Performance Evaluation of Energy Traffic In Ipv6 Networks

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Abstract:

In this paper, we present a study of energy traffic based simulative and analytical methods in IPv6 networks. This research examine to find out which MANET routing protocol performs better in the case of TCP/IP (Application and Physical layer) under congested IPv6 networks. We investigates & undertakes simulation based study of Ad-hoc routing protocols in wireless sensor Network. We compare the five MANET routing protocols AODV, DYMO, Olsrv2 Niigata, OLSR Inria and RIPng with varying network nodes and fixed random waypoint mobility model using QualNet 5.0.1 Simulator. The metrics used for performance evaluation in TCP/IP application layer are Throughput, Average Jitter, End-to End delay, Total packets received / efficiency. In addition, the energy traffic model in the physical layer we simulate Total energy consumed in transmit mode, Total energy consumed in received mode and Total energy consumed in ideal mode in Ipv6 networks. The simulation has been carried out using QualNet 5.0.1 which is scalable network simulator. Finally results obtained by scrutinized from different scenarios to provide qualitative evaluation of the protocols.

Keywords: AODV, DYMO, Energy Traffic, IPv6, Olsrv2 Niigata, OLSR Inria, RIPng , QualNet 5.0.1

1. Introduction

A MANET [1] [2] [9] consists of only mobile nodes with wireless interfaces and provides wireless lattice connectivity among them. Each node can communicate with each other directly when the two nodes are in transmission range. When the two nodes are not in transmission range, the MANET routing protocol automatically selects the next hop node to the destination node. We can introduce IPv6; the next generation internet protocol was developed as a successor to IPv4 to increase the scalability of the internet. The IPv6 protocol was developed to solve the IPv4 address exhaustion problem, so it expands the IP address space from 32 to 128 bit. Also IPv6 increases the Minimum Transmission Unit (MTU) requirement from 576 to 1,280 bytes considering the growth in link bandwidth [10] [13]. IPv6 was developed by the IETF to overcome the inadequacy of IPv4. The 128 bit address space of IPv6 is beyond anyone's imagination. According to Beijnum (2006) it is, "340,282,366,920,938,463,463,374,607,431,768,211,456" for IPv6 while there is only "4,294,967,296" possible addresses for IPv4. IPv6 was designed not only to increase the address space, but also includes unique benefits such as scalability, security, simple routing capability, easier configuration "plug and play", support for real-time data and improved mobility support. IPv6 has full support for IPSec, and IPv6 is more secure when compared to IPv4. The processing of an IPv6 packet will be more efficient than an IPv4 packet. However, that is not the only enhancement that comes with IPv6. Following is an outline of some efficiency enhancements that IPv6 brings [4]:

- IPv6 header has a fixed length
- IPv6 header is optimized for processing up to 64 bits at a time (32 in IPv4)
- IPv4 header checksum that is calculated every time a packet passes a router was removed from IPv6
- Routers are no longer required to fragment oversized packets; they can simply signal the source to send smaller packets
- All broadcasts for discovery functions were replaced by multicasts.

1.1. RANDOM WAYPOIINT MOBILITY MODEL:

Mobility models are used for simulation purposes when new network protocols are evaluated [3] [9]. The Random waypoint model is a random mobility model used to describe the movement of mobile users, and how their location changes with time. It is one of the most popular mobility model to evaluate Mobile ad hoc network (MANET) routing protocols, because of its simplicity and wide availability. Using this model, the mobile nodes move randomly and freely without any restriction i.e. the destination, direction and speed of all chosen randomly and independently of all other nodes.

1.2. Energy Traffic Model:

The Battery power consumption of the mobile devices depends on the operating mode of its wireless network interfaces. Considering a broadcast transmission between the nodes of the active network, then wireless interfaces can be assumed to be in any of the following operating modes: [6] [11] [12]

- Transmit: source to destination node packet transmitting,
- Receive: source to destination nodes packets received,
- Idle: the node is ready to transmit or receive packets,

Sleep: it is the low power consumption mode state when a node cannot transmit or receive until woken up. The rest of the paper is organized as follows; in section 2, MANET Routing Protocols and their detail steps to design and implementing a network model using QualNet. Section 3 Mobility and Energy Traffic, QualNet designed scenario discussed in section 4. and also describes how the statistics in QualNet was collected. Section 5 describes the simulation results followed by section 4. Finally section 5 concludes the research work with possible future work.

2. Manet Routing Protocols:

The routing of the information is the most challenging task due to the inherent characteristics of the wireless sensor networks like dense deployment, mobility of nodes and energy constraint. The major issues related to this are: maximizing network lifetime, minimum latency, resource awareness, topological changes, location awareness and scalability. We are taking five routing protocols such as AODV, DYMO, OLSRv2-Niigata, OLSR-Inria and RIPng for our simulation and evaluation comparison [14].

2.1. Ad-Hoc On Demand Distance Vector Protocol (AODV):

The Ad hoc On Demand Distance Vector (AODV) [7] [8] is a routing protocol which is designed for ad hoc mobile networks. AODV is capable of both multicast as well as unicast routing. It builds and maintains routes between source nodes to desired destination nodes. AODV consists of a routing table which contains next hop information with sequence number.

The protocol consists of two processes:

(i) Route discovery
(ii) Route maintenance

In route discovery process a source node broadcasts a route request (RREQ) packet across the network. While this Route Request packet propagates in the network, a reverse route to the source is established along the way. RREQ packet contains the source node's IP address, current sequence number, broadcast ID and the most recent sequence number for the destination of which the source node is aware. When this packet reaches the destination (or a node having route to the destination), a Route Reply packet is sent, in unicast, to the source node using this reverse path [9] [5]. The maintenance of routes is done only for the dynamic routes. A destination node after receiving the RREQ may send a route reply (RREP) reverse to the source node. The source node receives the RREP, and begins to forward data packets to the destination. A route is considered active as long as there are data packets intermittently travelling from the source node to the destination node along that path. Once the source stops sending data packets, the links will time out and ultimately be deleted from the intermediate node routing tables. In route maintenance process if a link breaks occurs while the route is active; the node upstream of the breaking link propagates a route error (RERR) message to the source node to inform it of the now unreachable destinations. After receiving the RERR, if the source node still requests the route, it can reinitiate route discovery.

2.2. Dynamic MANET On-demand (DYMO):

The DYMO [2] [6] [14] routing protocol enables reactive multihop unicast routing between source node to participating destination nodes. The working of DYMO is similar to AODV with small modification. The protocol also consists of route discovery and route maintenance process. During route discovery, the source node initiates broadcasting of a Route Request (RREQ) throughout the network to find a route to the destination nodes. During this hop by-hop dissemination process, each intermediate node records a route to the source nodes. When the destination node receives the RREQ, it responds with a Route Reply (RREP) sent hop-by-hop (multihop) toward the source node. Each intermediate node that receives the RREP creates a route to the target, and then the RREP is unicast hop-by- hop toward the source. When the source node receives the RREP, routes have been established between the source node and destination node In route maintenance process this protocol made two operations. In order to shield routes in use, node extends route life times upon successfully forwarding a packet. In order to reply to changes in the network topology, DYMO routers examine links over which traffic is flowing. When a data packet is received and a route for the destination node is not known or the route is broken down, then the DYMO source router is notified. A Route Error (RERR) is sent toward the source to indicate the current route to a particular destination is invalid or missing. When the source receives the RERR, it deletes the route, than the source node later receives a packet for forwarding to the same inference, it will need to perform route discovery once more for that destination.

2.3. Optimised Link State Routing Protocol (OLSR Inria)

The Optimised Link Sate Routing Protocol (OLSR Inria) [7] [13] [14] is supports the large, dense mobile networks, with high nodal mobility and topological changes. It uses periodic messages to update the topological information of the network among the respective nodes. It uses the concept of multi-point relays to calculate the route towards any source to destination in the network. The multi-point relays provide the optimal routes, and due the pro-active nature of the protocol based on link state algorithm. OLSR Inria is an optimization over a pure link state protocol as it squeezes the size of information send in the messages, and reduces the number of retransmissions. It provides optimal routes in terms of number of hops. OLSR Inria is particularly suitable for large and dense networks [12]. The functioning of the OLSR Inria protocol is based on periodically diffusing a topology control packet in the network. In OLSR Inria each node uses the most recent information to route a packet. Each node in the network selects a set of nodes in its neighborhood, which retransmits its packets. This set of selected neighbor nodes is called the multipoint relays (MPR) of that node. The neighbors that do not belong to MPR set read and process the packet but do not retransmit the broadcast packet received form node. For this purpose each node maintains a set of its neighbors, which are called the MPR Selectors of that node.

2.4. Optimized Link State Routing protocol v_2 Niigata (OLSRv2 Niigata)

OLSRv2-Niigata also supports the QualNet simulator [8]. But two features have not been yet implemented; OLSR packet fragmentation, and multiple addresses and multiple interfaces handling.

2.5. Routing Information Protocol next generation (RIPng)

RIPng is a proactive Interior Gateway Protocol based on the distance-vector algorithm [15]. RIPng is intended for use within the IPv6-based Internet. As it is a distance-vector routing protocol, it forms routing tables by exchanging routing table information with each router. There are two types of updates. One is a Regular update, which is periodically sent and contains the whole routing table information. The other is a Triggered update, which is sent when a router's routing table changes and contains only those routing entities which have been modified. When a router receives a packet, it updates its routing table and if its routing table has changed, it sends a triggered update to its neighbor router.

3. Simulation Scenarios:

We have using the QualNet 5.0.1 simulator for our analytical evaluation. In our simulation model, nodes are placed randomly within a 1500m x 1500m physical terrain area so that the average node degree for 10-100 nodes is respectively. In this scenario wireless connection of varying network size (100 nodes) for MANET is used for analytical comparison performance of routing protocol AODV, DYMO, OLSRv2-Niigata, OLSR-Inria and RIPng over it data traffic of Constant Bit Rate (CBR) is applied between source and destination. The nodes are placed randomly over the region of 1500m x 1500m. The network of size 100 nodes. The Qualnet5.0.1 simulator network simulator is used to analyze the parametric performance of all protocols defined above. We choose a square area in order to allow nodes to move more freely with equal node density. We have tested five different routing protocols and no. of different scenarios characterized by different network conditions. Each data point in the simulation graphs represent an average value obtained from 10 randomized simulation runs. The basic scenarios parameters are listed in table 1. The table 1 parameters implementing in the simulator then analyze the performance of AODV, DYMO, OLSRv2-Niigata, OLSR-Inria and RIPng routing protocols. The animated simulations of network size 100 are shown in Figure 1.The performance is analyzed with varying network size keeping energy traffic load and random way point mobility constant. The metrics are used to study the protocols Average Jitter, Throughput , Average End to End delay, percentage efficiency of total Packet received , Energy consumed in transmit mode, Energy consumed in receive mode, and Energy consumed in Ideal mode. The results are shown in from Figure 2 to Figure 8. We evaluate the performances metrics in Application and Physical layers of designed scenarios. The performance matrices are given below:

- Throughput
- Average Jitter
- End-to-End Delay
- Total Packet Received / Efficiency
- Energy Consumed in Transmit mode
- Energy Consumed in Receive Mode
- Energy Consumed in Idle Mode

Table 1. Simulation Parameters for Energy Based Performance Analysis of AODV, DYMO, OLSRv2-Niigata, OLSR-Inria and RIPng Routing Protocols

Simulator Parameters	
Mac Type	IEEE 802.11
Protocols under studied	AODV, DYMO, OLSRv2-Niigata, OLSR-Inria, RIPng
Transmission range	600m
Node movement model	Random way point, 0-5m/s, pause time 0s
Traffic type	CBR
Antenna	Omni directional
Node Speed	10m/s, 20m/s, 50m/s, 100m/s
Propagation model	Two Ray Ground
Channel Frequency	2.4 GHz
Network Protocols	IPv6
Scenario Parameters	
Number of nodes	10 to 100
Topology area	1500x1500
Packet size	512
Item to send	100
Simulation time	30 Seconds
Battery Charge Monitoring Interval	60 Sec.
Full Battery Capacity	1200 (mA,h)
Performance Matrices in Application Layer	Average Jitter, End to End Delay, Throughput, Total Packet received
Performance Matrices in Physical Layer	Energy consumed (in mjules) in transmit mode Energy consumed (in mjules) in received mode Energy Consumed (in mjules) in ideal mode
Energy model Parameters	
Energy Model	Mica motes
Energy Supply Voltage	6.5 Volt
Transmit Circuitry Power Consumption	100.0 mW

Receive Circuitry Power Consumption	130.0 mW
Idle Circuitry Power Consumption	120.0 mW
Sleep Circuitry Power Consumption	0.0 mW
Energy Model Specifications	
Initial Energy (Joules)	15
Transmission Power (Watt)	1.4
Receiving Power (Watt)	1.0
Idle Power (Watt)	0.0

Scenario designed for AODV, DYMO, OLSRv2-Niigata, OLSR-Inria, RIPng with Varying Network Size (10-100). The parameters of Table 1 deployed in QualNet simulator assigned in 10-100 nodes sources are randomly distributed over a 1500m x 1500m area. The maximum speed varies from 1 to 21 m/s. Pause time is set at 5 sec. Consequently, most nodes move at all times.

3.1. Snapshot of Simulation

The simulations of energy traffic model were performed using QualNet Simulator 5.0.1, the traffic sources are CBR (continuous bit rate). The source-destination pairs are multiplying randomly over the network. During the simulation, each node starts its journey from a source node to destination node. This process repeats throughout the simulation, causing continuous changes in the topology of the underlying network. Fig.1 Shows the running simulation of snapshot when we applying CBR (1 - 20) nodes and DYMO routing protocol.

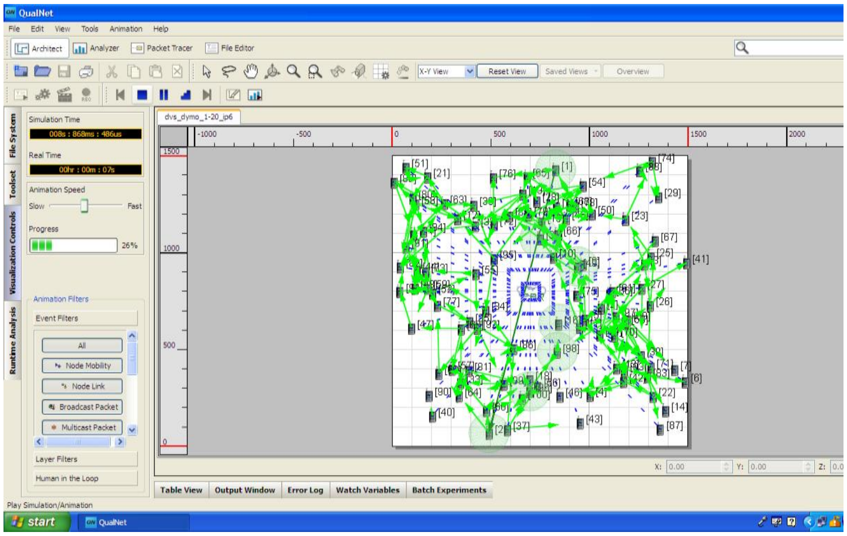

Figure1. Snapshot of QualNet Animator in action for applying DYMO protocol using 100 nodes.

4. Results & Analysis

4.1. Analysis and impact of Throughput (Bits/s):

The throughput of the protocols can be defined as successful average rate of data packets received at its destination among the packets sent by the source. Throughput of all protocols decreases when the size of network increases. The throughput is measured in bits per second (bit/s or bps). For better system performance the number of bits per sec must be high.

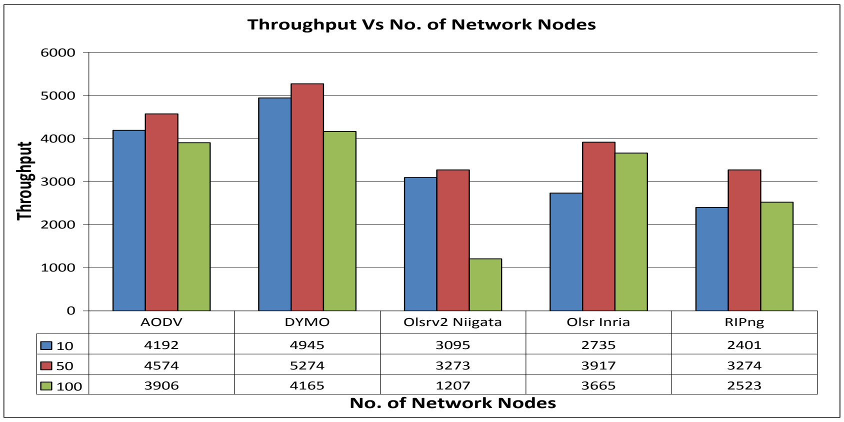

Figure.2 shows the impact variation of throughput for various routing protocols which considered for Ipv6 as parameter in application layer.

It has observed in Fig.2 that the throughput of DYMO is better than AODV & OLSRv2-Niigata, OLSR-Inria and RIPng whereas the performance of DYMO is better than others.

- DYMO, AODV, Olsr Inria, Olsrv2 Niigata, And Ripng Are Having Minor Degradation.
- By Observation The Throughput Is Maximum For DYMO Which Is Respectively By AODV, Olsr Inria, Olsrv2 Niigata, And RIPng for Ipv6. RIPng gives the minimum throughput for Ipv6 network.

4.2. Analysis And Impact Of Average Jitter (S):

The discrepancy in Jitter which is caused due to obstruction by network, timing drift, route changes, topology change etc. in a network. Low value of jitter provides the better performance of any protocol. This includes all possible delays caused by buffering during route discovery.

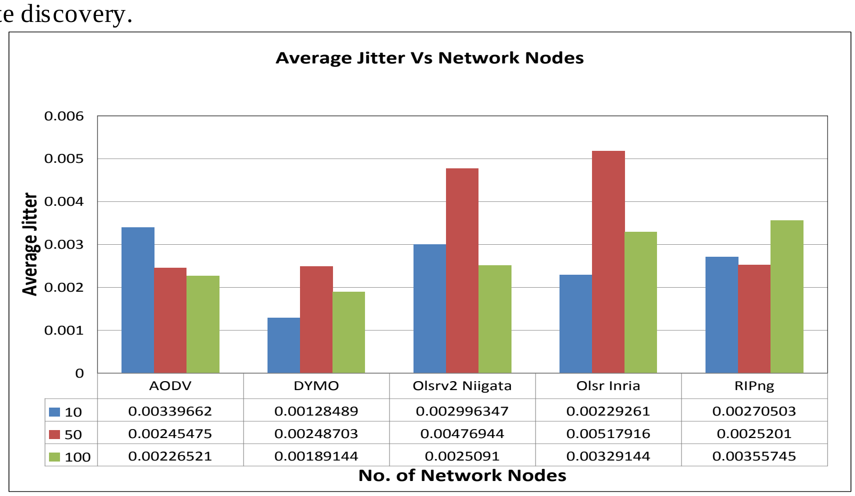

Figure 3. Shows the impact variation of average jitter for various routing protocols which considered for Ipv6 as parameter in application layer.

- DYMO shows the constant least jitter when mobility is restricted to only 60 nodes.
- By observation the Jitter is maximum for Olsrv2 Niigata which is followed by AODV, RIPng, Olsr Inria and Olsrv2 Niigata and DYMO. DYMO gives the minimum jitter for Ipv6 network.
- Olsr Inria gives an average amount of jitter.

4.3. Analysis of Average End-to-End Delay (AE2ED):

The successful data packet delivered and divides that sum by the number of successfully received data packets. The average time taken in delivery of data packets from source to destination nodes.

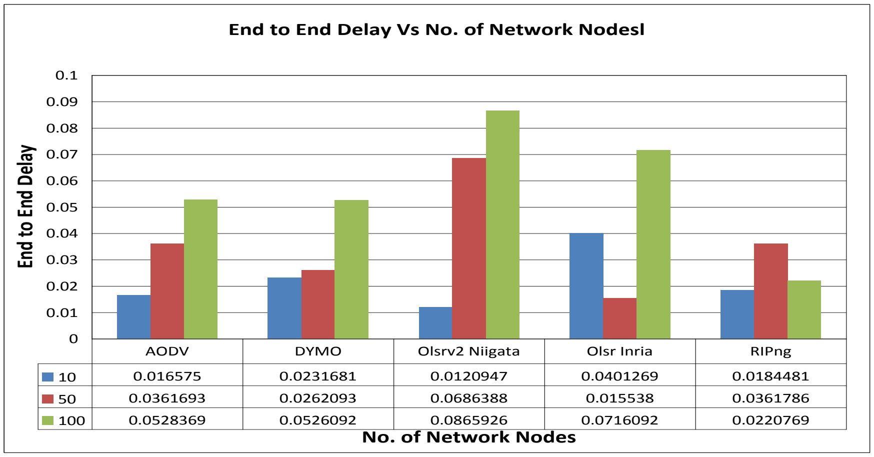

Figure 4. Shows impact variation of Average End to End Delay for various routing protocol as parameter Ipv6 network.

- By observation the Average End to End Delay is maximum for Olsrv2 Niigata which is followed by Olsr inria, AODV, DYMO then RIPng. RIPng gives the minimum average End to End delay for Ipv6 energy model.

4.4. Total Packet Received/Efficiency :

Ratio between the data packets received from to the destination and those generated by CBR sources. This evaluates the ability of the protocol to discover routes and its efficiency.

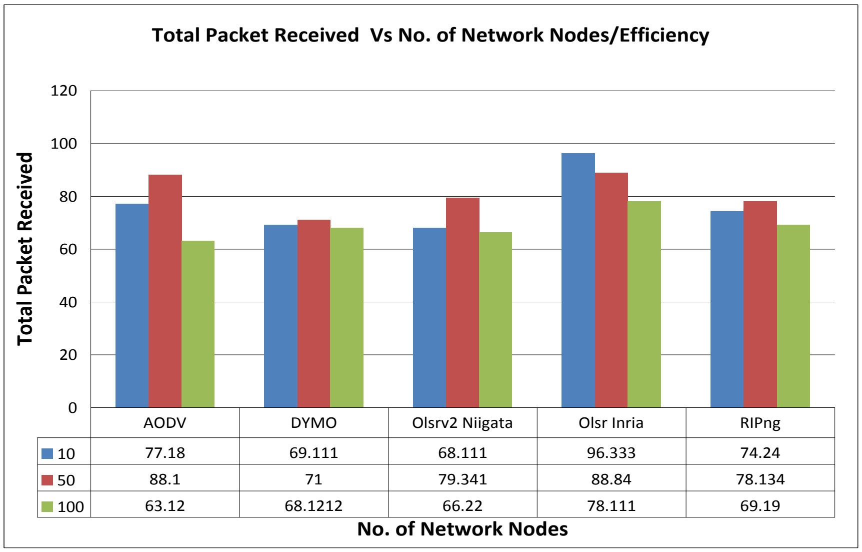

Figure 5: Comparison of Routing protocol with varying network size in effect to Total Packet Received in Application Layer

- By observation of Fig.5 the Total Packet Received in Ipv6 is maximum for Olsr inria which is followed by Olsrv2 Niigata, AODV, DYMO then RIPng. RIPng protocol received the minimum packets for Ipv6 in application layer.

4.5. Analysis And Impact Of Energy Consumed In Transmit Mode:

The mobility, efficiency, scalability, response time of nodes, lifetime of nodes, and effective sampling frequency, all these parameters of the MANET depend upon the energy. In case of power failure the network goes down break therefore energy is required for maintaining the individual health of the nodes in the network, during transmission of data as well receiving the packets.

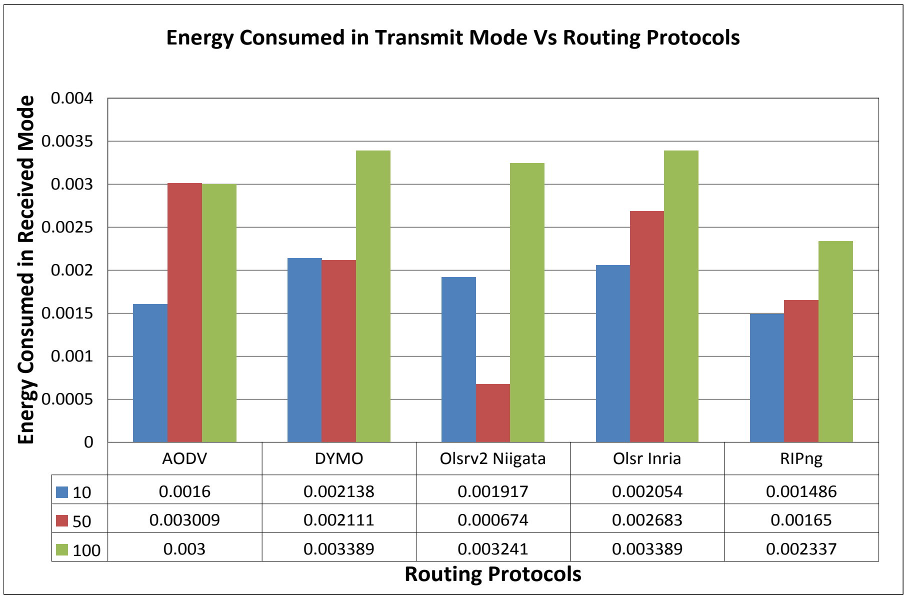

Figure 6. Shows the impact variation of Energy consumption in transmit mode with different routing protocols

Fig. 6 shows the total energy consumed (Joules) by all the nodes while varying the number of nodes in the network connection by (10-100). The routing packet is increased which impacts that energy consumption also increased of all protocols in Ipv6 network. AODV performed better than all other protocols due to route cache.

- By observation from graph the maximum energy consumes by AODV, followed by DYMO, Olsr inria , Olsrv2 Niigata and RIPng. RIPng consumes the minimum power in transmit mode for Ipv6 networks.

4.6. Analysis and impact of energy consumed in receive mode:

The mobile ad-hoc network routing protocol efficiency depends upon the energy of network. If more power failure then efficiency of network goes down therefore energy consumption in received mode is required for maintaining the efficiency of the nodes in the network, during transmission of data as well receiving the packets.

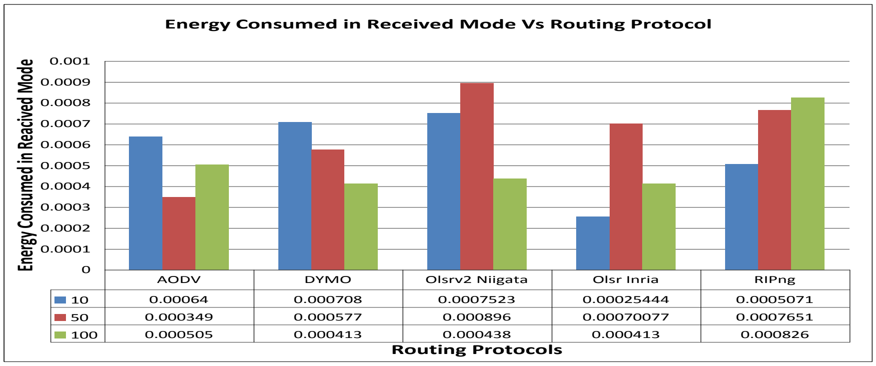

Figure .7 shows the impact variation of Energy consumption in receive mode with different routing protocols.

- By observation from graph the maximum energy received by AODV which is followed by DYMO, Olsr inria, RIPng than Olsrv2 Niigata in Ipv6 network.

4.7. Analysis and impact of energy consumed in ideal mode:

The energy consumption in idle mode that there is maximum consumption in AODV followed by Olsrv2 Niigata, DYMO, Olsr inria than RIPng.

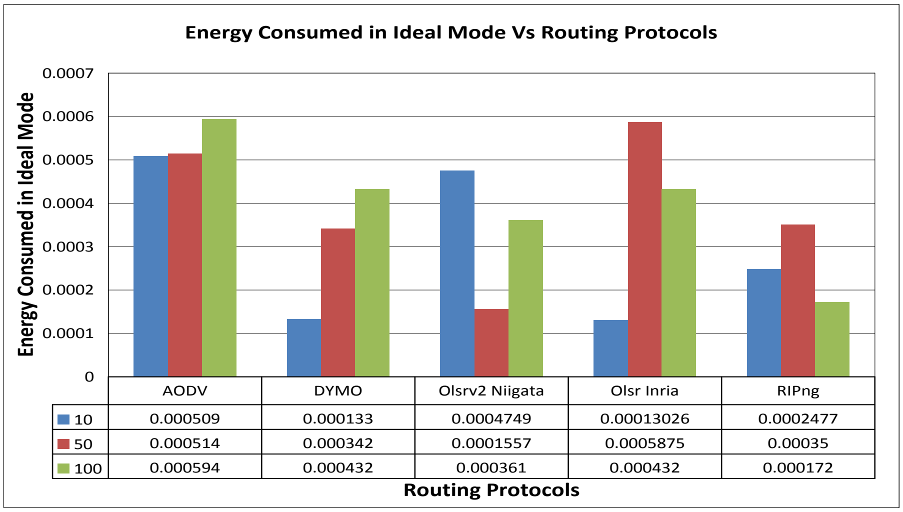

Figure 8. Shows the impact variation of Energy consumption in ideal mode with different routing protocols.

- By observation we are considering the energy consumed in idle mode AODV consumed more and RIPng consumes very less in idle mode but in the case of Olsrv2 Niigata , it is consumes in between DYMO and Olsr inria in Ipv6 network.

5. Conclusion

In this paper we have made a comparison between five different types of routing protocols in Ipv6 network i.e., AODV, DYMO, Olsrv2 Niigata, Olsr inria and RIPng. These results of comparison are very much useful for researcher to be implemented in professional purposes. We are observed that route maintenance and route construction mechanisms have much effect on protocol performance in Ipv6 network. The above graphical simulation results showed that the OLSR inria throughput is almost the same as the OLSRv2 Niigata packet throughput. Both take a different path as if the network topology is same Ipv6 network. We simulate and analyzed energy model comparison and impact shown in above graphs. As far as we can conclude, the performance of DYMO and Olsr inria was promising in almost all scenarios but with a high end-to-end delay varying between (10 to 50) nodes. AODV was the third best performing protocol but resulted to be more sensitive than the others to network size and traffic load. AODV performance is not much affected by mobility. Olsrv2 Niigata is the route maintenance mechanism does not locally repair the broken links which results in initiating another route discovery, which introduces extra delays with more routing overhead. We can conclude that Olsr inria is more reliable and more adaptable to changing network conditions in Ipv6 network. As mobility increases, the average end-to-end delay decreases. For future work we can next perform using QualNet simulator taking all above Manet routing protocols AODV, DYMO, Olsrv2 Niigata, Olsr inria and RIPng using Dual IP (Ipv4 and Ipv6) taking all performance matrices parameters same.

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