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Feasibility Study of DSDV and AODV Routing Protocols in Mobile Sensor Networks

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Abstract

In recent years, mobile sensor networks (MSNs) have become a hot area of research, in which sensor nodes are mobile. The proper selection of a routing protocol in a MSN is very important because network performance is significantly influenced by the routing protocol. In this paper, the feasibility of the two routing protocols in MSNs is studied and discussed with respect to network performance. The two protocols are destination sequence distance vector (DSDV) and ad hoc on demand distance vector (AODV) routing protocols and they are popularly used in mobile ad hoc networks. Our simulation study shows that the two routing protocols can be effectively used in MSNs and AODV is more reliable with affordable burden compared to DSDV.

Keywords: Wireless sensor network, routing protocol, feasibility, DSDV, AODV

1. Introduction

The advancements in wireless communication technologies enabled the challenging deployment of advanced wireless sensor networks [1]. Mobile sensor networks (MSNs) are a wireless sensor network, in which sensor nodes are mobile. Mobility makes the sensor network more efficient to acquire the information to be monitored. The physical attributes or events are sensed by low-power sensor nodes and the sensed information is transmitted to a remote processing unit called sink node or base station [2]. For example, a number of robots and unmanned vehicles with sensors can be deployed in a military or commercial application [3].

Such a network configuration can be regarded as a combination of a mobile ad hoc network and a wireless sensor network.

Routing is very important in MSNs because the sensed data should be delivered to the base station through multihop routing paths and every mobile sensor node plays a role of router in the dynamic environment of topology changes. Because sensor nodes are mobile, multihop routes change very often. Therefore, it is not possible to establish fixed routing paths [4]. Destination-sequenced distance vector (DSDV), dynamic source routing (DSR), and ad hoc On-demand distance vector routing (AODV) are good examples of routing protocols designed for mobile ad hoc networks [5 - 7]. In a large-scale network, however, DSR has much routing overhead because the packet header becomes large in size in proportion to the path length and, thus, DSR is not scalable.

In this paper, the feasibility of DSDV and AODV routing protocols is studied by comparing them quantitatively in terms of major performance metrics. This comparative study can be effectively used not only to make a decision of choosing a routing protocol in MSNs but also to develop a new routing protocol for MSNs. According to the performance study, the two routing protocols can be effectively used in MSNs and AODV is more reliable with affordable burden than DSDV.

The rest of the paper is organized as follows: In the following section, the two routing protocols of DSDV and AODV routing protocols are reviewed in brief. In Section 3, the performance of DSDV and AODV routing protocols is evaluated via simulation and discussed comparatively. This paper is concluded in Section 4.

2. Routing Protocols

In this section, the two representative routing protocols of DSDV and AODV are overviewed in terms of feasibility in MSNs.

2.1. DSDV

Destination-sequenced distance vector (DSDV) routing protocol [8] is based on the Bellman-Ford routing algorithm. It is a proactive protocol and belongs to the table-driven family. Routes between nodes in a network are always being maintained and updated. Each node in the network maintains a routing table which contains information about how old the route is, the shortest distance as well as the first node on the shortest path to every other node in the sensor network. In DSDV, routing messages are exchanged between neighboring mobile nodes. This data gets change in the routing table. Packets for which route to its destination is unknown are cached. The packets are allowed to receive till route-replies are received from the destination. The precise maximum buffer size of memory is available for collecting those packets, waiting for routing information. If the packets are received beyond that size, then the packets may be dropped. The sequence number to each entry is allotted. These numbers are generated by destination, and they are mostly even numbers if a link is present;

otherwise, they are an odd number [8]. Furthermore, it is necessary for the transmitter to transmit the next update with the sequence number.

2.2. AODV

AODV routing protocol [9] is an improvement on the DSDV algorithm. It is a reactive routing protocol that uses an on-demand approach to find and establish routes. AODV maintains routes as long as they are needed by the source nodes, and it is considered one of the best routing protocols in terms of energy consumption and establishing the shortest path.

The AODV routing protocol is suitable for unicast and multicast routing. Originally, it is designed for mobile ad hoc networks. It is loop-free and self-starting protocol. It builds routing paths between nodes only if demanded by source nodes. The routing path will remain connected till that particular node requires the same. It is suitable for a large number of mobile nodes, and it gives new sequence numbers to newly generated routes. The sequence number is used to keep track on updated information at the destination node. When there is a choice between two routes, the requesting node has to select the route with the greatest sequence number [9].

3. Performance Evaluation

3.1. Simulation Environment

In this paper, all simulations have been carried out using the ns-2 network simulator version 2.35. The simulator is a discrete event simulator targeted at networking research. It provides substantial support for simulation of various network protocols over wired and wireless networks [10].

Table 1. Simulation parameters

Parameter	Value
Network area	600 m × 1500 m
Node placement	Random
Number of nodes	50
Data transmission rate	2 Mbps
Radio transmission range	250 m
MAC	IEEE 802.11 DCF
Data payload size	512 bytes
Traffic source	Constant bit rate (CBR)
Packet outgoing rate	2, 4, 6, 8, 10, 12 packets/sec (default: 4 packets/sec)
Mobility model	Random waypoint model - Speed: 0 ~ 5 m/sec - Pause time: 0, 100, 200, 300, 400 sec (default: 100 sec)
Propagation channel model	Two-ray ground reflection model
Simulation time	900 sec

The three performance metrics of packet delivery ratio, end-to-end delay and normalized routing overhead are considered for evaluating the performance of routing protocols. Note here that energy efficiency is an important metric in general wireless sensor networks but it is not in MSNs. This is because energy consumption in communications is very small in comparison to that in the movement of robots or unmanned vehicles in MSNs. In our simulation, it is assumed that 50 mobile sensor nodes move around randomly over a network area of 600 $m \times 1500$ m. The mobile sensor nodes might be robots or unmanned vehicles. To observe the three performance metrics, two simulation factors are used: packet outgoing rate of 2 ~ 12 packets/sec and pause time of 0 ~ 400 sec. While one factor is varied during simulation, the other factor remains as default value. The simulation parameters are summarized in Table 1.

3.2. Simulation Results and Discussion

From Figures 1 and 2, it is clearly shown that the packet delivery ratio in AODV is better than that in DSDV for different scenarios of traffic and mobility. This is mainly due to the fact that AODV tries to guarantee that packets will be delivered to their destinations by delay compromising. However, if it is not possible for packets to be delivered, DSDV tries to drop them, resulting in lower packet delivery ratio as well as shorter delay. As an on-demand routing protocol, AODV adapts to the dynamic topology changes caused by mobile nodes, achieving higher packet delivery ratio. The normalized routing overhead is evaluated as shown in Figures 3 and 4. AODV has a little more routing overhead than DSDV, but the difference is minor. The impact of the network traffic and the mobility on the routing overhead is also minor. DSDV is more stable with respect to the routing overhead than AODV. This is because DSDV is a table driven protocol and, thus, a node does not need to find a route before transmitting packets. On the other hand, AODV requires on-demand route discovery that may incur a little more overhead.

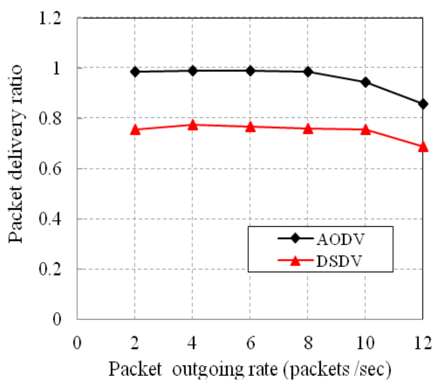

Figure 1. Packet delivery ratio vs. packet outgoing rate

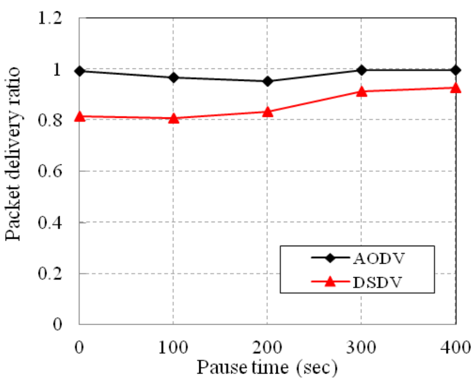

Figure 2. Packet delivery ratio vs. pause time

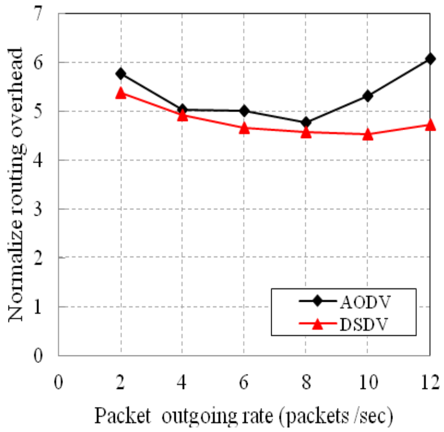

Figure 3. Normalize routing overhead vs. packet outgoing rate

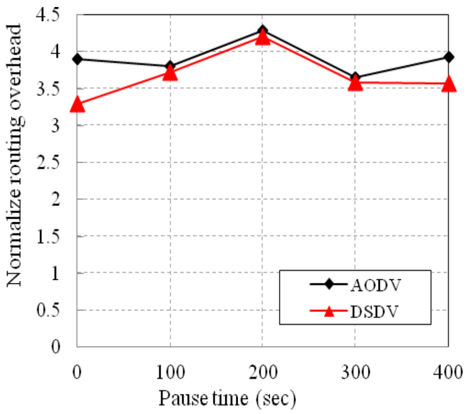

Figure 4. Normalize routing overhead vs. pause time

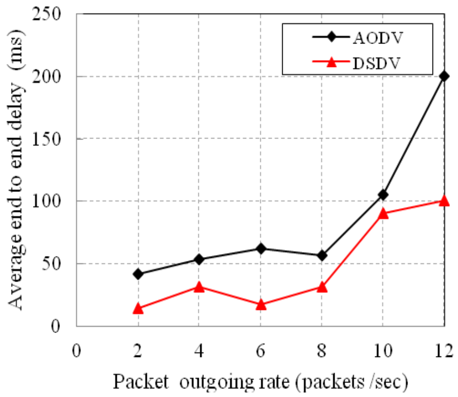

Figure 5. End-to-end delay vs. packet outgoing rate

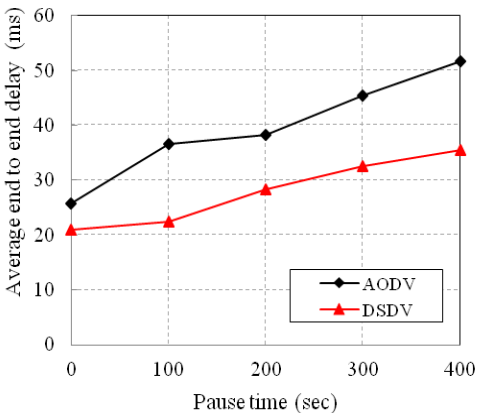

Figure 6. End-to-end delay vs. pause time

From Figures 5 and 6, it is shown that DSDV outperforms AODV in terms of the end-to-end delay. DSDV is a proactive routing protocol, in which the routing path to a destination is immediately available when necessary. That is, there is no delay caused by on-demand routing discovery. In addition, if it is not possible to deliver the data packets, the DSDV routing protocol tries to drop the packets, resulting in shorter end-to-end delay. In AODV, however, the packets stay in the send buffer till the route is discovered in order to be sent to the destination.

4. Conclusion

The feasibility of DSDV and AODV routing protocols in MSNs has been studied by quantitatively evaluating the two with respect to the three performance metrics of packet delivery ratio, routing overhead and end-to-end delay. Our simulation results shows that the two routing protocols under evaluation can be effectively used in MSNs and AODV is more reliable with affordable burden compared to DSDV.

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