Proficiency Analysis of AODV, DSR and DSDV, Adhoc Routing Techniques for Internet of Things

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Abstract: With massive technological advancements and the growing popularity of digital assistance in everyday life, the world is witnessing the formation of Internet of Things (IoT), where real-world entities augmented with computing devices, sensors, and actuators are connected to the Internet, enabling them to share their generated data through Web. By mashing up these Smart Things with the services and data available on the Web, novel IoT applications can be created. In these applications, routing service is required to enable efficient exchange of information among smart things. In this paper, three routing techniques AODV, DSR & DSDV have been studied and their proficiency has been analyzed using network simulator NS2 based on three performance metrics, End to End Delay, Packet Delivery Ratio and Average Energy Consumption.

Keywords: Routing Techniques, Internet of Things (IoT), Wireless Sensor Networks (WSN), AODV, DSR, DSDV.

I. INTRODUCTION

Internet of Things (IoT) is the vision of machine to machine communication between devices embedded in things called smart objects [1]. The Internet of Things, as given syntactically by its name, is composed of two terms: “Internet” and “Things”. The first term describes a networking-oriented aspect of the IoT where the Internet serves as the central building block interconnecting every possible computing device in the world. This aspect is explicitly reflected in the definition for IoT by DG-CONNECT as “a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols” [2]. The second term “Things” describes everything that is addressable and communicable. This thing-oriented aspect of the IoT is further elaborated in the IoT’s definition by IERC - the Cluster of European Research Projects on IoT: “a dynamic global network infrastructure with self-configuring capabilities based on standard and inter-operable communication protocols where physical and virtual ‘things’ have identities, physical attributes, use intelligent interfaces, and are seamlessly integrated into the information network”. Thus, an object or a thing, according to this definition, can be understood as an entity that is augmented with computing and communication capabilities, thus is able to possess a certain degree of intelligence and interacts with other things that are also connected to a global information network (i.e., the existing Internet). The popularization of wireless and sensor technologies, allied to the demand for new Internet of Things (IoT) applications, is creating a new ubiquitous and smart IoT applications era. The IoT [3] is composed of a set of technologies that provide connectivity at all times, everywhere, and about everything. IoT is based on the principle that objects or things interact and cooperate with each other by using wireless links to ensure ubiquitous communications. They might be Radio-Frequency Identification (RFID) tags, sensor nodes, actuators, or mobile phones, among others. In this context, Wireless Sensor Networks (WSNs) [4,5] play an important role in providing ubiquitous computing that is capable of connecting both real and virtual worlds. In almost all the IoT applications, the sensed data must be sent to the Base Station (BS) for further processing. This should be accomplished through efficient routing protocols that are key components to improve the data transmission, energy-efficiency, and scalability in WSNs/IoT. However, the characteristics of WSNs/IoT raise many challenges in designing efficient communication protocols, owing to limited resources. At the same time, there still remains a need to find a multipath-aware routing protocol that assures data transmission with low delay, latency, and minimum energy consumption for various IoT applications [6].

II. ROUTING TECHNIQUES

A. AODV: AODV (Adhoc On-Demand Distance Vector) [7] routing technique enables dynamic, multihop routing between participating nodes wishing to establish and maintain an adhoc network. AODV allows nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication. AODV allows nodes to respond to link breakages and changes in network topology in a timely manner. The operation of AODV is loop-free, and by avoiding the Bellman-Ford” counting to infinity” problem offers quick convergence when the adhoc network topology changes (typically, when a node moves in the network). In case of link failure, AODV causes the affected set of nodes to be notified so that they are able to invalidate the routes using the lost link. One distinguishing feature of AODV is its use of a destination sequence number for each route entry. The destination sequence number is
created by the destination to be included along with any route information it sends to requesting nodes. Using destination sequence numbers ensures loop freedom and is simple to program. Given the choice between two routes to a destination, a requesting node is required to select the one with the greatest sequence number. As long as the endpoints of a communication connection have valid routes to each other, AODV does not play any role. When a route to a new destination is needed, the node broadcasts a RREQ to find a route to the destination. A route can be determined when the RREQ reaches either the destination itself, or an intermediate node with a 'fresh enough' route to the destination. any intermediate node that is able to satisfy the request.

B. DSR: DSR (Dynamic Source Routing protocol) [8] is a simple routing technique designed specifically for use in multi-hop wireless ad hoc networks. Using DSR, the network is completely self-organizing and self-configuring, requiring no existing network infrastructure or administration. Network nodes cooperate to forward each others packets to allow communication over multiple "hops" between nodes not directly within wireless transmission range of one another. As nodes in the network move about or join or leave the network, and as wireless transmission conditions such as sources of interference change, all routing is automatically determined and maintained by the DSR routing protocol. Since the number or sequence of intermediate hops needed to reach any destination may change at any time, the resulting network topology may be quite rich and rapidly changing. In DSR, Route Discovery and Route Maintenance each operate entirely "on demand". In particular, unlike other protocols, DSR requires no periodic packets of any kind at any layer within the network. For example, DSR does not use any periodic routing advertisement, link status sensing, or neighbor detection packets and does not rely on these functions from any underlying protocols in the network. This entirely on-demand behavior and lack of periodic activity allows the number of overhead packets caused by DSR to scale all the way down to zero, when all nodes are approximately stationary with respect to each other and all routes needed for current communication have already been discovered. As nodes begin to move more or as communication patterns change, the routing packet overhead of DSR automatically scales to only what is needed to track the routes currently in use. Network topology changes not affecting routes currently in use are ignored and do not cause reaction from the protocol.

C. DSDV: DSDV (Destination-Sequenced Distance Vector) [9] routing technique uses the Bellman-Ford algorithm to calculate paths. The cost metric used is the hop count, which is the number of hops it takes for the packet to reach its destination. DSDV is a table-driven proactive protocol, thus it maintains a routing table with entries for all the nodes in the network and not just the neighbors of a node. The changes are propagated through periodic and trigger update mechanisms used by DSDV. Due to these updates, there is a chance of having routing loops within the network. To eliminate routing loops, each update from the node is tagged with a sequence number. The sequence number from each node is independently chosen but it must be incremented each time a periodic update is made by a node. The sequence number of normal update must be an even number, since each time a periodic update is made the node increments its sequence number by 2 and adds its update to the routing message it transmits. The node cannot change the sequence number of other nodes. If a node wants to send an update for an expired route to its neighbors, only then it increments the sequence number of the disconnected node by 1. The nodes receiving this update will then look at the sequence number and if it is odd, will remove the corresponding entry from the routing table.

III. METHODOLOGY AND SIMULATION SETUP

The network scenario has been designed and implemented using Network Simulator NS2. Network Simulator (Version 2), widely known as NS2, is an event-driven simulation tool that is useful in studying the dynamic nature of communication network. Routing techniques, AODV, DSR and DSDV have been implemented on NS2 to evaluate and analyze their performance based on following performance metrics:

(i) End to End Delay: It is the time taken by the data packet to transmit across the network from source to destination. End-to-End delay includes Transmission Delay, Propagation Delay, Processing Delay, and Queuing Delay.

(ii) Packet Delivery Ratio (PDR): The ratio of packets that are successfully delivered to a destination compared to the number of packets that have been generated by the source. It is given as,

Packet Delivery Ratio = (received packets/generated packets)* 100.

(iii) Average Energy Consumption: Average Energy consumption is the proportion of sum of entire energy used up by every node to the entire number of nodes.

Tracegraph has been used to calculate Average End to End Delay and Packet Delivery Ratio and AWK script has been used to calculate the Average Energy Consumption. All the sensors are homogeneous in terms of
initial energy. When a sensor node transmits or receives a data or a control packet, the reduction in the node’s energy depends on the size of the packet, bandwidth used and precise NIC features. Energy is consumed by the equipment during data transmission, reception and listening. Table 1 shows the various simulation parameters.

### Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulator</td>
<td>N3-2.35</td>
</tr>
<tr>
<td>Platform</td>
<td>Ubuntu</td>
</tr>
<tr>
<td>Area</td>
<td>800 m*800 m</td>
</tr>
<tr>
<td>Antenna</td>
<td>Omni Antenna</td>
</tr>
<tr>
<td>Node Deployment</td>
<td>Random</td>
</tr>
<tr>
<td>Routing Protocol</td>
<td>AODV, DSR, DSDV</td>
</tr>
<tr>
<td>No. Of Nodes</td>
<td>5, 15, 20, 25</td>
</tr>
<tr>
<td>Data Payload</td>
<td>512 bytes</td>
</tr>
<tr>
<td>Packet Rate</td>
<td>0.5 Mbps</td>
</tr>
<tr>
<td>Traffic Type</td>
<td>CBR</td>
</tr>
<tr>
<td>Simulation Time</td>
<td>100 sec</td>
</tr>
<tr>
<td>Initial Energy</td>
<td>10 J</td>
</tr>
<tr>
<td>Transmission Power</td>
<td>1.0 W</td>
</tr>
<tr>
<td>Receiving Power</td>
<td>0.5 W</td>
</tr>
</tbody>
</table>

### IV. OBSERVATIONS

The table (Table 2) shows the values of Delay, PDR and Energy Consumption for AODV, DSR, DSDV routing techniques with varying no. of nodes (5, 15, 20, and 25 respectively).

### Table 2

<table>
<thead>
<tr>
<th>Delay (sec)</th>
<th>PDR</th>
<th>Energy Consumption(Joules)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AODV</td>
<td>DSR &amp; DSDV</td>
</tr>
<tr>
<td>0.613</td>
<td>74.8</td>
<td>74.1</td>
</tr>
<tr>
<td>0.619</td>
<td>73.9</td>
<td>75.0</td>
</tr>
<tr>
<td>0.614</td>
<td>73.9</td>
<td>74.4</td>
</tr>
<tr>
<td>0.614</td>
<td>74.7</td>
<td>74.5</td>
</tr>
</tbody>
</table>

### V. RESULT ANALYSIS

Fig.1 shows the effect of number of nodes on Average End to End Delay in AODV, DSR and DSDV. It is evident from the figure that Average End to End Delay in AODV is less as compared to both DSR and DSDV. DSR is a On-Demand source routing protocol, and this is the major reason for it having a higher End-to-End Delay, where route is looked only
when needed and there is a route Discovery mechanism happening every time and it also has to carry a large overhead each time, thus the higher delay. AODV on the other hand has only one route per destination in the routing table, which is constantly updated based on sequence number and DSDV has to continuously update the whole routing table periodically and when needed, which leads to a slight delay in delivery.

Fig. 2 shows the effect of number of nodes on packet delivery ratio of AODV, DSR and DSDV. The Packet Delivery Ratio (PDR) indicates the efficiency of a protocol in delivering packets from source sensor nodes towards the sink node. It is evident from figure that PDR of DSDV is higher than both AODV and DSR. This is because of table driven nature of DSDV.

Fig. 3 shows the effect of number of nodes on Average Energy Consumption in AODV, DSR and DSDV. It is evident from the figure that Average Energy Consumption in DSDV is high as compared to both AODV and DSR. This is because DSDV utilizes more bandwidth as it is a proactive protocol.

VI. CONCLUSION

The network was set up for varying number of nodes to test the proficiency of the routing techniques (AODV, DSR, DSDV). The routing techniques were evaluated based on three parameters, Average End to End Delay, Packet Delivery Ratio and Average Energy Consumption. In case of Average End to End Delay, AODV outperforms the other two routing techniques and in case of Packet Delivery Ratio (PDR), DSDV outperforms the other two techniques. However DSDV consumes more energy as compared to both AODV and DSR. In future, a technique combining the best properties of above mentioned techniques can be proposed.

REFERENCES


