ISSN 2319 - 6629
Volume 6, No.4, June - July 2017
International Journal of Wireless Communications and Networking Technologies
Available Online at http://warse.org/IJWCNT/static/pdf/file/ijwcnt01642017.pdf

Feature based analysis of ad hoc routing protocol by using simulation

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ABSTRACT

In Article, briefly described comparative study and the key features of the DSDV, TORA, DSR, and AODV protocols studied in our simulations. And on the base of comparative study of all packet routing protocols performance, people can identify ability of different routing protocol. By using Observation of advantages and disadvantages of routing , the existing techniques can improve and optimal solution is also possible by making same changes in existing routing protocols.

Key words: Ad hoc network / MANET, DSDV, MCDS, TORA, DSR, and AODV protocols.

1. INTRODUCTION

MCDS: A connected dominating set (CDS) is used to reduce broadcast overhead. A common source of overhead in a wireless ad hoc network comes from blind broadcasts. Assuming the worst case, nodes in a wireless ad hoc network rebroadcast all received broadcast messages. Nodes may receive multiple copies of the same message form more than one neighbor. Therefore reducing redundant broadcast messages can reduce channel bandwidth consumption and increase bandwidth efficiency. It is possible to significant reduction of overhead by using the minimal connected dominating set (MCDS) to reduce redundancy due to these blind broadcasts [5].

The algorithm for finding the MCDS can be classified into two categories .Global information based algorithms, Local information based algorithms .Global algorithms are centralized algorithms and example of this is Guha and Khuller CDS / DS[7]. Local algorithms are decentralized algorithm which is described in distributed manner. And its example is Wu and LI algorithm.

2. ROUTING PROTOCOL :

DSDV: Destination Sequenced Distance Vector. A distance vector algorithm modified to guarantee loop freedom even in the face of the rapid topology changes of an ad hoc network. After experimenting with the protocol, we found that a change in the rule for sending triggered updates resulted in better performance. We report the performance of this improved variant, which we call DSDV-SQ.

- **TORA:** Temporally-Ordered Routing Algorithm [1]. A link reversal algorithm that emphasizes minimizing reaction to topology change.
- **DSR:** Dynamic Source Routing. Our routing protocol, as described briefly in this report.
- **AODV:** Ad Hoc On Demand Distance Vector. A combination of DSDV and DSR, designed to use the on-demand nature of DSR's Route Discovery mechanism to adapt to ad hoc network topology changes, while using hop-by-hop routing to eliminate the need for source routes. Experimentation with AODV led us to develop an improved variant called AODV-LL that also incorporates ideas from DSR's on-demand Route Maintenance [7].

3. MANET Routing Issues

The routing protocols for MANET should have following properties:

- Distributed operation: route computation must be distributed amongst the nodes of the network because centralized routing in a dynamic network is impossible even for fairly small networks.
- Loop freedom: This property is desirable for efficient use of resources and better overall performance. It is achieved by means of sequence number in the routing packet header.
- Sleep mode operation: in order to conserve power nodes of a MANET may stop transmitting and/or receiving for arbitrary time periods when inactive.
- Unidirectional link support: the MANET Protocols must be able to work satisfactorily over unidirectional links.

Table 1: Constants used in the DSDV-SQ simulation

Periodic route update interval	15 s
Periodic updates missed before link declared broken	3
Initial triggered update weighted settling time	6 s
Weighted settling time weighting factor	7/8
Route advertisement aggregation time	1 s
Maximum packets buffered per node per destination	5

Table 2: Constants used in the DSR simulation.

Time between retransmitted ROUTE REQUESTs (exponentially backed off)	500 ms
Size of source route header carrying *n* addresses	$4n + 4$ bytes
Timeout for nonpropagating search	30 ms
Time to hold packets awaiting routes	30 s
Max rate for sending gratuitous REPLYs for a route	1/s

Table 3: Constants used in the AODV-LL simulation.

Time for which a route is considered active	300 s
Lifetime on a ROUTE REPLY sent by destination node	600 s
Number of times a ROUTE REQUEST is retried	3
Time before a ROUTE REQUEST is retried	6 s
Time for which the broadcast id for a forwarded ROUTE REQUEST is kept	3 s
Time for which reverse route information for a ROUTE REPLY is kept	3 s
Time before broken link is deleted from routing table	3 s
MAC layer link breakage detection	yes

Table 4: Constants used in the TORA simulation.

BEACON period	1 s
Time after which a link is declared down if no BEACON or HELLO packets were exchanged	3 s
Time after which an object block is retransmitted if no acknowledgment is received	500 ms
Time after which an object block is not retransmitted and the link to the destination is declared down	1500 ms
Min HELLO and ACK aggregation delay	150 ms
Max HELLO and ACK aggregation delay	250 ms

4. SOME DEFINITIONS AND NOTATIONS

Definition 1. A subset S of V is a dominating set if each node u in V is either in S or is adjacent to some node v in S. Nodes from S are called dominators, while nodes not from S are called dominates.

Definition 2. Connected Dominating Set (CDS): A subset C of V is a connected dominating set if C is a dominating set and C induces a connected sub graph. In the CDS, the nodes in C can communication with any other node in the same set without using nodes in V -C.A dominating set with minimum number is called minimum dominating set, denoted by MDS. A connected dominating set with minimum number is denoted by MCDS.

The algorithm for finding the MCDS can be classified into two categories:-

- Global information based algorithms
- Local information based algorithms

Global algorithms are CENTRALIZED algorithms and classified as:-

- Guha and Khuller CDS /DS
- Das DS/CDS

Local algorithms are decentralized algorithm and are described in distributed manner.

- Wu and LI algorithm
- Wan algorithm
- Bo Gao algorithm
- Funke algorithm
- Mnif algorithm

5. NETWORK TOPOLOGY

Figure 1 shows a logical view of the ad hoc network test bed. The ad hoc network includes 5 moving car-mounted nodes, labeled **T1-T5**, and 2 stationary nodes, labeled **E1** and **E2**. Each of these nodes communicates using 900 MHz Wave LAN-I radios. These radios do not implement the IEEE 802.11 MAC protocol [4], since at the time the test bed was built; the WaveLAN-IEEE radios were not available.

The ad hoc network is connected to a *field office* using a 2.4 GHz point-to-point wireless link over a distance of about 700 m. This point-to-point link does not interfere with the 900MHz radio interfaces on the individual ad hoc network nodes. At the field office is a router **R** that connects both the ad hoc network and an IP subnet at the field office back to the *central office* via a wide-area network (i.e., the Internet). The visualizer node **V** is used to monitor the status of the ad hoc network, and the GPS reference station (**RS**), located on the roof of the field office, and is responsible for sending differential real-time kinematic (RTK) GPS corrections to nodes in the ad hoc network [2].

The central office is home to a *roving node* (**RN**) that drives between the central office and the ad hoc network, participating in three networks: its home wireless LAN, the Bell Atlantic Cellular Digital Packet Data (CDPD) service, and the ad hoc network. Node **HA** provides Mobile IP home agent services [2] for the roving node, enabling it to leave the central office and still maintain routing connectivity with all of the other nodes in the Internet

During a typical experiment, which we call a *run*, the drivers of each of the cars carrying an ad hoc network node follow the course shown in Figure 2 at speeds varying from 25 to 40 Km/hr. (15 to 25 miles per hour). Each run lasts for between 30 and 120 minutes. The road we use is open to general vehicle traffic and has several Stop signs, so the velocity of each node varies in a complex fashion, just as it would in any real network. Likewise, the nodes are constrained to move along the paved surfaces of the site. This prevents us from testing the arbitrary topologies used in some theoretical simulations on abstract flat planes, but enables us to evaluate the performance we can expect in a real application [4].

During each run, the network was subjected to the composite workload shown in Table 1, consisting of synthetic voice calls, bulk data transfer, location-dependent transfers, and real-time data. The workload includes: each node making one voice call to every other node once per hour; each node transferring a data file to every other node once per hour; each moving node (**T1-T5**) making a location-dependent transfer to **E1** when located within 150mof **E1**; and multicast differential RTK GPS corrections. Finally, the workload also includes real-time situational awareness data sent by the Position and Communication Tracking daemon (PCTd) on each node to the visualizer machine located at the Field Office. Sent once per second, these packets contain the current location of the node, as read from the node's GPS unit, and status information on the node, such as the number of packets it has forwarded, dropped, queued, originated or retransmitted.

The visualizer machine continuously displays on a map of the site the last known location of each node. The visualizer can also graph the protocol status information, and it logs all the data it receives, thereby allowing a detailed replay of the run after the fact.

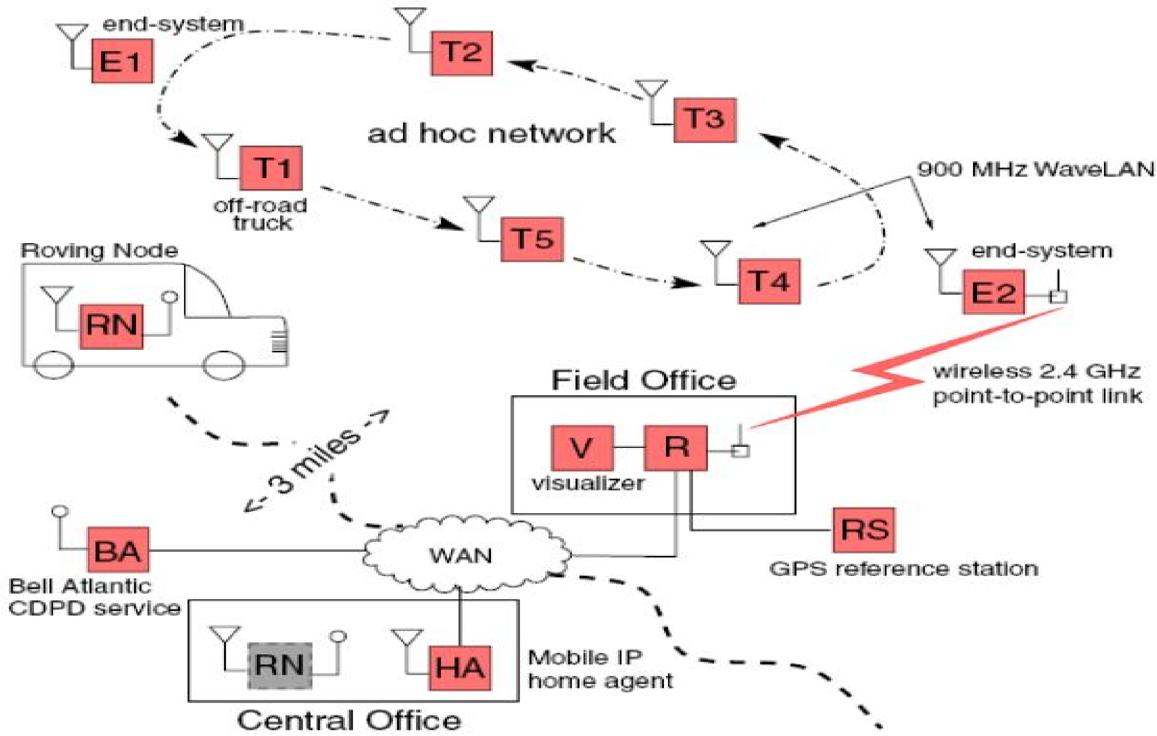

Figure 1 Logical overview of the testbed network.

6. INTEGRATION WITH MOBILE IP

Since node **RN** in Figure 1 must be able to participate in different IP subnets depending on its current location, it uses Mobile IP to connect to the Internet. Figure 2 shows an example where **RN** is homed in a subnet not belonging to the ad hoc network, but it has wandered into range of the ad hoc network. Node **E2** provides Mobile IP foreign agent services, in addition to being configured as a gateway between the ad hoc network and the Internet.

As part of normal Mobile IP operation, **RN** periodically checks to verify that it is currently using the best means available to maintain connection with the Internet. We configured **RN** to operate in LAN mode as its top preference, to connect to the Internet via a DSR ad hoc network as second choice, and to connect via CDPD when no other options are available. When **RN** receives DSR packets, such as ROUTE REQUESTs, ROUTE REPLYs or data packets with DSR source routes on them, it knows it is within range of a DSR network and enables that connectivity option in its Mobile IP code.

If node **RN** decides its best connectivity would be via the ad hoc network, it transmits a Mobile IP AGENT SOLICITATION piggybacked on a ROUTE REQUEST targeting the IP limited broadcast address (255.255.255.255). This allows the SOLICITATION to propagate over multiple hops through the ad hoc network, though gateways will not propagate it between subnets. When the foreign agent at **E2** receives the SOLICITATION, it will reply with an AGENT ADVERTISEMENT, allowing **RN** to register itself with this foreign agent and with its home agent as a Mobile IP mobile node visiting the ad hoc network. Once the registration is complete, the mobile node's home agent will use Mobile IP to tunnel packets destined for mobile node **RN** to the foreign agent at **E2**, and **E2** will deliver the packets locally to the mobile node using DSR.

- **Layer 3 Mechanisms for Acknowledgments and Retransmission**

Since the WaveLAN-I radios do not provide link-layer reliability, we implemented a hop-by-hop retransmission and acknowledgment scheme within the DSR layer that provides the feedback necessary to drive DSR's Route Maintenance mechanism. One interesting aspect of our ARQ scheme was the use of passive acknowledgments [5], which significantly reduces the number of acknowledgment packets transmitted when compared to acknowledgment schemes that acknowledge every packet (e.g., IEEE 802.11 [4]).

7. IMPLEMENTATION OVERVIEW

Our implementation utilizes passive acknowledgments whenever possible, meaning that if node **A** originating or forwarding a packet hears the next hop node **B** forward the packet, **A** accepts this as evidence that the packet was successfully received by **B**.

If **A** fails to receive a passive acknowledgment for a particular packet that it has transmitted to **B**, then **A** retransmits the packet, but sets a bit in the packet's header to request an explicit acknowledgment from **B**. Node **A** also requests an explicit acknowledgment from **B** if **B** is the packet's final destination, since in this case, **A** will not have the opportunity to receive a passive acknowledgment from **B**. To avoid the inefficiencies of a stop-and-wait ARQ scheme, node **A** uses a buffer to hold packets it has transmitted that are pending acknowledgment plus an identifier based on the IP ID field to match acknowledgments with buffered packets.

This acknowledgment procedure allows **A** to receive acknowledgments from **B** even in the case in which the wireless link from **A** to **B** is unidirectional, since explicit acknowledgments can take an indirect route from **B** to **A**. During an average run, 90 percent of the acknowledgments used a direct one-hop route, and 10 percent of the acknowledgments were sent over routes with multiple hops. While this strongly suggests the presence of unidirectional links in the network, it does not support a conclusion that 10 percent of the packets travel over a unidirectional link. Once a multiple-hop route for acknowledgments is discovered, it may continue to be used for some period of time even after the direct route begins working again.

When performing retransmissions at the DSR layer, we also found it necessary to perform duplicate detection, so that when an acknowledgment is lost, a retransmitted packet is not needlessly forwarded through the network multiple times. The duplicate detection algorithm used in our implementation specified that a node should drop a received packet if an identical copy of the packet was found in a buffer awaiting either transmission or retransmission.

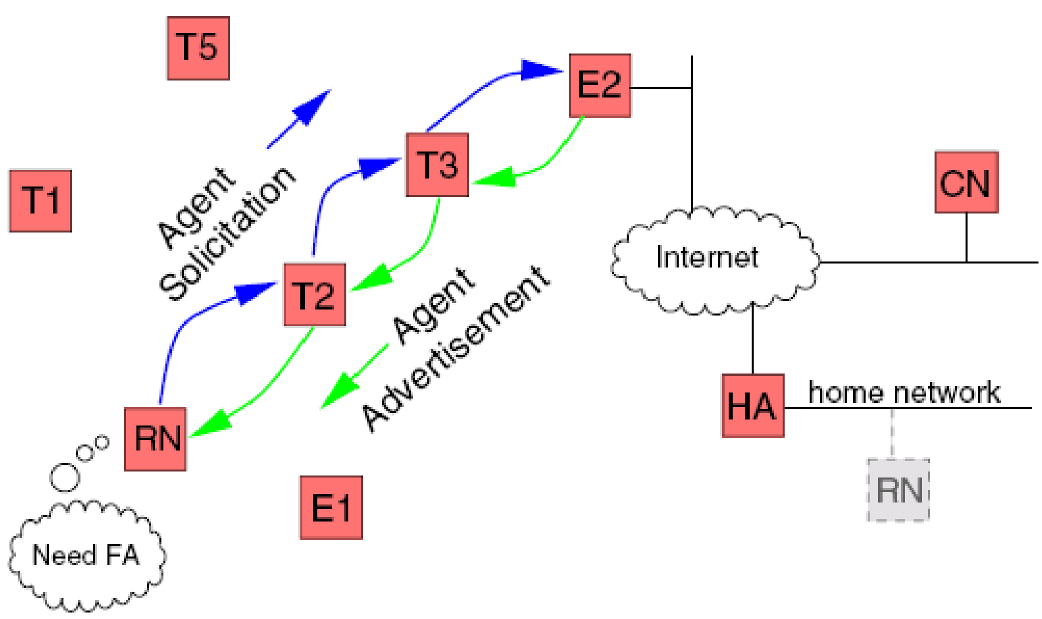

Figure 2 The roaming node RN registering with a foreign agent located on E2 in the ad hoc network.

8. SUMMARY

Our test bed successfully demonstrates that DSR, and the on-demand mechanisms it embodies, can be successfully implemented in real networks carrying meaningful traffic across multiple hops. The test bed features 2 stationary nodes, 5 car-mounted nodes that drive around the test bed site, and 1 car-mounted roving node that enters and leaves the site [6].

DSR not only routes packets between the nodes in the ad hoc network, but it seamlessly integrates the ad hoc network into the Internet via a gateway. DSR was also extended to integrate with Mobile IP, allowing nodes to roam transparently between the ad hoc network and normal IP subnets [7].

Table 5 Load offered to the network by nodes in the test bed.

Application	Rate	Protocol	Size
Voice	6/hour/node	UDP	Average of 180 Kbytes
Data	5/hour/node	TCP	30, 60, or 90 Kbytes
Location-dependent	When near **E1**	TCP	Average of 150 Kbytes
GPS	1 pkt/sec multicast	UDP	150 bytes
PCTd	1 pkt/sec/node unicast	UDP	228 bytes

9. CONCLUSION :

In Ad Hoc networks various advantages achieved by applying MCDS on DSR Protocol which makes DRS more powerful and also able to solved Blind Broadcast problem in networks, In Blind Broadcast problem, network face more traffic load on links, duplicate packets , more garbage data occurrence , cast of system so on [6]. This article provides a base line to invent new techniques and algorithms for packet routing in wireless networks and wired networks.

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