PERFORMANCE COMPARISON OF DIFFERENT ROUTING METRICS ON AODV AND DSR UNDER VARYING CONDITION OF NODE IN WIRELESS MESH NETWORK

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Abstract: Routing metric always plays a key issue in performance of wireless mesh network. Utilizing the routing metric for efficient communication is always a skilled work to be done. Wireless mesh network always have its advantages to be used for forwarding the network traffic. We have examined some of the routing metrics and compared the performances under varying conditions for finding out the comparative analysis of routing protocols.

Keywords: AODV, DSR, Routing Metric, Wireless Mesh Network.

Introduction: Mesh networks are made up of three types of nodes they are gateways (access points), mesh routers, and mesh clients [1]. Gateways enable the integration of WMNs with various other networks along the Internet. Dedicated devices providing stable high throughput for mesh clients, the mesh routers have minimal mobility and form the mesh backbone. In order to further improve the flexibility and capacity of WMNs, the mesh routers are often equipped with multiple wireless interfaces. As a result, two transmissions of two nearby pairs can be simultaneously scheduled if non-overlapping channels are assigned.

In general wireless networks were operating with a single radio, thus the cost is low and will increase by increased number of radio. Different methods were proposed by different researchers aimed to improve the network throughput, for single-radio wireless mesh networks. In this paper, we analyze the performance of wireless mesh networks in different conditions with different channel assignment schemes. We look at new ways to try and improve the network throughput in wireless mesh networks.

Performance Challenges in WMN: The routing protocol is an important factor in any network, but in WMNs it can mean the difference between success and failure. The challenges in WMNs are summarized below:

Scalability/Efficiency: If the routing protocol has a high overhead and requires global information, it will be impossible to scale it to a large number of nodes.

Reliability: The routing protocol should be able to reroute fast around failed nodes, broken links, and upon the failure of a gateway it should be able to redistribute the orphaned clients among neighboring gateways. For this property, fast reconfiguration and support of multiple gateways is essential.

Mobile User Connectivity: To ensure seamless mobile user connectivity, the routing protocol should enable fast hand-offs.

Flexibility: The routing protocol should be flexible and adapt to different network topologies.

Quality of Support: In addition to support from the MAC layer and/or the forwarding engine, selecting the best routes for different traffic classes is an essential ingredient for Quality of Support (QoS) support.

Characteristics of Routing Metrics and Routing Protocols for WMN: Some of the desirable characteristics of a good routing metric for WMNs, that is, some of the criteria routing metric needs to address [4].

A. **Interference:** Interference in a mesh network can be of three types
   - *Intra-flow Interference:* It occurs when the radios of two or more links of a single path or low operate on the same channel
   - *Inter-Flow Interference:* It is caused by other lows that are operating on the same channels and are competing for the medium.
   - *External Interference:* It occurs when a link experiences interference outside of the control of any node in the network.

B. **Locality of Information:** Some metrics require information such as channels used on previous hops of a path, or other metrics observed on other nodes of the networks, such as packet delivery rate or noise levels.

C. **Load Balancing:** The ability of a metric to balance load and provide fairer usage of the networks distributed resources.

D. **Agility:** The agility of a metric refers to its ability to respond quickly and efficiently to changes in the network in terms of topology or load.

E. **Isotonicity:** It means that a metric should ensure that the order of weights of two paths is preserved if they are appended or prefixed by a common third path.

F. **Throughput:** In general, a metric should be able to select routes with greater throughput consistently.

Routing Protocols for Wireless Mesh Networks: In order to have a better understanding of the routing metrics, in this section, we describe three different routing protocols in which routing metrics are incorporated in wireless mesh networks to find best possible paths [5].

A. **Destination Source-Routing Protocol (DSR) [6]:** DSR is an on-demand routing protocol that is based on concept of source routing. In source routing algorithm, each data packet contains complete routing information to reach its destination. Nodes are required to maintain route caches that contain source routes of which the node is aware. DSR has route cache to maintain route information to the destination. Route maintenance is done through the use of route error packets and acknowledgments. Main disadvantage of DSR is it has increased traffic overhead as it contains complete route information in each of its data packet. This degrades DSRs routing performance.

B. **Ad-hoc On-demand Distance Vector Routing Protocol (AODV) [8]:** AODV is a reactive on-demand routing protocol which builds on both DSR and DSDV. AODV is an improvement on DSDV because it minimizes the number of required broadcasts [7]. It is also an improvement on DSR as a node only needs to maintain routing information about the source and destination as well as next hop,thereby largely cuts back the traffic overhead. The process of route discovery is similar to DSR. Route request (RREQ) packets are broadcasted for route discovery while route reply (RREP) packets are used when active routes towards destination are found. HELLO messages are broadcasted periodically from each node to its neighbors, informing them about their existence.

Routing Metrics for Wireless Mesh Networks [5]:

Hop Count: Hop count is the traditional routing metric used in most of the common routing protocols like AODV, DSR, DSDV designed for multi-hop wireless networks. It finds paths with shortest number of hops.

ETX: Expected Transmission count ETX [9] is defined as the number of transmissions required to successfully deliver a packet over a wireless link. Pf be the packet loss probability in forward direction and Pr is the packet loss probability in the reverse direction. Then P denote the probability as

$$P = (1 - P_f).(1 - P_r) \qquad [1]$$

The Expected number of transmissions to successfully deliver a packet in 1 hop can be expressed as

$$\mathrm{ETX} = \sum_{k=1}^{\infty} xp^{x}(1-\mathrm{p})^{x-1} = \frac{1}{1-\mathrm{p}}\,.\mathrm{ETX} \qquad [2]$$

is measured in link of a real network by $ETX = \frac{1}{D_f * D_r}$, where Df is the forward delivery ratio (1-Pf), Dr is the reverse delivery ratio (1-Pr).

ETT: The Expected transmission time (ETT) [10] metric is an extension of ETX which considers different link routes or capacities. ETT is expected time to successfully transmit a packet at the MAC layer and is defined for a single link as

$$ETT = ETX * \frac{S}{B} \qquad [3]$$

S denotes the average size of packet and B denotes current link bandwidth

PDF: PDF or goodput is the ratio of TCP packets successfully delivered to the total number of TCP packets transmitted(which includes retransmitted packets)

$$\mathrm{PDF} = \frac{\text{Total number of TCP packets received}}{\text{Total numberof TCP packets transmitted}} \qquad [4]$$

$$TCP <= 1 \quad (always)$$

When the number of nodes are more, when route discover is initiated, the larger number of replies cause overhead. i.e. PREQ +HELLO msgs + RREP

Simulation and Result: The simulation was carried out in Network Simulator (NS-2) [11]. To use it, we need to define few simulation parameters as mentioned in following table I.

Parameter	Value	Description
Channel	Channel/Wireless Channel	Channel type
Propagation Type	Depends on scenario	Wireless Ray Controller
Routing protocol	AODV/DSR	Protocol responsible for routing the data throughout network
MAC Protocol	Mac/802_11	Medium Access Control Protocol
Link Layer Type	LL	Link layer type
Interface Queue Type	Queue/DropTail/PriQueue	Priority queue implementation.
Interface Queue Length	50	Interface queue buffer length
Antenna Type	Antenna/OmniAntenna	Omni directional antenna

Table I. Simulation parameters

The results are analyzed and discussed in different scenarios having network size of four, eight, sixteen, thirty two and sixty four mobile nodes for monitoring applications. These different networks having mobile nodes represent monitoring applications in WMN. In the first scenario, the performance evaluation of the AODV and DSR is performed with Avg. hop count parameter. After this same procedure is repeated for the other parameter like E2E, Throughput and PDF.

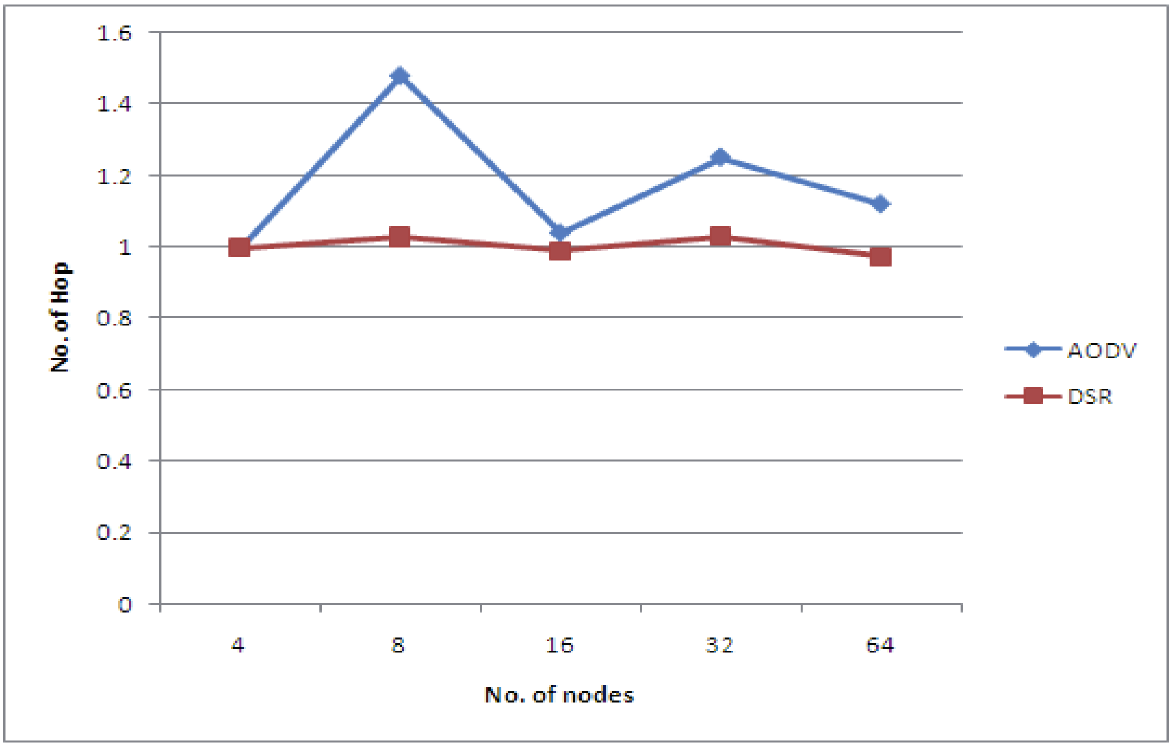

Fig a: Average hop count

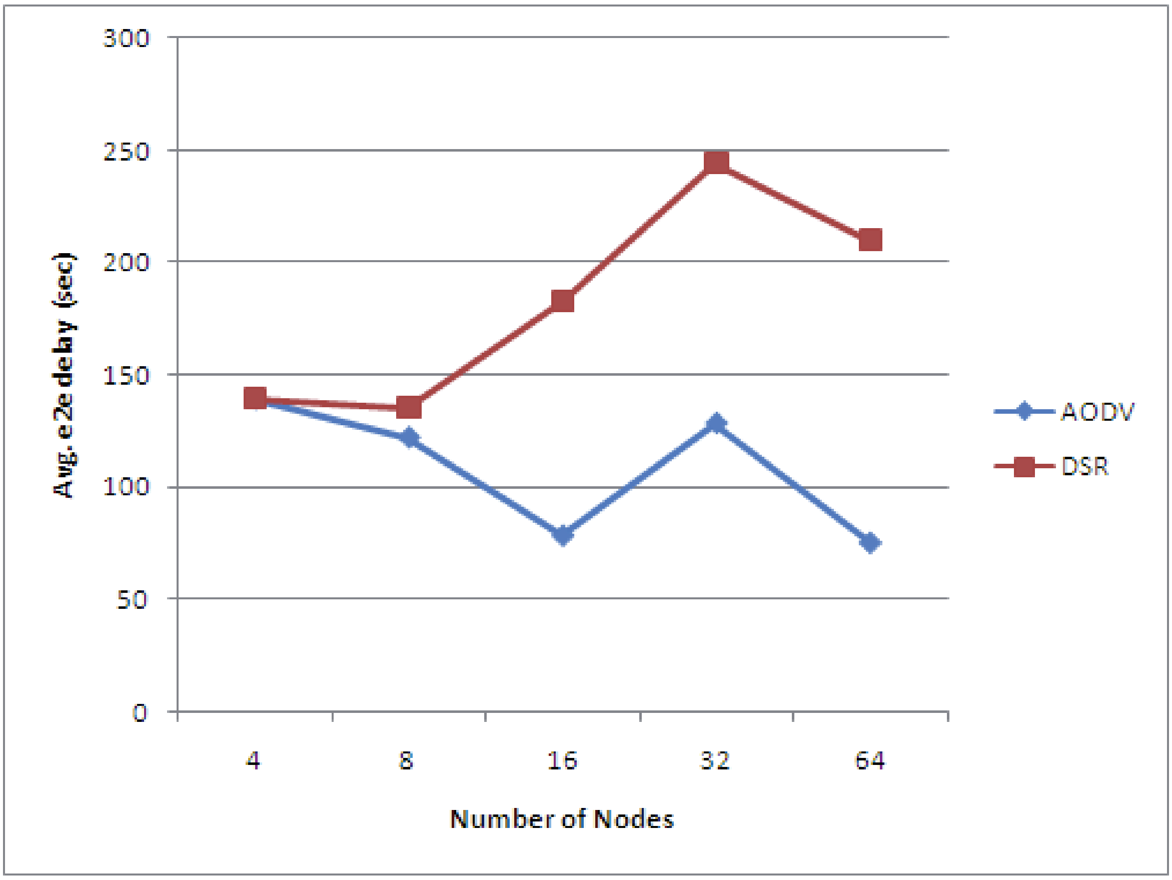

Fig b: E2E delay

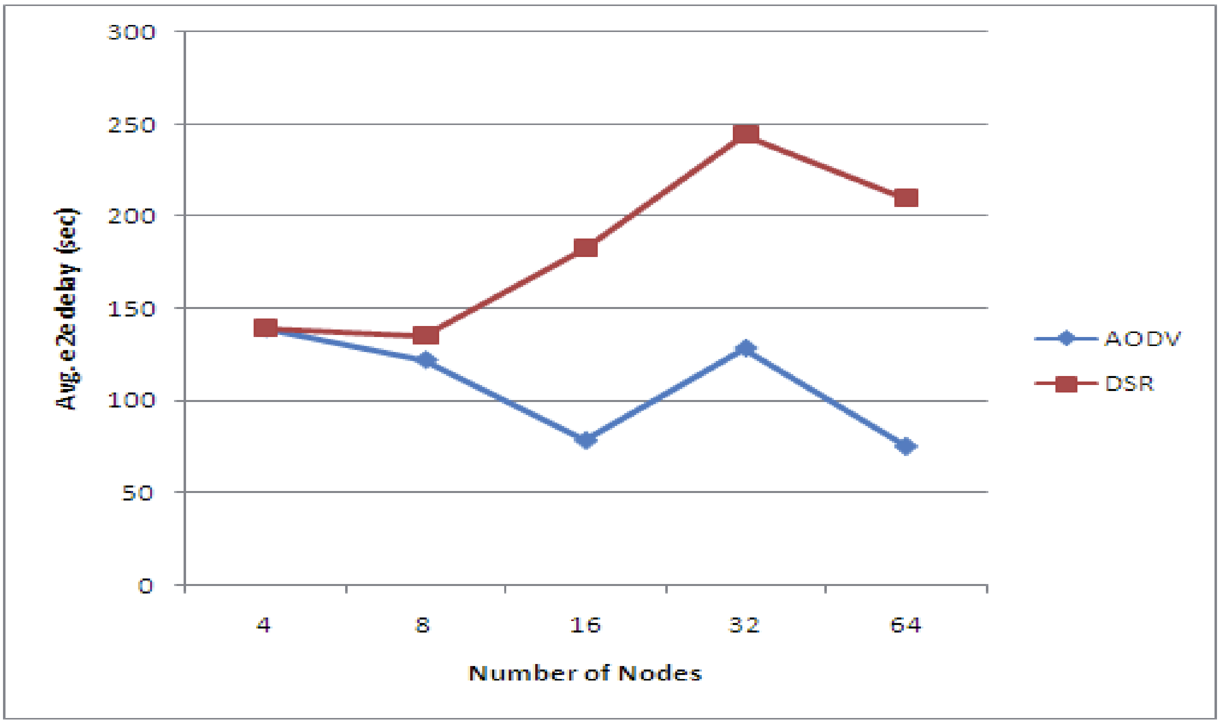

Fig c: Throughput

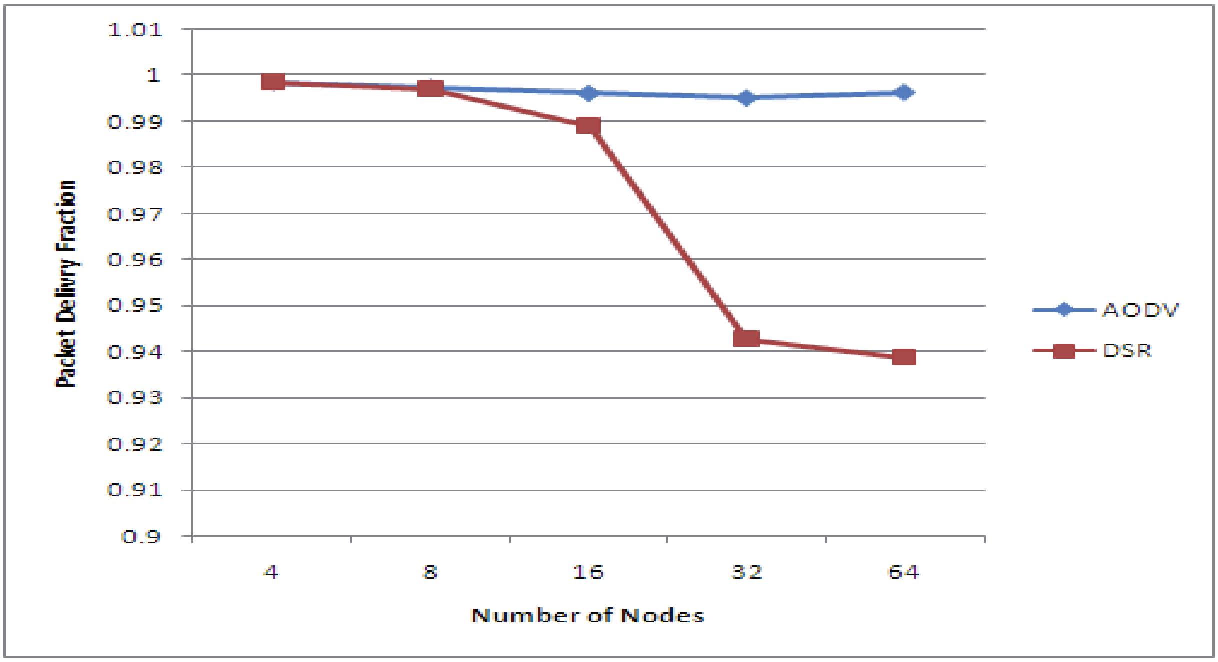

Fig d: PDF

Above figures shows that the packet delivery ratio for DSR it is less when compared to AODV and we see that it is fairly stable even with increased number of sources. A relatively stable normalizes routing load is a desirable property for scalability of the protocols. We find that major contribution to AODV routing overhead is from route requests, while route replies constitute a large fraction of DSR routing overhead. By virtue of aggressive caching, DSR is more likely to find the route in the cache and hence the route discovery process occurs less frequently than AODV and hence the routing overhead for DSR is less when compared to AODV.

The below table briefly show the difference between the DSR and AODV protocol considering different performance metric for different sizes of networks which we have shown earlier in the form of graphs.

Protocol	Metric	Small Network	Large Network	Very Large Network
DSR	E2E delay	139.313 ms	182.306 ms	209.964 ms
	Throughput	884	619	727
	Avg hop count	0.998118	0.989677	0.97416
	PDF	0	33	133
AODV	E2E delay	139.413 ms	78.8567 ms	75.672 ms
	Throughput	885	1515	2068
	Avg hop count	0.997744	1.03817	1.11963
	PDF	0	1565	4681

Table II. Comparison of DSR and AODV

Conclusion and Future Direction: This paper presented an overview of routing metrics specifically designed for wireless mesh networks. In wired networks hop count becomes the most attractive solution. In wireless network the minimum hop metric tends to select paths with slow links. As a result, these paths have low effective throughput and increase total network congestion. In addition, these paths are likely to contain long links that result in low reliability.

Our future work is to find a new routing metric and to investigate the performance of all of the existing routing metrics in real mesh network environment based on actual hardware measurements.

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