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On the Improved Distance Vector Routing Protocol for UDP Traffic

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Abstract

The idea of Mobile Ad-Hoc Networks is to support communication where readily available infrastructure is missing. Nodes are expected to forward each other messages to the final destination within a decentralized environment. In mobile communication, finding the best routing path is always been a problem. DSDV protocol is well-known for its packet dropping problem in the event of link breakages. Whereas, IDSDV protocol as its popular enhancement, assigned to address this specific issue. But, this also gives rise to a question whether IDSDV does not degrade other performance parameters of DSDV. In this paper, we investigate the performance of IDSDV against DSDV specific for UDP traffics, for parameters such as average end-to-end delay, routing overhead and normalized routing load. Simulation result reaffirms that IDSDV has to some degree resolved the stale route problem within DSDV. Moreover, IDSDV outclasses DSDV in most aspects notably within highly density and dynamic environment.

Keywords: MANET, performance, routing, proactive, UDP

1 Introduction

The idea of wireless communication is dated back to the late 20th century and credit is due to Tesla and Marconi. In wireless communication, information is transmitted from one place to another using electromagnetic waves. The initial breakthrough occurs in the early of 21st century with the deployment of radio and later TV broadcasting.

The need for bidirectional wireless communication gave birth to the cellular network that supports voice communication between mobiles phones. Originally based on analogue system, it slowly embraces into digital system in order to better support rapid growth of cellular market. Another side of wireless communication is the interconnection of computers to support data transmission through wireless local area networks. Nonetheless, these wireless networks require certain equipment such as access point or base station in order to operate and therefore is pronounced as infrastructure-based networks.

However, there is another type of wireless (local) network known as *ad-hoc* network that supports communication between mobile devices without the aid of any fixed infrastructure and thus labeled as infrastructure-less network. Within this network, the devices are free to move at any speed in any direction and organize themselves randomly. Each device acts not only as a source or destination node but also an intermediate node, in charge of forwarding neighboring packets to destination in peer-to-peer mode using multi-hop routing. For this, every node must be able to route packets. Since nodes are able to enter and leave the network as wished, the network is considered having a dynamic topology. Any changes in topology must be made known to the other nodes so that routing information can be updated. Nodes are also allowed to move at any speed and thus the network is considered as highly mobile.

Since there is no supporting devices involves, mobile ad-hoc network (MANET) is a low cost network with high flexibility. However, high mobility causes battery life reduction and high bandwidth consumption. Some applications of MANET are during military operation and rescue/emergency operation.

The mobility behavior of nodes renders classical routing protocols incompatible for MANET. A new set of protocol is needed to operate within dynamic and mobile environment. A good routing protocol should have the characteristics of being decentralized, self-organisable and self-healing. Moreover, it should be adjustable under bandwidth constraint and multi-hopping environment.

By looking from different angles, routing algorithms are categorized based on network configuration, routing strategy (proactive or reactive), geographical location, multi-casting, hierarchical and so on. Different algorithms are meant to tackle unique challenges posed by MANET.

Based on routing strategy, there are two different approaches, proactive (table driven) protocol and reactive (on-demand) protocol. Numerous comparative studies on the proactive and reactive protocols undertaken [1, 2], reported that reactive protocols perform better than the other, but that only under certain conditions.

Although every protocol has its own advantages, in this study we focus on proactive protocols. Various protocols fall under this category such as DSDV, OLSR, CGSR, WRP [3]. But we limit our interest to DVDV and its variation, IDSDV. In this paper, we measure the degree of improvement introduced by IDSDV over DSDV for various performance metrics over UDP traffic.

The remainder of this paper is organized as follows: Section II provides materials for background studies and the methodology for this research. Section III presents the simulation result with logical explanation as to why it so happens. Section IV concludes the findings from this research.

2 Materials and Methods

In wireless communication and specifically MANET, the study of routing protocol is always tied up to the behavior of mobile nodes and the properties of packets generated by applications.

The behavior of mobile nodes can be described by a mobility model. Random Way Points Mobility is a model that is frequently used for assessing the performance of routing protocols due to its simplicity. In this model, the starting and destination points of nodes are uniformly distributed. It works by randomly selects its destination and travels in a straight line at a constant speed. On arrival, it stays stationary for a specified pause time before continuing with another journey, and this process takes place throughout the whole simulation.

Adapted from classical Bellman-Ford algorithm, a destination-sequenced distance-vector (DSDV) algorithm [4] was developed to handle the limitations experienced by MANET such that to support infrastructure-less, multi-hops environment. DSDV uses a routing table that is updated constantly in order to maintain path to destination. One drawback of DSDV is its inability to tackle stale route problem in the event of broken links.

For this, improved-DSDV (IDSDV) was developed that is for finding an alternate route to replace the one via the broken links. In such event, packets are routed via a newly discovered path. Earlier studies show that IDSDV has successfully overcome the packet dropping problem [5, 6, 7]. But a question arises whether IDSDV does not degrade other performance metrics. Further down, is the improvement covers for different traffic patterns.

A study on DSDV in relation to traffic patterns was conducted and the result was intermixed, in general TCP traffic outperformed UDP traffic [8, 9]. Moreover, TCP load is much efficient in high mobility environment while UDP is suitable for less mobility environment.

Recently, another study was conducted to determine whether the improvement brought by IDSDV over DSDV specific for TCP traffic is comprehensive [10] enough such that we could totally agree on the betterment brought by IDSDV. Simulation shows that IDSDV outclasses DSDV in routing overhead metric, but for others the result is intermixing and no concrete conclusion can be drawn. In this paper we proposed a continuity study on the possible improvement brought by IDSDV over DSDV but specific for UDP traffic. UDP is known to be a non-reliable data carrier still it provide faster and more efficient delivery than TCP. We examine how the properties of UDP traffic affect the performance metrics in MANET.

The study is conducted using NS-2 environment. The simulation is performed by varying one of the three parameters; number of nodes in the environment, node's pause time between journeys and node's speed during travelling. For each scenario, we measure the four performance metrics, for both routing protocols DSDV and IDSDV from where comparison is can be made.

- Packet delivery fraction (PDF) – the ratio of the number of data packet received at the destination to the number of packets sent by the source.
- Average end to end delay (AE2ED) – the ratio of the time taken for each data packet that successfully travels from a source to a destination to the total data packets received.
- Routing Overhead (RO) – The number of control packets produced during data packets transmission. Control packet includes route request, replies and error messages.
- Normalized Routing Load (NRL) - The ratio of the number of control packets transmitted for every data packet received at the destination.

The detail for each of the three scenarios is given by Table 1, Table 2 and Table 3 respectively.

Table 1 Simulation Parameter for Various Numbers of Nodes

Performance Matric Evaluated	**Packet Delivery Fraction** **End-to-End Delay** **Routing Overhead** **Normalized Routing Load**
Various Number of Nodes	5, 10, 15, 20, 25, 30, 35, 40, 45 and 50
Packet size	1400 Bytes
Area size	1000 X 1000 flat area
Node Speed	Fixed 20 ms
Mobility Models	Random Way Point
Pause time	0
Simulation time	400 seconds

Table 2 Simulation Parameter for Various Pause Time

Performance Metric Evaluated	**Packet Delivery Fraction** **End-to-End Delay** **Routing Overhead** **Normalized Routing Load**
Various Pause Time	0, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750 and 800
Simulation time	400 sec
Number of Nodes	20 nodes (Fixed)
Packet size	1400 Bytes
Area size	1000 X 1000 flat area
Node Speed	Fixed 20 ms
Mobility Models	Random Way Point

Table 3 Simulation Parameter for Various Node Speed

Performance Metric Evaluated	**Packet Delivery Fraction** **End-to-End Delay** **Routing Overhead** **Normalized Routing Load**
Various Node Speed	10, 20, 30, 40, and 50 ms
Simulation time	400 sec
Number of Nodes	30 nodes (Fixed)
Pause time	0
Packet size	1400 Bytes
Area size	1000 X 1000 flat area
Transmission range	250 m
Mobility Models	Random Way Point

3 Results and Discussion

In this section, we simulate and compare the performance of IDSDV against DSDV for UDP traffic. For the purpose of increasing the accuracy, each scenario is repeatedly simulated to obtain an average result.

A. Number of Nodes

This test is conducted by varying the node density, whereas node pause time and node speed are fixed to some values. The effect of an increase in the number of nodes would be an increase in the possible number of breakages and an increase in the number of receiving packets for some nodes.

Packet Delivery Fraction**:** From Figure 1 we observe that the performance for both IDSDV and DSDV is high at low density and gradually degraded as nodes increases. Whenever we increase the number of nodes, the number of breakages is also increases. More breakage causes even more packets dropped. The performance of IDSDV is significantly better than DSDV as a result of solving the stale route problem.

Average End-to-End Delay**:** From Figure 2 we found that an AE2ED for both protocols is up-trending. More breakages means more packets stays in a queue, and when the limit has been reached, those packets will be discarded. Nonetheless, the IDSDV outperforms DSDV due to an ability of IDSDV to reduce the number of packet delivery failure which in turn reduce the queuing time for packets within the buffer to the maximum value before get discarded.

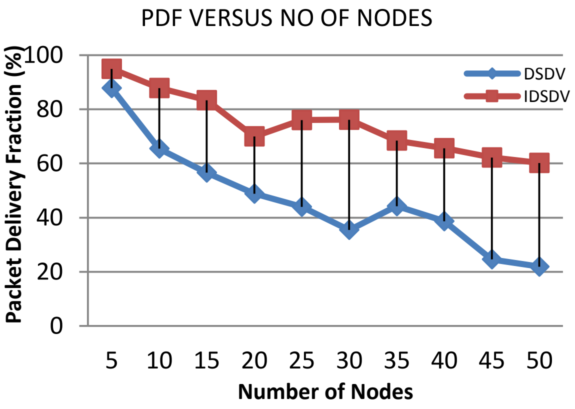

Figure 1: Packet Delivery Fraction Vs Number of Nodes

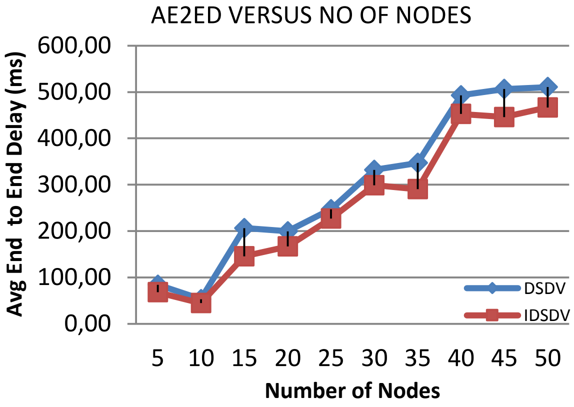

Figure 2: Average End to End Delay Vs Number of Nodes

Routing Overhead: Figure 3 shows there is a consistency for both protocols with slight increases in RO as the network becomes denser. Moreover, the performance of DSDV is slightly better at the beginning but when the number of nodes increases beyond 30, the IDSDV starts to overtake. As more nodes are introduced, the searching of alternative route becomes easier for IDSDV. The RO for DSDV is mainly contributed by periodic routing updates. Although in case of link breakage, IDSDV automatically updates the route and therefore increases the period for every update.

Normalized Routing Load: Figure 4 shows a sharp increment in NRL for DSDV. This effect is due to an increase in RO (Figure 3) and sharp decrease in PDF (Figure 1). Nonetheless, for IDSDV, there is a slight increment for NRL due to a slow increment in RO (Figure 3) which is almost balanced by PDF (Figure 1).

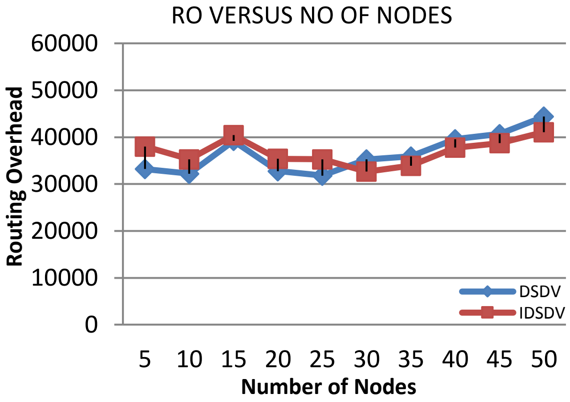

Figure 3: Routing Overhead Vs Number of Nodes

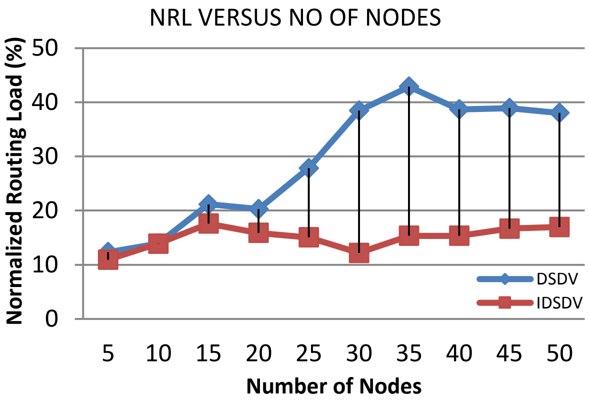

Figure 4: Normalized Routing Load Vs Number of Nodes

B. Pause Time

This test is conducted by varying the pause time for each node, by fixing the number of nodes and node speed to some values. The effect of an increase in the pause time would be a decrease in the possible number of breakages and an increase in the number of receiving packets for some nodes.

Packet Delivery Fraction**:** Figure 5 shows an incremental trend for both protocols. An increase in pause time is closely related to less number of possible breakages. Therefore, less data packets will be dropped for both protocols. IDSDV outperforms DSDV in that it delivers an average of more than 80% packets, an increase of 15% over DSDV, as a result of no stale route problem.

Average End-to-End Delay**:** Figure 6 shows the constant decrement in AE2ED for both protocols. Whenever nodes stay longer between two journeys, the environment experiences less number of breakages and therefore, packets remains in the queue for shorter time. IDSDV exhibits longer AE2ED all the time regardless to node pause time comparing to DSDV. IDSDV uses a new message exchange scheme to create new loop-free route to destination when link breaks, and buffered data packets are transmitted through the new route, its average end-to-end delay ascends due to the longer transmission time of buffered data packets.

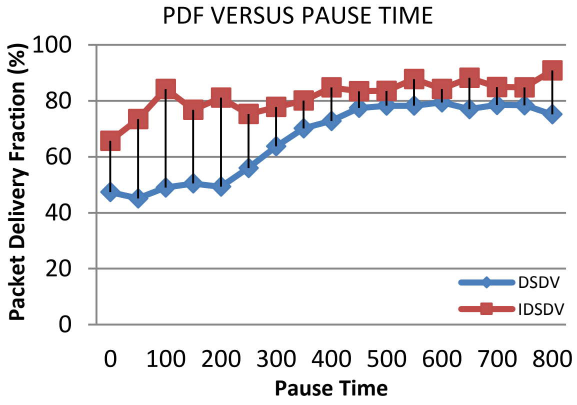

Figure 5: Packet Delivery Fraction Vs Pause Time

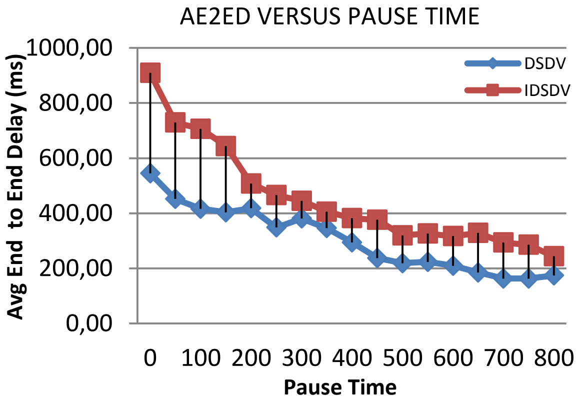

Figure 6: Average End to End Delay Vs Pause Time

Routing Overhead**:** Figure 7 shows the overheads for both protocols is down-trending. This is very much related to what happen to AE2ED. With more pause time, less number of breakages is expected, and therefore lesser routing packets will be triggered. Throughout, IDSDV produces more routing overhead compare to DSDV, this may be the result of IDSDV tries to rebuild the invalid routes via exchanging message in local area when link breaks. Due to this, the frequency of periodic routing update is shortened, and therefore increases the number of routing packets.

Normalized Routing Load**:** Figure 8 shows a downtrend in NRL for IDSDV as a result of slow decrease in RO (Figure 5) coupled with the even slower increase in PDF (Figure 7). For DSDV, the NRL experience a sharp decrease at the very beginning but regain upward momentum afterward. This is due to a slow decrease in RO (Figure 5) but with a sharp increase in PDF (Figure 7).

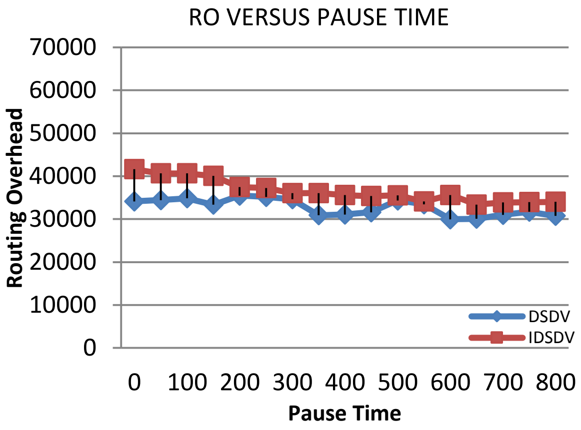

Figure 7: Routing Overhead Vs Pause Time

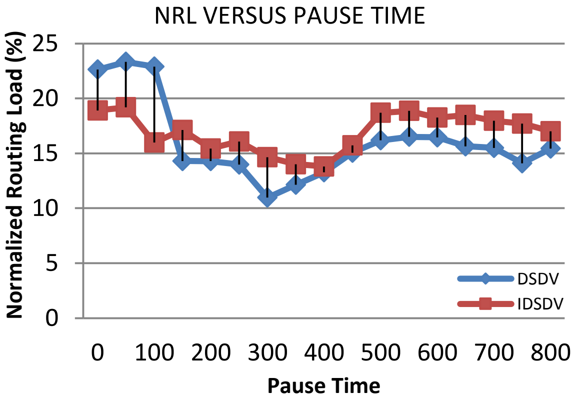

Figure 8: Normalized Routing Load Vs Pause Time

C. Node Speed

This test is conducted by varying the speed for each node, by fixing the number of nodes and pause time to some values. The effect of an increase in the node speed would be an increase in the possible number of breakages and an increase in the number of packets dropped.

Packet Delivery Fraction**:** From Figure 9**,** as the number of node’s speed increases, the number of breakages will also experience little increase. Therefore, the number of packets dropping for both protocols is very slowly increases. IDSDV exhibits better PDF than DSDV as a result of successful re-routing during link breakage within IDSDV.

Average End-to-End Delay**:** From Figure 10, we observe the up-trending of AE2ED for both protocols simply due to an increase in the number of link breakages which result in longer time for data packets to reside in the buffer. However, IDSDV outclasses the performance of DSDV in that it reduces the period of its data packets to stay in the queue by re-routing the packets via alternative routes.

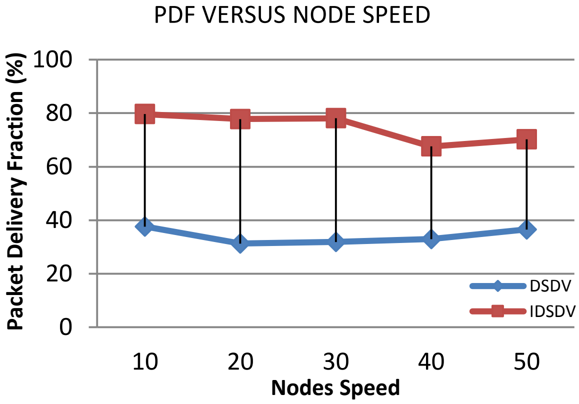

Figure 9: Packet Delivery Fraction Vs Node Speed

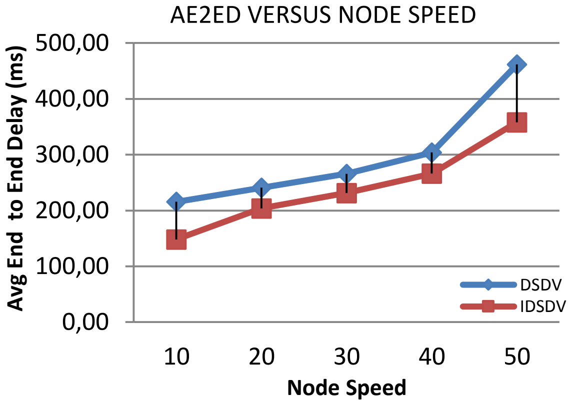

Figure 10: Average End to End Delay Vs Node Speed

Routing Overhead: Figure 11 shows the performance of both protocol IDSDV and DSDV for routing overhead as a function of node speed. The routing overhead of IDSDV is found to be slightly higher than the regular DSDV protocol as expected. This increase is due to the fact that the additional routing control messages are generated in the case of broken links. One hop Route-Request and Route-Ack packets are broadcasted by the node observing the stale route. These additional packets are not present in regular DSDV.

Normalized Routing Load: Figure 12 shows the two different behaviours of IDSDV and DSDV. The NRL for IDSDV is almost constant due to an equivalent reduction of RO (Figure 11) and PDF (Figure 9). Whereas, the NRL for DSDV is decreasing due to a sharp decrease in RO (Figure 11) compared to small increment in PDF (Figure 9).

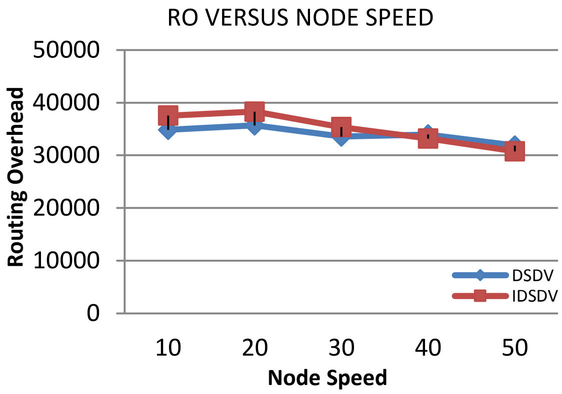

Figure 11: Routing Overhead Vs Node Speed

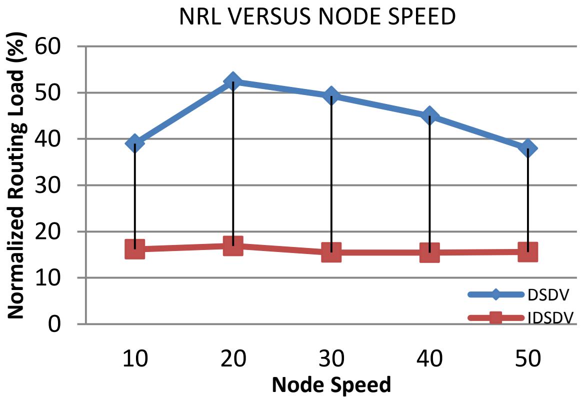

Figure 12: Normalized Routing Load Vs Node Speed

From experiment, we figured that, specific to UDP traffic, IDSDV has to some degree resolved the stale route problem within DSDV. This is observable from the graphs which show that PDF for IDSDV is always higher than that of DSDV. Moreover, the graphs for RO and AE2ED also show that IDSDV is a protocol of choice when it comes to highly density and dynamic environment.

4 Conclusion

In this paper, we study the behavior of IDSDV comparing to DSDV specific for UDP traffic. We found that IDSDV not only resolved the stale route problem within DSDV but also improve other performance parameters such as average end-to-end delay and routing overhead. This improvement is comprehensive and therefore we suggest IDSDV as a replacement for DSDV for future implementation.

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