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Routing Protocol Performance Evaluation in Wireless Ad hoc Network

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Abstract: In recent years, handheld wireless devices have increased in popularity. Users are no longer confined to fixed locations using a wired network, but can access wireless networks anytime, anywhere. In this study, we use three different routing protocols (DSDV, DSR and TORA) and the NS2 simulation software for a performance evaluation of an ad hoc network. The main idea is to use the routing protocols while observing the packet delivery fraction and the average end-to-end delay of data packets (in the case of TCP and CBR packets). These observations with data are then plotted for evaluation of the performance of the three kinds of routing protocols in the ad hoc network.

Key words: Ad hoc network, Routing protocol, NS2, Performance evaluation

INTRODUCTION

As technology advances, more and more popular mobile devices, smart phones, PDA (Chen and Chen, 2012), notebooks are examples of wireless devices (Shih *et al*., 2012) and their wireless transmission can be divided into two categories. One is through the base station must by the central control of the transmission mode, the other is Wireless Ad Hoc Network.

Ad Hoc network, formerly known as Packet Radio Network (Toh, 2002) Research on wireless network packet from military communications needs and has lasted nearly 20 years. Ad Hoc Network with traditional wireless networks, it has the following characteristics.

No infrastructure or central node: Ad Hoc Network is no base station, access point or strict control center. Equal status of all nodes is a peer to peer network. Nodes can join and leave the network at any time. Any node failure does not affect the operation of the entire network, with strong invulnerability.

Self-organization: Ad Hoc Network's layout or expand without relying on any default network facilities. Node through a hierarchical distributed algorithms development agreements and their connection method, the node after exposure through radio signals can be quickly and automatically form an independent network.

Multi-point jump connection: When the junction to be outside the scope of their coverage when communicating nodes, intermediate nodes need to multi-point jump forward. And fixed networks of different multi-point jump, Ad Hoc Network in the multi-hop routing completed by the common network node, rather than by a dedicated routing devices (such as routers) to complete.

Dynamic topology: Ad Hoc Network is a dynamic network. Network nodes are with a high degree of mobility so the network topology structure is not a fixed structure and its topological architecture is always in change.

Wireless Ad Hoc Network transmission mode is the most important feature of all nodes on a reciprocal way to do wireless network access, without going through the wireless base station. Currently there are many common wireless network problems, such as: Bandwidth and transmission life issues, processing power, location and network topology management, memory capacity and network security.

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In addition, the wireless network transmission speed is limited, yet cannot with transfer speeds comparable to a wired network. Although, the wireless network routing algorithm like wired network routing algorithm, may not care about the speed limit. However, in a wireless network routing algorithm must carefully consider the bandwidth allocation. All of the wireless devices, the device size and life of battery is the absolute effect on communication.

Therefore, electricity or sleep mode is the most effective method to reduce power consumption. In processing ability, ability of mobile device is usually weak, so the design of algorithms cannot be too complicated, must be able to take a short time to complete all the work.

Due to location and network topology management is not fixed, must spend a lot of cost to tracking mobile host location, the pursuit of miniaturization in the mobile device's request, the memory can't be expanded, so the mobile device cannot record large amounts of data, can only record some important information. In a wireless network environment, decided to the most efficient path transfer is a very important task. This study uses three kinds of routing protocols and the use of TCP flow and CBR flow to evaluate the results of execution.

DSDV, DSR, TORA ROUTING PROTOCOLS

DSDV (destination-sequenced distance-vector routing): In DSDV (Perkins and Bhagwat, 1994) each node needs to follow a routing table. The routing table entry includes the destination node, hops and the destination sequence number, the destination sequence number assigned by the destination node, mainly for determining routing is outdated and may prevent routing loops. Each node must periodically exchange routing information with neighboring nodes, of course, can also according to the routing table changes to trigger the routing table update.

Routing table update in two ways: One is to update all (Full dump), namely the topology update message will include the entire routing table, mainly applied to network changes rapidly. Another way is part of the update (Incremental update), contains only changes in the routing update message and usually applies to network changes slowly.

Using only the sequence number of the highest routing in DSDV, if the two route with the same sequence number, then will choose the best routing (such as the shortest hops).

DSR (dynamic source routing): DSR (Broch *et al*., 1998) routing protocol is composed of two main mechanisms: Route Discovery mechanism and Route Maintenance mechanism.

Routing Discovery mechanism to use that the source node needs to the destination node sending a packet and also do not know when to reach the destination node path. When the source node is using a path of arrived at the destination node, the source node can use the Route Maintenance mechanism to detect cannot use path with topology changes.

When the Route Maintenance mechanism that a source routing has been interrupted and no longer work path, in order to make the transmission of the data packet to the destination node, the source node will use a chance path, or to call Route Discovery mechanism to find a new path.

In DSR routing protocol, Routing Discovery mechanism and Route Maintenance mechanism operation is completely according to the requirements. Any situation will not affect the DSR routing protocol correct operation; because all the situation is established according to the demand, all situations in the loss if still needed can easily get quick recovery.

TORA (temporally ordered routing): TORA (Park and Corson, 2000) defined as an area for each node. This area is involved some nodes, the node distance (or hops) in a limited range, this range is known as the zone radius. Each node only needs to know the topology in routing area and with the topology update to update. Although, the network is very large, but update only in the local.

If S wants to communicate with D, S sends a query message, it will be directly sent to the boundary node by node within the area. And broadcasts it, until you reach the D, D respond to this request.

EXPERIMENTS AND PREPARATION

NS2: NS2 (http://www.isi.edu/nsnam/ns/) it is the object oriented network environment simulator and driven by discrete events. NS2 provides simulation of the wireless or wired networks, TCP, routing protocol.

NS2 consists of two kinds of programming language, OTCL (with object-oriented characteristics) and C^{++} implementation. The reason to using two kinds of programming language, because the simulator has two things to do. On one hand, to realize the simulation of protocol, the need for a programming language, on the other hand, need to efficiently process information.

In order to achieve this objective, the program speed (run-time speed) is very important and run the simulation environment time, to find and fix the time of bug, compile and run time (run-around time) is not very important. In this case, the C^{++} language is very suitable.

On the other hand, need to simulate the network environment in a short period of time and is convenient to

modify and found, repair Bug. In this case, the script language has great advantage, the OTCL script language can fully meet the needs.

Whatever, NS2 provides a good test bed for us. It uses two languages, C++ is favorable to fast running speed; TCL is beneficial to quickly set up a test environment.

Cbrgen and setdest: This experiment uses Cbrgen and Setdest tools to generate the required experimental environment.

The following is a method of using Cbrgen and Setdest:

- **Cbrgen:** Cbrgen can be used to generate TCP flow and CBR flow.It is use method:

ns cbrgen.tcl [-type cbr|tcp] [-nn nodes] [-seed seed]
[-mc connections] [-rate rate]

The parameters are defined in Table 1.

For example: Generate a TCP flow, this TCP flow a total of 10 nodes, the maximum number of connections is 3, seed number is 1, 5 TCP packets per second. You can use the following command:

ns cbrgen.tcl-type tcp-nn 10-seed
1-mc 3-rate 5.0> tcp1.

The output results are saved to tcp1.

- **Setdest:** Setdest can be used to produce wireless network environment of mobile node needs.It is use method:

./setdest [-n nodes] [-p pausetime] [-M maxspeed]
[-t time] [-x x] [-y y]

The parameters are defined in Table 2.

Table 1: Cbrgen parameter

Parameters	Definition
-nn	Specify how many nodes
-type	Choose generated packets are TCP flow or CBR flow
-mc	Maximum number of connections
-seed	How many seed
-rate	Rate of packets sent per second

Table 2: Setdest parameter

Parameters	Definition
-n	Specify how many nodes
-p	Residence time to reach the destination node
-M	MAX node move speed
-t	Execution Time
-x,-y	Moving Range

For example: There are 10 nodes, constantly moving in the 500×500 m range, the maximum speed of 50 m sec^{-1}, the simulation time of 20 sec. You can use the following command:

./setdest -n 10 -p 0 -M 50 -t 20 -x 500 -y 500 > set1

Using TCP flow performance comparison: According to Table 3, after the simulation parameters derived its effectiveness in Fig. 1 and 2.

When the time is 30 sec, the Packet delivery fraction show in Fig. 1.DSR is 98.67%, DSDV is 98.57%, TORA is 89.23%. The Average end-to-end delay show in Fig. 2. DSR is 295 m sec, DSDV is 377 m sec, TORA is 142 m sec. When the time is 240 sec, the Packet delivery fraction shown in Fig. 1. DSR is 99.43%, DSDV is 95.45%, TORA is 89.37%. The Average end-to-end delay show in Fig. 2. DSR is 233 m sec, DSDV is 378 m sec, TORA is 195 m sec.

Based on the above information and then use the TCP flow case, three kinds of routing protocol has good

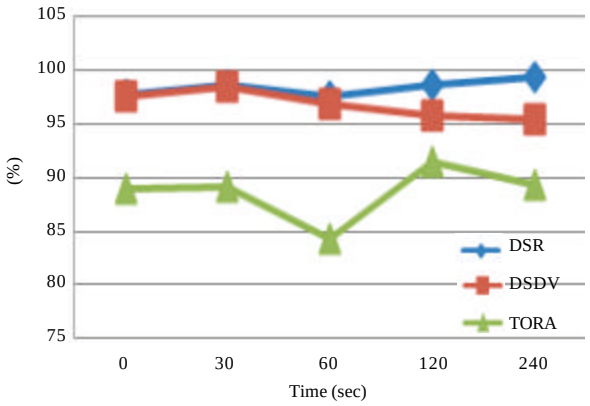

Fig. 1: Packet delivery fraction of TCP

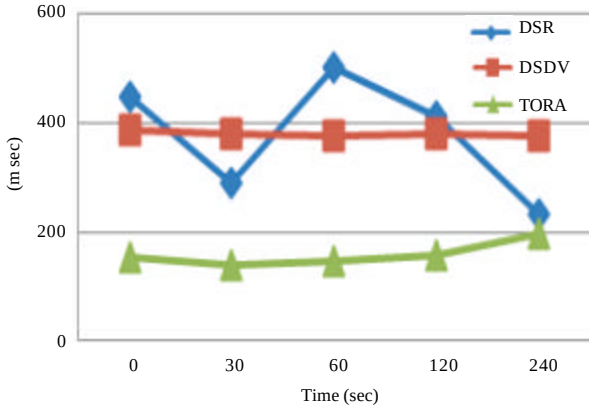

Fig. 2: Average end to end delay of data packets of TCP

Table 3: Environmental parameter

Environmental parameters	Value
Nodes	50
Seed	1
Time	240 (sec)
MAX speed	20 (m sec^{-1})
Source node	30
Rate	128 (kb sec^{-1})
Moving range	5000×5000 (m)

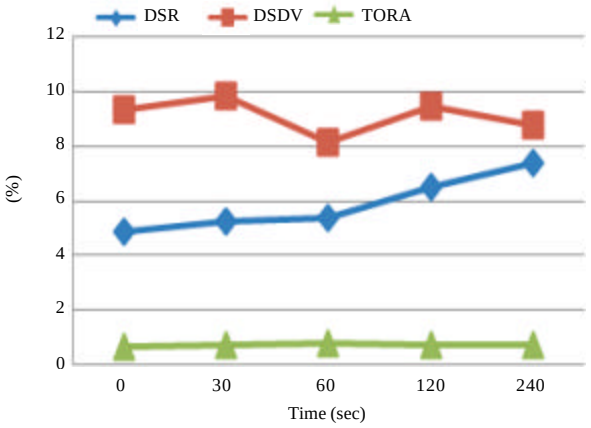

Fig. 3: Packet delivery fraction of CBR

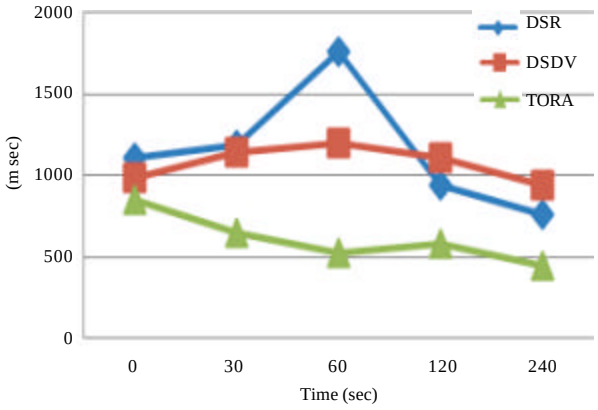

Fig. 4: Average end to end delay of data packets of CBR

performance. Packet delivery fraction of DSR and DSDV better than TORA. Average end-to-end delay is TORA better performance, DSDV is not much change, DSR is a sharp ups and downs.

Using CBR flow performance comparison: Also according to Table 3, after the simulation parameters derived its effectiveness in Fig. 3 and 4.

When the time is 30 sec, the Packet delivery fraction show in Fig. 3. DSR is 5.23%, DSDV is 9.87%, TORA is 0.72%. The Average end-to-end delay show in Fig. 4. DSR is 1187 m sec, DSDV is 1133 m sec, TORA is 653 m sec. When the time is 240 sec, the Packet delivery fraction shown in Fig. 3. DSR is 7.37%, DSDV is 8.79%, TORA is 0.68%. The Average end-to-end delay show in Fig. 4. DSR is 761 m sec, DSDV is 945 m sec, TORA is 449 m sec.

Based on the above information and then use the CBR flow case. Packet delivery fraction of DSDV is better than DSR, TORA is quite low. Average end-to-end delay of three kinds are high, TORA but better.

CONCLUSION

Each protocol as time becomes longer, the Packet delivery fraction is higher and the Average end-to-end delay is lower. In the same environment parameters, Packet delivery fraction of DSR and DSDV are higher and TORA is poor. When using TCP flow, Packet delivery fraction of DSR is the highest, DSDV Secondly, the Average end-to-end delay of TORA remains lower values, DSR have a greater change. When using CBR flow, Packet delivery fraction of DSDV is the best, the Average end-to-end delay of TORA remains lower values. As described above, the overall performance of DSR and DSDV are better than TORA. The performance of TCP flow is better than CBR flow.

All in DSDV routing nodes must announcement and therefore does not support hibernation, never use most of the routing information so overhead is too large, its scalability is also a major problem. Therefore, DSDV suitable for a small network and node moves slower occasion. DSR routing protocol is the first on-demand routing protocols thinking. The advantage is that intermediate nodes do not maintain routing information to all nodes, can avoid routing loops. While using the routing cache technology, build fast and routing overhead is small and supports multi-path; Disadvantage Each data packet carries path information, resulting in a larger data packet overhead and its route request message using the flood way, the adjacent node route request message transmission conflicts may occur and may result in duplicate broadcast, DSR is not suitable large network diameter Ad Hoc network. TORA the topology change occurs, the control message is only a partial change in the topology scale dissemination. Therefore, neighbor nodes only need to maintain routing information. TORA is highly adaptive, efficient and better scalability, mainly for high-speed dynamic multi-hop wireless networks. In this study using simulation software compared DSDV, TORA and DSR routing protocol performance and under different conditions, analyze their performance and pointed out their respective applicable occasions, for the actual work to choice routing protocols provides a reference.

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