Simulation and Comparison about MAC Protocols Based on 802.11b

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Abstract

In this article, some main routing algorithm used in Ad Hoc network, such as DSR, DSDV, TORA and AODV are analyzed with the help of NS2 simulator. Firstly, performances of these four routing protocols are tested in NS2, and then draw a design of the routing protocol in Ad hoc network. Different routing protocols, which can be classified into two main categories – proactive and reactive, correspond to different scenarios. Among the four algorithms, AODV is superior to others in most scenarios. On the other hand, the performance including delay, drop and throughput of the MAC layer with different number and different packet size is tested. So the number of the nodes or the packet size should not be out of the capability when designing a new Ad hoc network. All the conclusions drawn from this article can be used further to develop and optimize routing protocol for Ad hoc network.

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1. Introduction

As the continuous development of computer network technology, people attach more importance on wireless network as it is more convenient and scalable than other communication ways. In the field of wireless network, 802.11, as a protocol of WLAN set by IEEE, is one of the most popular choose to establish wireless network.

The router protocol of Ad Hoc can be divided into following three ways: proactive protocol, reactive protocol, and mixed protocol.

Proactive router protocol, also named protocol based on table. In such router protocol, each node maintains a table including information about the way to other nodes. When the network detects a change about topology of network, the node broadcast the update information in the network. Other nodes, received updating information, will update their router table in order to make router information coherent, timely and correct. Thus, the table can react the real situation about topology of network. Once the source node sends message, it can acquire the router information about how to reach the destination node.
immediately. Therefore, the delay in such protocol is very small, while the overhead is large. Reactive protocol, also called protocol based on demand, is a protocol that node will look for router algorithm when it has message to send to. That is, the node doesn’t need to maintain the timely and correct route information. The source node will start to seek route in order to a proper access to destination when it sends message. Compared with proactive protocol, reactive protocol requires smaller overhead. On the other hand, it generates a longer delay.

Neither proactive nor reactive protocol can solve the route problem in Ad Hoc network. In such dynamic topology, proactive protocol will generate amount of control messages. Moreover, most of them are redundant. For reactive protocol, it will find route information for every message. Obviously, this is unreasonable, especially when a source node send messages continuously. In a word, a mixed protocol, combining proactive and reactive protocol, is a compromised method. In local area, we can adopt proactive protocol to guarantee the reliability of route information. When the destination node is far, reactive protocol is used to seek route in order to reduce the overhead.

2. Four Kinds of Route Algorithm in Ad Hoc

2.1. DSDV(Destination-Sequenced Distance-Vector Routing)

DSDV improve the Bellman-Ford route algorithm. In another word, each mobile node should maintain a route table including destination node, hops and serial number of destination which is allocated by destination node. The serial number is mainly used for deciding whether the route information is outdated. Each node exchanges route information with neighbor nodes periodically. There two ways to update route table. One is full dump, applied in network which changes fast. That is, the updating information will contain the whole route table. The other is incremental update, which only include changed route information. It is common in network which changes slowly.

The detailed implementation of DSDV by NS-2 is: a packet will be cached if it doesn’t find route information. At the same time, the node send checking information continuously until it find reacting message from the receiver. When cache is overflowed, the latest packets will be abandoned.

2.2. DSR(Dynamic Source Routing)

DSR is a protocol based on demand at source node. It adopts source route algorithm instead of hops route algorithm. DSR includes two main processes: route discovery and route maintain. When node S sends message to node D, it firstly check cache weather it contains route information about destination node which is not outdated. It will use route information directly when the information is not outdated. If not, it will start route discovery. First of all, node S will send RREQ in flooding way which has address of source and destination. Other nodes forward this RREQ, and attach their ID on it. When RREQ reach the destination D, D will make a RREP to S which including route information from S to D. In addition, immediate nodes will use routing cache to optimize the protocol.

The advantages of DSR:Nodes only need to maintain route information about nodes in communication which will reduce overhead.

The technology of cache will decrease time on route discovery.

Disadvantages of DSR:The header in each message should contain route information. It leads to large overheads.

The flooding way will result in a conflict on transmission.

2.3. TORA (Temporally-Ordered Routing Algorithm)
TORA is an adaptive and distributed algorithm which is used in dynamic wireless network. As a protocol established by source node based on demand, it can seek multiple route information.

The main character of TORA is that the control information can only be transmitted in area whose topology of network changes. Therefore, nodes only need to maintain route information about adjacent nodes.

This protocol can be divided into three aspects: route generation, route maintain, and route deletion. When initializing, the sequence number of destination node is set to 0. Then the source node broadcast a message contains ID of destination node and QRY packet. A node whose sequence number is not 0 will respond a UDP packet. Meanwhile, nodes, received UDP packets, will generate a larger sequence number. In this way, it can establish a DAG from source to destination. In addition, the route information should be re-established when nodes move.

The problem in TORA is that it will lead to route shaking when several nodes delete routes at the same time. In NS-2, each node runs a separate process for all possible destination nodes.

2.4. AODV (Ad hoc On-Demand Distance Vector Routing)

AODV is an improved version of DSDV. As a matter of fact, the essential difference between them lies in reactive route protocol. In order to find route to destination, the source node will broadcast a request. Moreover, adjacent nodes will broadcast that packet until it reaches a node which contains the route information about destination node. When the node forward packets, it type in ID in its table so that it constructs route from destination node to source node. If the source node moves, it will start route discovery again. If the intermediate node moves, the link will be invalid and the node will send this message to source nodes. Then, the source node will start route discovery again.

3. Simulate and Result

NS-2 is oriented object simulator which use C++ language. We will discuss the following two simulations of Ad Hoc under 802.11b.

Scenario 1: Test of route protocol. In this experiment, the model consists of three mobile nodes (A, B, C) in an area with 670mX670m. The initial location of those three nodes is node A (81,240), node B (257,245), node C (591,199). At the beginning, node A move to (89,283) at 19m/s when t=33s. At t=50s, node C move to (369,173) at 3.37m/s, and node B move to (221, 80) at 14.90m/s. We establish a constant bit rate between node A and node C which is 512 byte and 4096 byte. Besides, they send messages every 4s or 2s. In addition, node A begins to send CBR data packet to node C from 127s to 527s.

Scenario 2: Test of layer of MAC. Under the same conditions of bandwidth, topology of network, we test the influence on MAC layer by the number of nodes (3, 10, 30, 50), and packet size (0.5k, 1k, 2k, 4k).

Some key parameters: Topology: 100X100
The number of nodes: 10
Antenna: omni-directional antenna
Route protocol: DSDV
Queue capacity: 50
Queue mode: DropTail (FIFO)
MAC layer: DCF
Transmission mode: CBR (period =0.25s)
Specification: In route layer, if data packets exceed 1000, they will be divided into pieces. The rule for dividing is that every packet has 1000 bytes. For example, a packet contains 2048 bytes will be divided into three parts, 1000 bytes, 1000 bytes and 48 bytes. Route information will be described by extra 20 bytes.
We compare the statistic of those two scenarios, and depict results in the following diagrams.

3.1. Performance Testing of Routing Protocol in NS

The 1st result of project 1 is a comparison of 4 routing protocols in their processing speed and capacity, which is shown in Figure 1.

Analysis: Processing speed of routing protocol can be valued by the end to end delay time of packet transmission.

According to Figure 1, it is easy to see that: AODV protocol and DSDV protocol have similar processing speed. The advantages of them are obvious when load and the change of topology are small. Considering further in routing overhead, AODV protocol is the optimal choice. TORA protocol is based on a distributed routing algorithm which uses link reversal method and self-adaption. It is mainly applied in multi-hop wireless networks which are high-speed and dynamic. As a source-initiated on-demand routing protocol, it can find several routes from the source to a destination node, thus it has a great advantage when the load and the change of topology are large.

The 2nd result of project 1 is a comparison of 4 routing protocols in routing overhead, which is shown in Figure 2.

Analysis: As TORA, DSR and AODV are all on-demand routing protocols, their overhead will decrease as the node mobility decreases, and it will also decrease as the network load increases. DSDV is a routing protocol that using Prior type, and its overhead does not related to node mobility. Since the
The characteristics of the DSR and AODV are similar, their performances are also approximate. DSR uses caching technology and mixed reception to listen Route request, so it greatly reduces the routing overhead. TORA's overhead can be separated in 2 parts. One is constant and unrelated to the mobility, and the other one is varied and related to the mobility.

The constant one is caused by the neighbor discovery mechanism of IMEP, this mechanism ask each node in each signal cycle to send at least one HELLO packet. The varied one is caused by two factors, one is routes grouping which is used in generation and maintenance of routing, and the other one is used to ensure the reliable and sequential delivery of confirmation packet and retransmission packet.

In this experiment, hybrid AODV has the smallest routing overhead, because the number of nodes is small, and the topology is simple in our test. It only needs to make a connection at the beginning when it requires. The mechanism of DSDV protocol needs the regular broadcasts of routing information, which increases its overhead.

Conclusion: Different routing protocols have their own applications, advantages and disadvantages. It is not realistic to design a universal routing protocol. One of the better solutions is hybrid routing that combines the prior routing protocol and reactive routing protocol. It can reduce the overhead under the premise of reducing packet delay. To sum up, the performance of hybrid AODV routing protocol is better, even larger changes in the topology. It can have lower routing overhead and better processing speed and capacity, even when the change of topology is large. Comparing with hybrid AODV, the DSDV protocol can only apply to the case of small topology changes. When the topology has rapid changes in structure, the DSDV protocol may has packet loss.
3.2. Performance Testing of MAC Layer

The 1st result of project 2 is about the impact of the number of nodes to the performance in MAC layer, which is shown in Figure 3.

Analysis: As the number of nodes increases, the network traffic increases, and the throughput also increases. In particular, the throughput is straight up when the number of nodes is between 10 and 30. After the number of nodes is more than 30, packet loss rates increases, but the delay becomes more stable.

![Figure 3 The Result 1 of Scenario 2](image)

Considering future in the actual situation, the transmission capacity should be greater than the CBR mode. If we also think over the comparison of delay, in a 100 × 100 range, the best number of nodes should be between 10 and 30.

The 2nd result of project 2 is about the impact of the packet size to the performance in MAC layer, which is shown in Figure 4.

Analysis: It is easy to say that the impact of the packet size to these 3 parameters is large.

As the packet size increases, the increasing of throughput is not obvious. When the package was too much, the throughput decreases, but the packet loss rate is straight up. Especially when the packet size reaches 4k, the packet loss rate is extremely great. Because of the sub-system, its impact to delay is smaller.
Conclusion: According to the above testing results, especially considering packet loss and throughput, the most appropriate packet size should be 1 k for MAC layer.

4. Conclusion

With the help of NS network simulator, we contrasted and compared the routing algorithm in four Ad hoc networks which are based on the 802.11bMAC protocol. We designed two simple experiments to analyze those four routing protocols. We mainly focused on the effects on the throughput, delay and the packet loss rate on MAC layer which are caused by the number of nodes and the size of the packets, and we obtained a conclusion in the end.

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