet Rate (Throughput per Node)



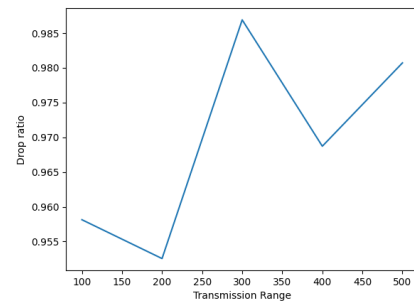
(a) Tx Range Vs Throughput



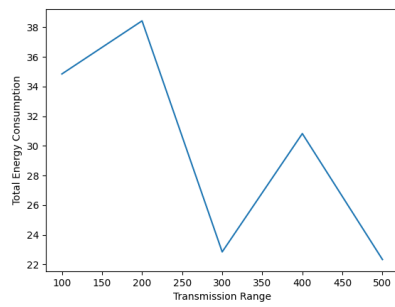
(b) Tx Range Vs Average Delay



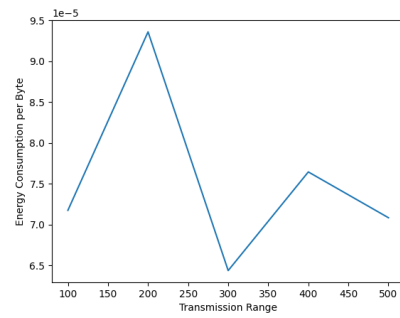
(c) Tx Range Vs Delivery Ratio



(d) Tx Range Vs Drop Ratio

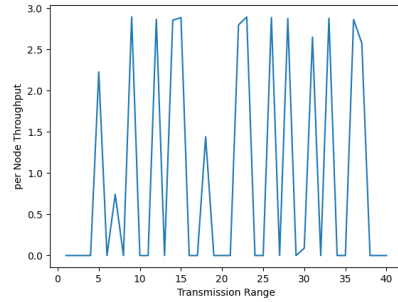
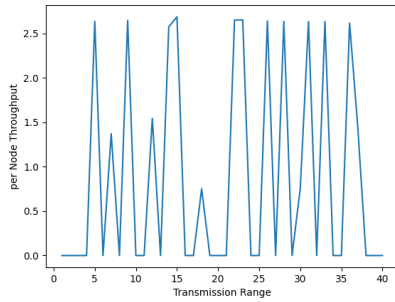


(e) Tx Range Vs Energy Consumption

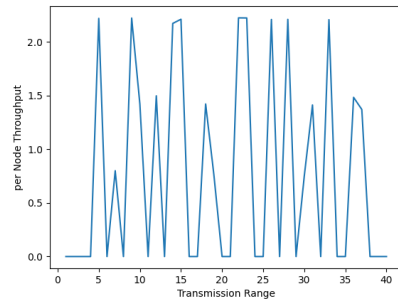
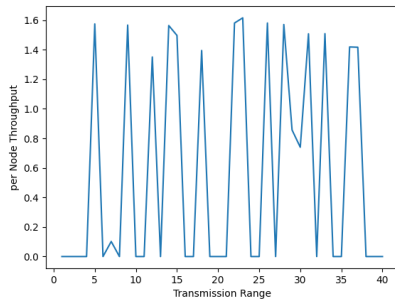


(f) Tx Range Vs Energy Per Byte

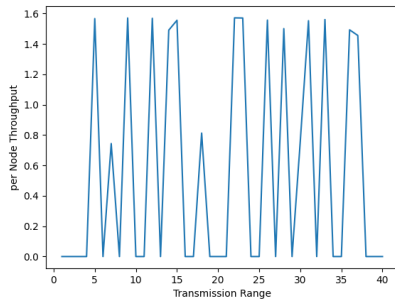
Figure 1.7: Varying Transmission Range



(a) Tx Range(100) Vs Throughput per Node (b) Tx Range(200) Vs Throughput per Node



(c) Tx Range(300) Vs Throughput per Node (d) Tx Range(400) Vs Throughput per Node



(e) Tx Range(500) Vs Throughput per Node

Figure 1.8: Varying Transmission Range (Throughput per Node)

2 WIRELESS IEEE 802.11.2 MOBILE NETWORKS

2.1 Description of the simulation

The simulation is based on the IEEE 802.11.2(mobile) standard. Routing is based on the aodv protocol. The simulation is based on the ns-2 simulator. The simulation is based on the following parameters:

- Channel: Wireless channel
- Propagation: Two-ray ground
- Antenna: Omnidirectional
- Link: IEEE 802.11.2
- Queue: Drop-tail
- Routing: AODV
- Mobility: Random waypoint
- Position: Grid
- Area: 500 x 500 meters
- Flow: Random source to random destination
- Packet size: 64 bytes
- Number of nodes: Variable
- Number of flows: Variable
- Packet rate: Variable
- Speed: Variable
- Simulation time: 60 seconds

2.2 Results

2.2.1 *Varying Number of Nodes*

Baseline parameters are as follows:

- Number of flows: 20
- Packet rate: 100 packets per second
- Speed: 5 meters per second

The number of nodes is varied from 20 to 100 in steps of 20. See Figure 2.1a ,2.1b , 2.1c , 2.1d, 2.1e , 2.1f and 2.2 for the result.

2.2.2 *Varying Number of Flows*

Baseline parameters are as follows:

- Number of nodes: 40

- Packet rate: 100 packets per second
- Speed: 5 meters per second

The number of flows is varied from 10 to 50 in steps of 10. See Figure 2.3a ,2.3b , 2.3c , 2.3d, 2.3e , 2.3f and 2.4 for the result.

2.2.3 Varying Packet per Second

Baseline parameters are as follows:

- Number of nodes: 40
- Number of flows: 10
- Speed: 5 meters per second

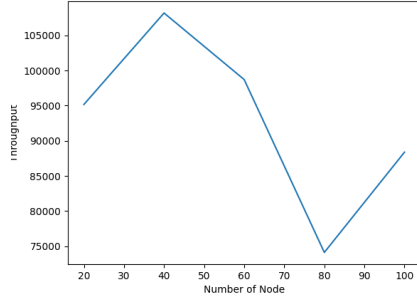
The packet rate is varied from 100 to 500 packets per second in steps of 100. See Figure 2.5a ,2.5b , 2.5c , 2.5d, 2.5e , 2.5f and 2.6 for the result.

2.2.4 Varying Speed

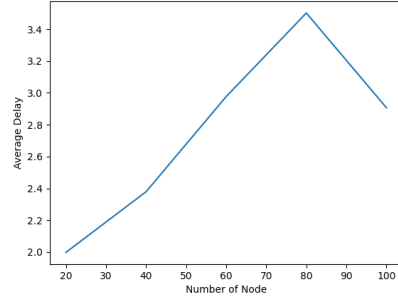
Baseline parameters are as follows:

- Number of nodes: 40
- Number of flows: 20
- Packet Rate: 100 packets per second

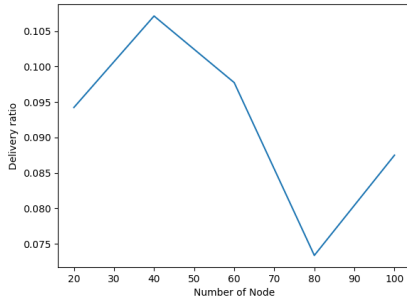
The speed is varied from 5 to 25 meters per second in steps of 5. See Figure 2.7a ,2.7b , 2.7c , 2.7d, 2.7e , 2.7f and 2.8 for the result.



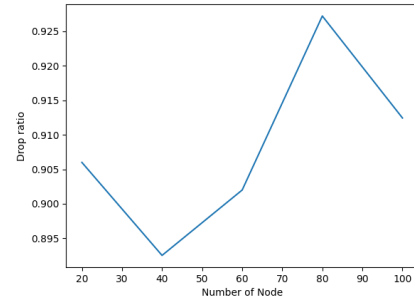
(a) Number of Nodes Vs Throughput



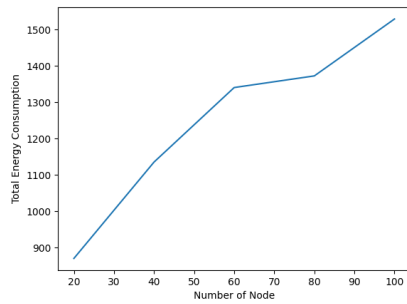
(b) Number of Nodes Vs Average Delay



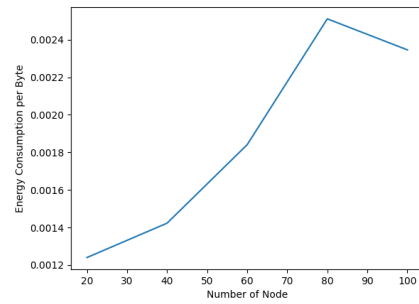
(c) Number of Nodes Vs Delivery Ratio



(d) Number of Nodes Vs Drop Ratio

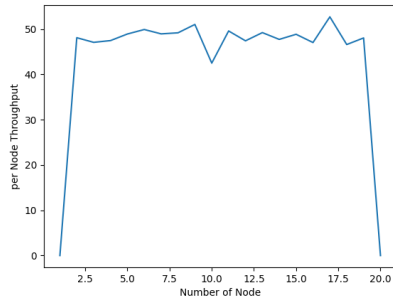


(e) Number of Nodes Vs Energy Consumption

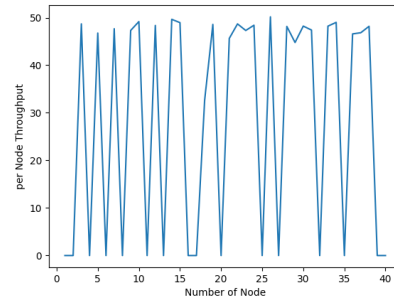


(f) Number of Nodes Vs Energy Per Byte

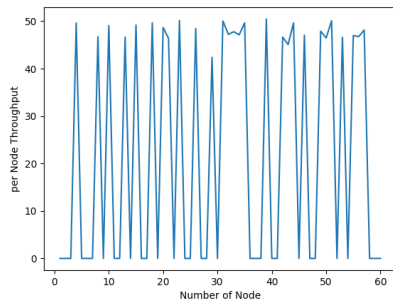
Figure 2.1: Varying Number of Nodes



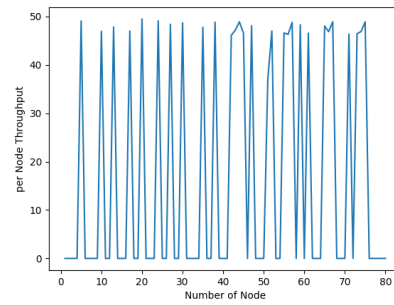
(a) Number of Nodes(20) Vs Throughput per Node



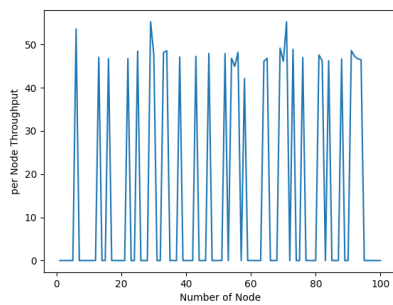
(b) Number of Nodes(40) Vs Throughput per Node



(c) Number of Nodes(60) Vs Throughput per Node

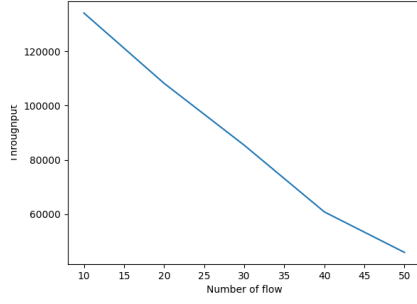


(d) Number of Nodes(80) Vs Throughput per Node

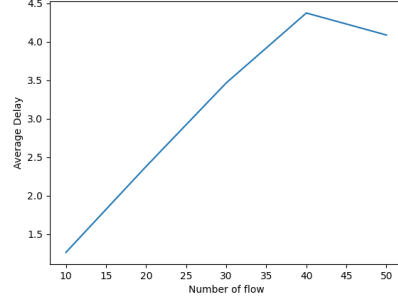


(e) Number of Nodes(100) Vs Throughput per Node

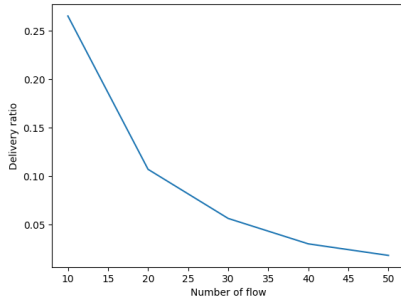
Figure 2.2: Varying Number of Nodes (Throughput per Node)



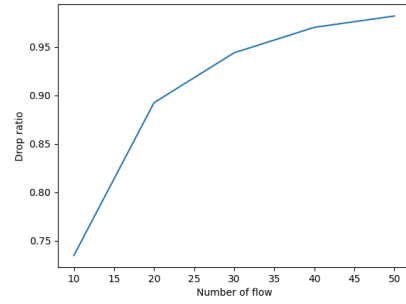
(a) Number of Flows Vs Throughput



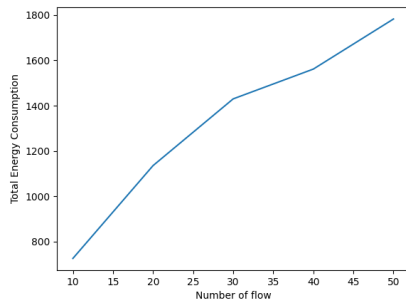
(b) Number of Flows Vs Average Delay



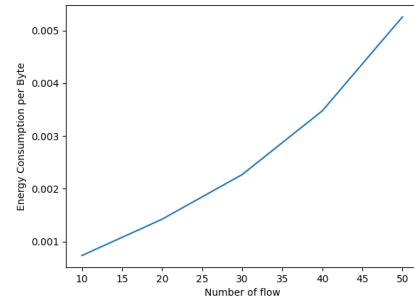
(c) Number of Flows Vs Delivery Ratio



(d) Number of Flows Vs Drop Ratio

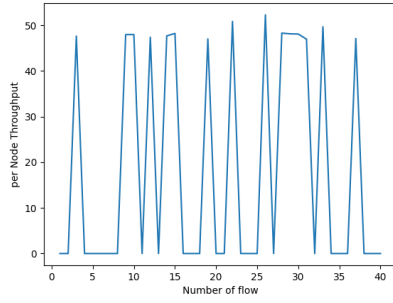


(e) Number of Flows Vs Energy Consumption

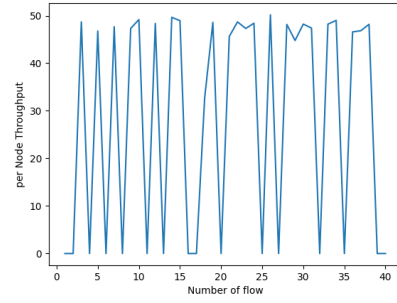


(f) Number of Flows Vs Energy Per Byte

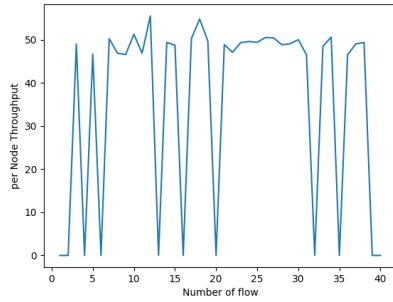
Figure 2.3: Varying Number of Flows



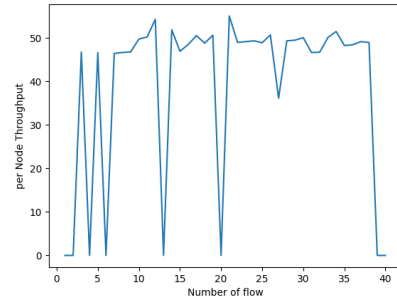
(a) Number of Flows(10) Vs Throughput per Node



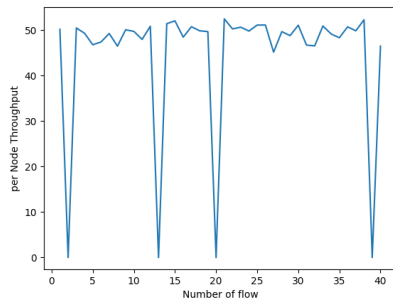
(b) Number of Flows(20) Vs Throughput per Node



(c) Number of Flows(30) Vs Throughput per Node

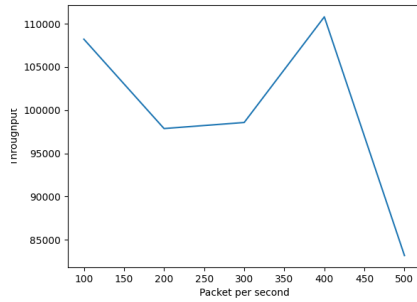


(d) Number of Flows(40) Vs Throughput per Node

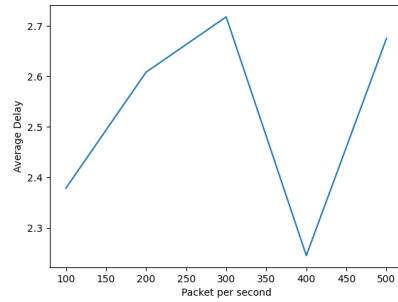


(e) Number of Flows(50) Vs Throughput per Node

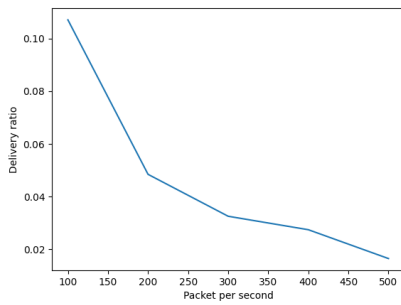
Figure 2.4: Varying Number of Flows (Throughput per Node)



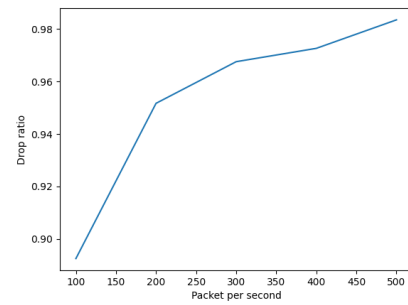
(a) Packet Rate Vs Throughput



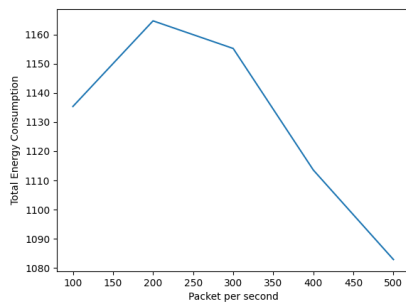
(b) Packet Rate Vs Average Delay



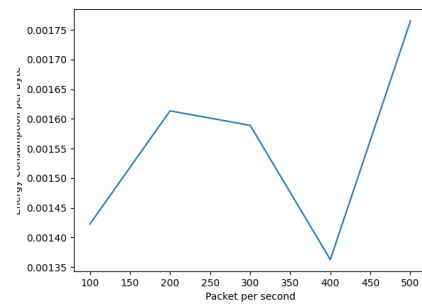
(c) Packet Rate Vs Delivery Ratio



(d) Packet Rate Vs Drop Ratio

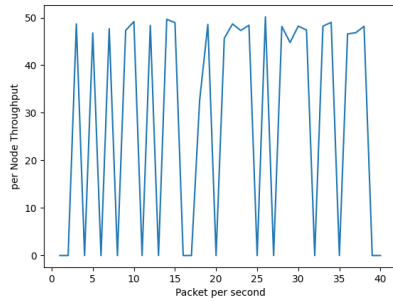


(e) Packet Rate Vs Energy Consumption

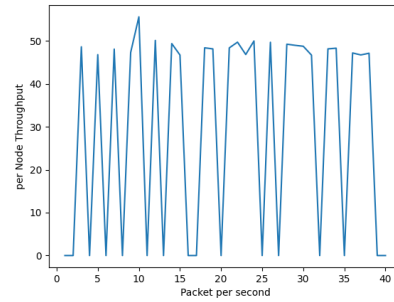


(f) Packet Rate Vs Energy Per Byte

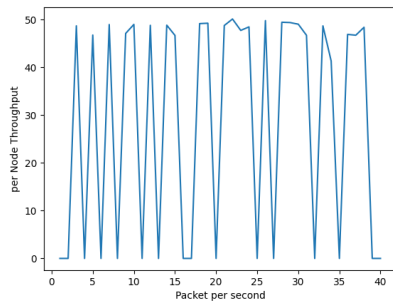
Figure 2.5: Varying Packet Rate



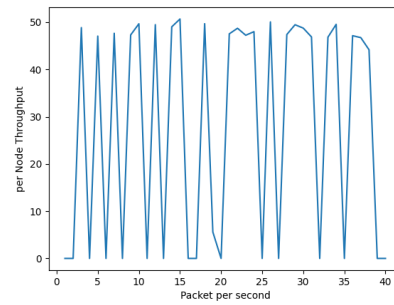
(a) Packet Rate(100) Vs Throughput per Node



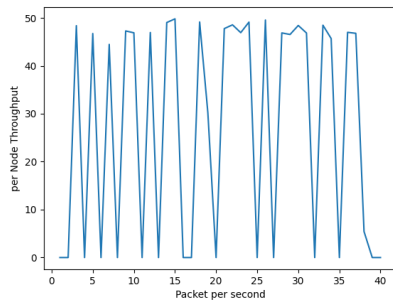
(b) Packet Rate(200) Vs Throughput per Node



(c) Packet Rate(300) Vs Throughput per Node

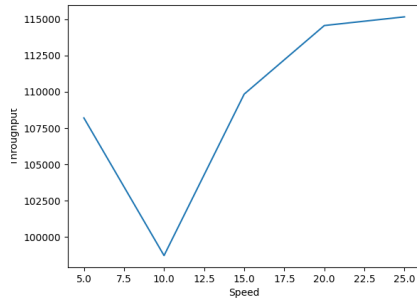


(d) Packet Rate(400) Vs Throughput per Node

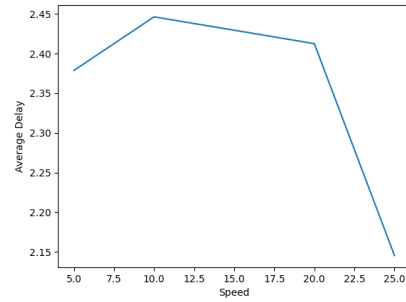


(e) Packet Rate(500) Vs Throughput per Node

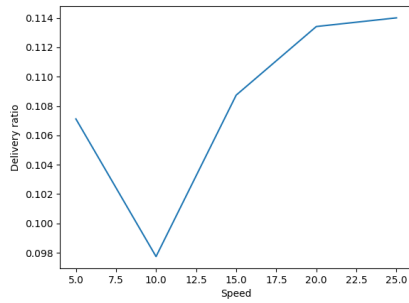
Figure 2.6: Varying Packet Rate (Throughput per Node)



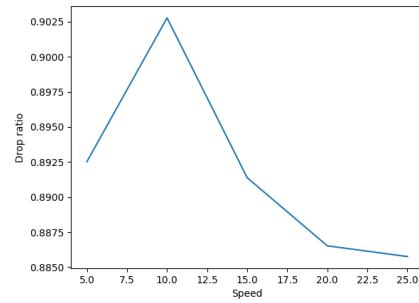
(a) Speed Vs Throughput



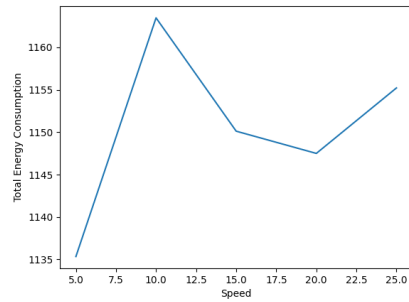
(b) Speed Vs Average Delay



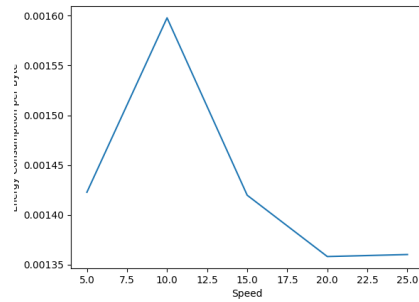
(c) Speed Vs Delivery Ratio



(d) Speed Vs Drop Ratio

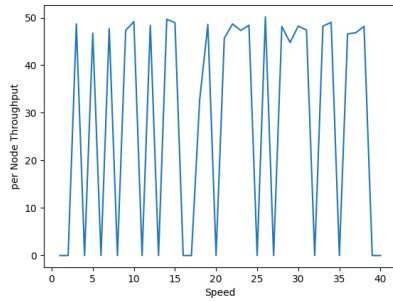


(e) Speed Vs Energy Consumption

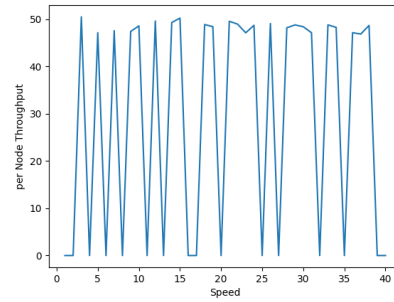


(f) Speed Vs Energy Per Byte

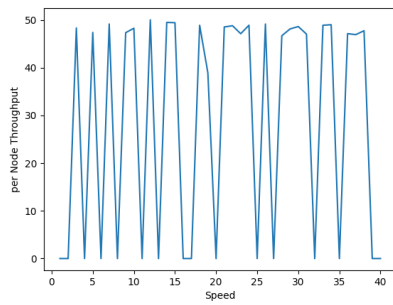
Figure 2.7: Varying Speed



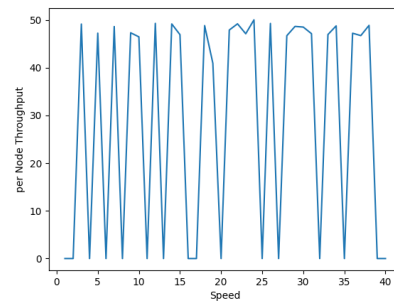
(a) Speed(5) Vs Throughput per Node



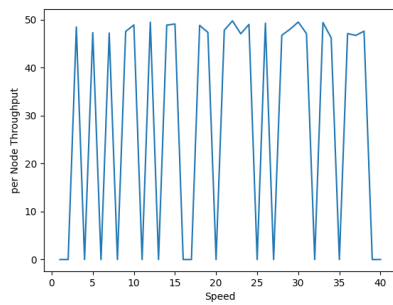
(b) Speed(10) Vs Throughput per Node



(c) Speed(15) Vs Throughput per Node



(d) Speed(20) Vs Throughput per Node



(e) Speed(25) Vs Throughput per Node

Figure 2.8: Varying Speed (Throughput per Node)

3 MODIFIED AODV ROUTING PROTOCOL

3.1 Proposed Algorithm

The below Algorithm is proposed by The paper:

A new field will be added in the RREQ for calculating transmission energy. The format of the new RREQ will be

<source_address, dest_sequence_id, source_sequence_id, broadcast_id, dest_address, hop_count, transmission_energy> Now based on each packets Transmission energy:

Calculate drop factor d for every transmitting node.

Generate a random number between 0 and 1.

if $random_value > dropfactor$ **then**

 broadcast/forward RREQ_packet,

else

 drop RREQ_packet.

end if

This algorithm has some major problem. It always drop packet when network isn't congested at all. I propose a modification on this algorithm. The idea is to count last d seconds RREQ packet number and drop packet if number of packet cross the average.

$average \leftarrow get_average_per_second()$

$number_of_packet_in_last_second \leftarrow get_last_second_count()$

Calculate drop factor d for every transmitting node.

Generate a random number between 0 and 1.

if $number_of_packet_in_last_second < average \ \& \ random_value > dropfactor$ **then**

 broadcast/forward RREQ_packet,

else

 drop RREQ_packet.

end if

3.2 Implementation

The following code is added to aodv.cc in AODV::recvRequest(Packet *p) function:

```
int flag = 0;
while(current_time < (int)CURRENT_TIME) {
    current_time++;
    for (int i=0; i<MAX_SECOND-1; i++) {
```

```

        rreq_count[i] = rreq_count[i+1] ;
    }
    rreq_count[MAX_SECOND-1] = 0;
}
rreq_count[MAX_SECOND-1]++;
// calculating average rreq count
    int sum = 0;
    for(int i=0;i<MAX_SECOND;i++){
        sum += rreq_count[i];
    }
    double avg = (double)sum/MAX_SECOND;
    // drop if high rreq count
    if(avg<rreq_count[MAX_SECOND-1]){
        flag = 1;
    }
// drop if low energy
    double drop_prob = 1.0 -
        (double)rq->rq_transmission_energy/AODV_MAX_TRANSMISSION_ENERGY
// decrease Transmission Energy
    if(rq->rq_transmission_energy>1){
        rq->rq_transmission_energy--;
    }

/* ----- more code ---- */
/*
    * Can't reply. So forward the Route Request
    */
    else {
        if((Random::uniform() < drop_prob) && flag==1){
            Packet::free(p);
            fprintf(stderr,"freeing_packet\n");
            return;
        }
        ih->saddr() = index;
        ih->daddr() = IP_BROADCAST;
        rq->rq_hop_count += 1;
        // Maximum sequence number seen en route
        if (rt) rq->rq_dst_seqno = max(rt->rt_seqno, rq->rq_dst_seqno);
        forward((aodv_rt_entry*) 0, p, DELAY);
    }

```


While sending a packet initially, I set the energy to a certain value. Code in AODV::sendRequest(nsaddr_t dst)

```
// Fill up some more fields.
rq->rq_type = AODVTYPE_RREQ;
rq->rq_hop_count = 1;
rq->rq_bcast_id = bid++;
rq->rq_dst = dst;
rq->rq_dst_seqno = (rt ? rt->rt_seqno : 0);
rq->rq_src = index;
seqno += 2;
rq->rq_transmission_energy= AODV_MAX_TRANSMISSION_ENERGY;
assert ((seqno%2) == 0);
rq->rq_src_seqno = seqno;
rq->rq_timestamp = CURRENT_TIME;
```

And the new packet Type -> Code snipped from packet.h

```
struct hdr_aodv_request {
    u_int8_t      rq_type;      // Packet Type
    u_int8_t      reserved[2];
    u_int8_t      rq_hop_count; // Hop Count
    u_int32_t     rq_bcast_id;  // Broadcast ID

    nsaddr_t      rq_dst;       // Destination IP Address
    u_int32_t     rq_dst_seqno; // Destination Sequence Number
    nsaddr_t      rq_src;       // Source IP Address
    u_int32_t     rq_src_seqno; // Source Sequence Number

    u_int8_t      rq_transmission_energy; // Transmission Energy

    double        rq_timestamp; // when REQUEST sent;
}
```

3.3 Results

3.3.1 Description of the simulation

The simulation is based on the IEEE 802.11.2(mobile) standard. Routing is based on the aodv protocol. The simulation is based on the ns-2 simulator. The simulation is based on the following parameters:

- Channel: Wireless channel

- Propagation: Two-ray ground
- Antenna: Omnidirectional
- Link: IEEE 802.11.2
- Queue: Drop-tail
- Routing: AODV
- Mobility: Random waypoint
- Position: Grid
- Area: 1000 x 1000 meters
- Flow: Random source to random destination
- Packet size: 64 bytes
- Number of nodes: Variable
- Number of flows: Variable
- Packet rate: Variable
- Speed: Variable
- Simulation time: 60 seconds

3.3.2 Results

Varying Number of Node. Baseline parameters are as follows:

- Number of flows: 20
- Packet rate: 100 packets per second
- Speed: 5 meters per second

The number of nodes is varied from 20 to 100 in steps of 20. See Figure 3.1a ,3.1b , 3.1c , 3.1d, 3.1e and 3.1f for the result.

Varying Number of Flows. Baseline parameters are as follows:

- Number of nodes: 60
- Packet rate: 100 packets per second
- Speed: 5 meters per second

The number of flows is varied from 10 to 50 in steps of 10. See Figure 3.2a ,3.2b , 3.2c , 3.2d, 3.2e and 3.2f for the result.

Varying Packet per Second. Baseline parameters are as follows:

- Number of nodes: 60
- Number of flows: 10
- Speed: 5 meters per second

The packet rate is varied from 100 to 500 packets per second in steps of 100. See Figure 3.3a ,3.3b , 3.3c , 3.3d, 3.3e and 3.3f for the result.

Varying Speed. Baseline parameters are as follows:

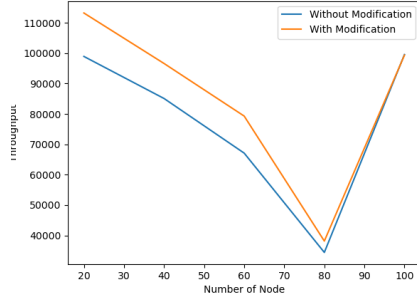
- Number of nodes: 60
- Number of flows: 20
- Packet Rate: 100 packets per second

The speed is varied from 5 to 25 meters per second in steps of 5. See Figure 3.4a ,3.4b , 3.4c , 3.4d, 3.4e and 3.4f for the result.

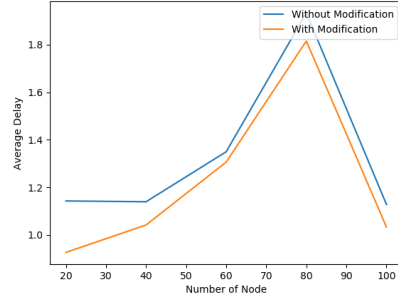
3.4 Findings

Almost in every simulation, modified algorithm did better performance than the existing algorithm. In throughput, Delivery Ratio as well as in every parameters, modified algorithm did perform better. Findings are:

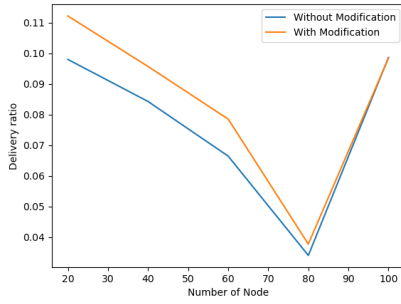
- Existing AODV Does't perform well in big topology and where large number of communication is going on.
- A proverb goes - "The game is not worth the candle." Meaning is- Number of RREQ packet is increased so much that it congested the overall network. So it should be handle carefully.
- My solution works well as it tries to minimize redundant RREQ Packet by dropping them when they tries to congest the network
- RREQ packet shouldn't send blindly. It should manage more intelligently like a node can use previous experience to selectively send packet to those node which resolve RREQ request recently. Those node will be more tented to connected with other node.
- This approach is also energy efficient. As it forward less packet than the existing protocol, It saves energy. And Energy is important in network like this where there is no infrastructure.



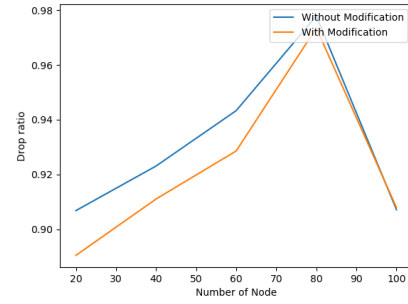
(a) Number of Nodes Vs Throughput



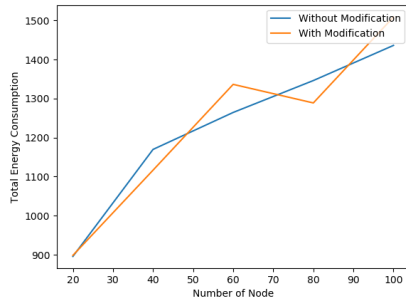
(b) Number of Nodes Vs Average Delay



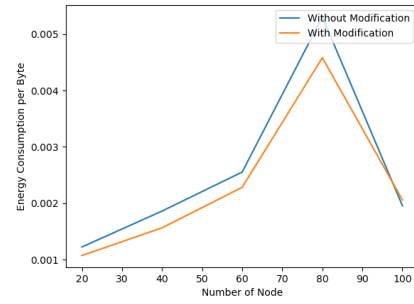
(c) Number of Nodes Vs Delivery Ratio



(d) Number of Nodes Vs Drop Ratio

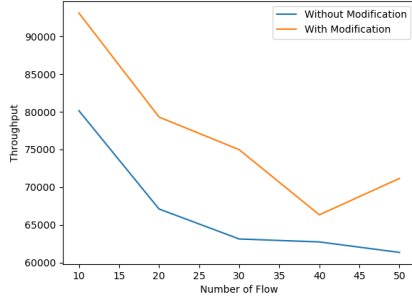


(e) Number of Nodes Vs Energy Consumption

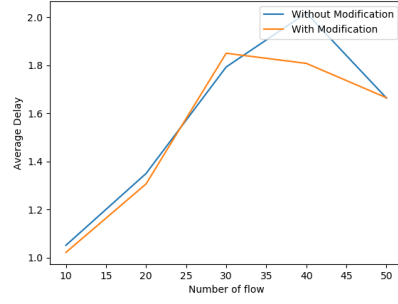


(f) Number of Nodes Vs Energy Per Byte

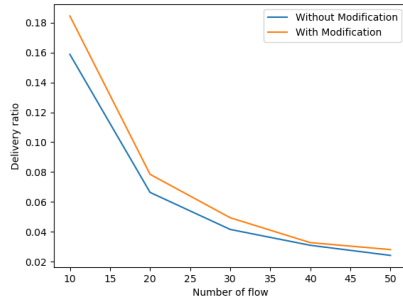
Figure 3.1: Varying Number of Nodes



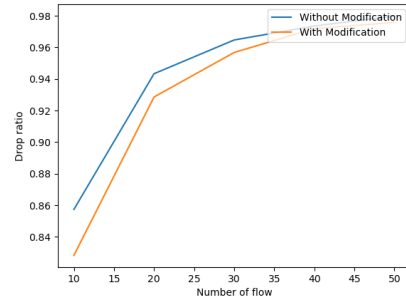
(a) Number of Flows Vs Throughput



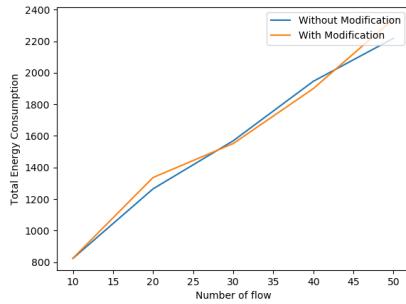
(b) Number of Flows Vs Average Delay



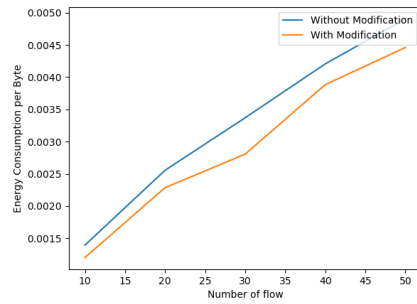
(c) Number of Flows Vs Delivery Ratio



(d) Number of Flows Vs Drop Ratio

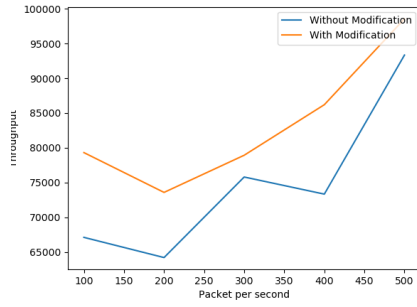


(e) Number of Flows Vs Energy Consumption

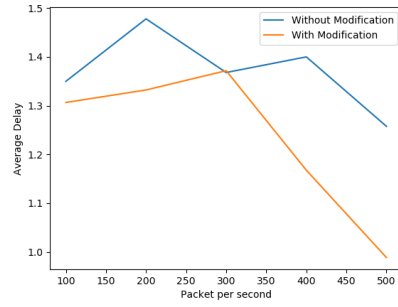


(f) Number of Flows Vs Energy Per Byte

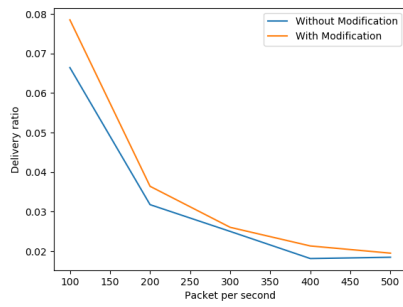
Figure 3.2: Varying Number of Flows



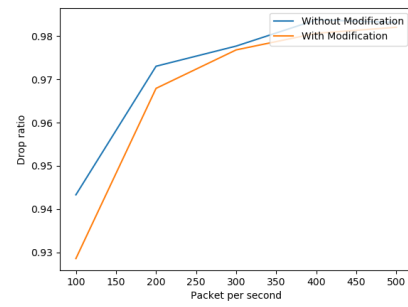
(a) Packet Rate Vs Throughput



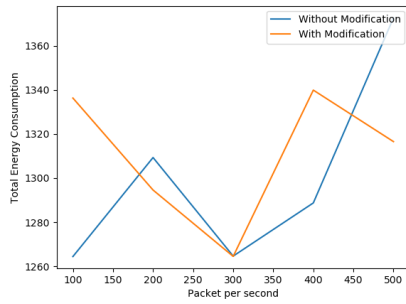
(b) Packet Rate Vs Average Delay



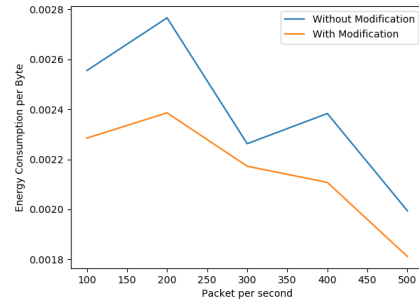
(c) Packet Rate Vs Delivery Ratio



(d) Packet Rate Vs Drop Ratio

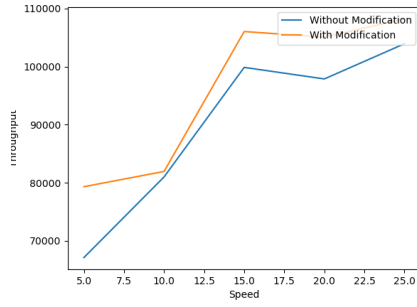


(e) Packet Rate Vs Energy Consumption

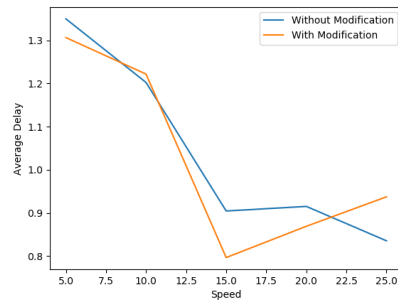


(f) Packet Rate Vs Energy Per Byte

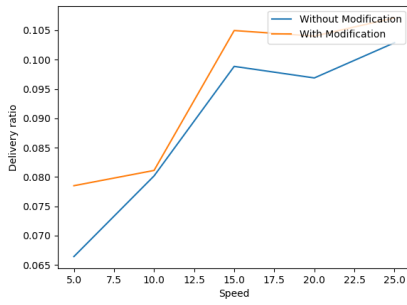
Figure 3.3: Varying Packet Rate



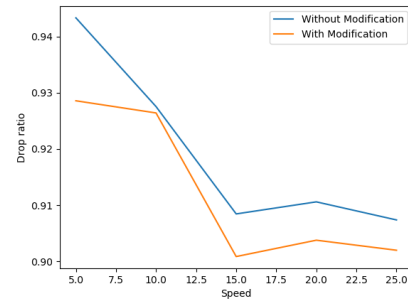
(a) Speed Vs Throughput



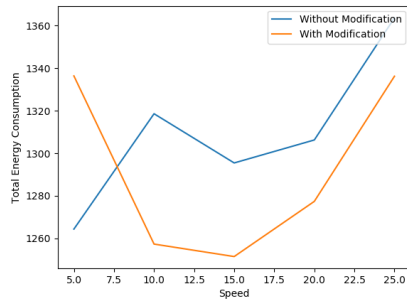
(b) Speed Vs Average Delay



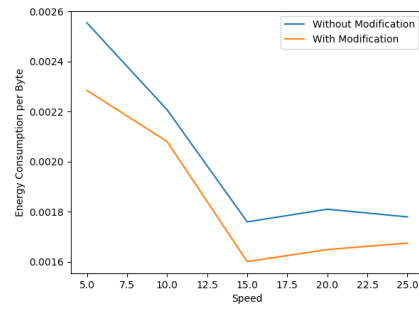
(c) Speed Vs Delivery Ratio



(d) Speed Vs Drop Ratio



(e) Speed Vs Energy Consumption



(f) Speed Vs Energy Per Byte

Figure 3.4: Varying Speed