Three- hop Distributed Routing Protocol for Hybrid Network

Judith jacob[1] Shinu koyakutty[2]
Post Graduate Student, Computer Science and Engineering , KMEA , Ernakulam,India[1]
Department of Information Technology, KMEA Engineering College, Ernakulam, India[2]

Abstract— Hybrid wireless networks combining the advantages of both mobile ad-hoc networks and infrastructure wireless networks .Network simply combine ad-hoc transmission mode with cellular transmission mode. Distributed Three-hop Routing protocol (DTR) for hybrid wireless networks take full advantage of the widespread base stations, DTR divides a message data stream into segments and transmits the segments in a distributed manner. Furthermore, sending segments to a number of base stations simultaneously increases throughput and makes full use of widespread base stations. DTR significantly reduces overhead due to short path lengths and the elimination of route discovery and maintenance. DTR also has a congestion control algorithm to avoid base stations overload. DTR in comparison with other routing protocols in terms of throughput capacity, scalability and mobility resilience. Data splitting based on Chinese remainder theorem will reduce data loss and lost data can be recollected.

***Index Terms*— Hybrid wireless network, Mobile Ad-hoc Network, Distributed Three-hop Routing Protocol**

I. Introduction

Mobile ad-hoc network (MANET) is a type of ad-hoc networks. MANET is a collection of mobile nodes sharing a wireless channel without any centralized control or established communication backbone. Each terminal which may be mobile act as host and terminal MANET has dynamic topology and each node has limited resources. This kind of infrastructure-less network is very useful in battlefields, natural disasters etc. The nodes which are in the transmission range of each other communicate directly otherwise communication is done through intermediate nodes which are willing to forward packet hence these networks are also called as multi-hop networks. To setup MANET is simple, fast and cheap. As the network structure is decentralized single component failure will not affect up to a certain limit. The capacity of the wireless links is always much lower than in wired counter parts.

Hybrid wireless network consists of both an infrastructure wireless network and a mobile ad-hoc network. Wireless devices such as smart-phones, tablets and lap-tops, have both an infrastructure interface and an ad-hoc interface. As the number of such devices has been increasing sharply in recent years, a hybrid transmission structure will be widely used in the near future. Such a structure synergistically combines the inherent advantages and overcome the disadvantages of the infrastructure wireless networks and mobile ad-hoc networks.

A hybrid wireless network synergistically combines an infrastructure wireless network and a mobile ad-hoc network to leverage their advantages and overcome their shortcomings, and finally increases the throughput capacity of a wide-area wireless network. A routing protocol is a critical component that affects the throughput capacity of a wireless network in data transmission. Most current routing protocols in hybrid wireless networks simply combine the cellular transmission mode (i.e. BS transmission mode) in infrastructure wireless networks and the ad-hoc transmission mode in mobile ad-hoc networks the protocols use the multi-hop routing to forward a message to the mobile gateway nodes that are closest to the BSes or have the highest bandwidth to the BSes. The bandwidth of a channel is the maximum throughput that can be achieved. The mobile gateway nodes then forward the messages to the BSes, functioning as bridges to connect the ad-hoc network and the infrastructure network.

In DTR a source node divides a message stream into a number of segments. Each segment is sent to a neighbor mobile node. Based on the QoS requirement, these mobile relay nodes choose between direct transmissions or relay transmission to the BS. In relay transmission, a segment is forwarded to another mobile node with higher capacity to a BS than the current node. In direct transmission, a segment is directly forwarded to a BS. In the infrastructure, the segments are rearranged in their original order and sent to the destination. The number of routing hops in DTR is confined to three, including at most two hops in the ad-hoc transmission mode and one hop in the cellular transmission mode.

Hybrid networks are made by adding base stations to ad-hoc Network. Hybrid wireless networks have the advantages of both ad-hoc and base stations Hybrid wireless network used in wireless communications that are highly supporting real time transmission with limited Quality of Service.

The hybrid networks inherit advantages of both infrastructure networks and MANETs which improves scalability, coverage.

A hybrid topology is reliable and the failure of one node does not affect the performance of the network. There are multiple pathways between the nodes. The failure of one cable or transmission line allows the network to provide an alternate route between a sender and a receiver.

Hybrid wireless networks combining the advantages of both mobile ad-hoc networks and infrastructure wireless networks have been receiving increased attention due to their ultra-high performance. An efficient data routing protocol is important in such networks for high network capacity and scalability. However, most routing protocols for these networks simply combine the ad-hoc transmission mode with the cellular transmission mode, which inherits the drawbacks of ad-hoc transmission.

I. Existing System

Direct combination of the two transmission modes inherits the following problems that are rooted in the ad-hoc transmission mode.

1. *High overhead*: Route discovery and maintenance incur high overhead. The wireless random access medium access control (MAC) required in mobile ad-hoc net-works, which utilizes control handshaking and a back-off mechanism, further increases overhead.

2. *Hot spots*: The mobile gateway nodes can easily become hot spots. Hotspots lead to low transmission rates, severe network congestion, and high data dropping rates.

3. *Low reliability*: Dynamic and long routing paths lead to unreliable routing. Multi-hop transmission process cause a high data drop rate. Long routing paths increase the probability of the occurrence of path breakdown due to the highly dynamic nature of wireless ad-hoc networks.

The protocols use the multi-hop routing to forward a message to the mobile gateway nodes that are closest to the BSes or have the highest bandwidth to the BSes. The bandwidth of a channel is the maximum throughput (i.e., transmission rate inbits/s) that can be achieved. The mobile gateway nodes then forward the messages to the BSes, functioning as bridges to connect the ad-hoc network and the infrastructure network.

Here single path transmission has been carried out from source to destination .source node sent message to neighbor node then forward message to nearby base station then reaches destination base station then finally sent to destination node. There may be traffic congestion may occur and time delay.

III. PROPOSED DTR SCHEME DESIGN

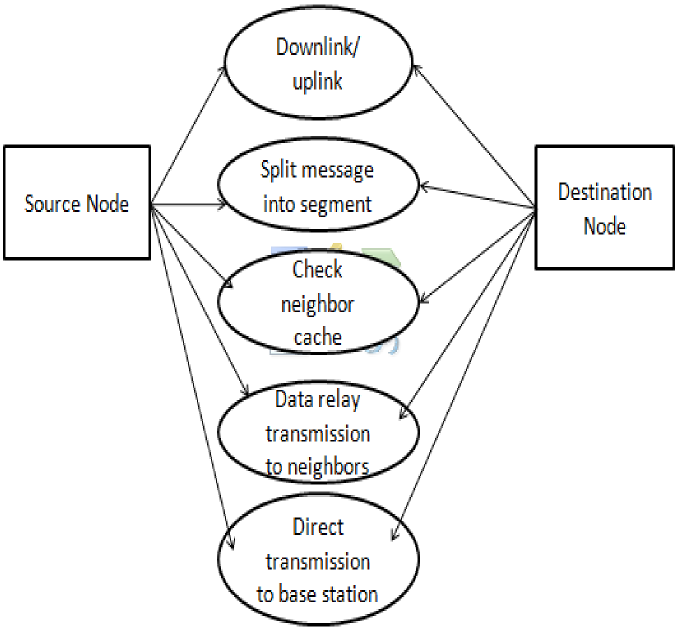
Distributed Three-hop Data Routing protocol (DTR). In DTR a source node divides a message stream into a number of segments. Each segment is sent to a neighbor mobile node. Based on the QoS requirement, these mobile relay nodes choose between direct transmissions or relay transmission to the BS. In relay transmission, a segment is forwarded to another mobile node with higher capacity to a BS than the current node. In direct transmission, a segment is directly forwarded to a BS.

DTR significantly increases the throughput capacity and scalability of hybrid wireless networks by overcoming the three shortcomings of the previous routing algorithms. It has the following features:

Low overhead: It eliminates overhead caused by route discovery and maintenance in the ad-hoc transmission mode, especially in a dynamic environment.

Hot spot reduction: It alleviates traffic congestion at mobile gateway nodes while makes full use of channel resources through a distributed multi-path relay.

High reliability. Because of its small hop path length with a short physical distance in each step, it alleviates noise and neighbor interference and avoids the adverse effect of route breakdown during data transmission. Thus, it reduces the packet drop rate and makes full use of spacial reuse, in which several source and destination nodes can communicate simultaneously without interference.



Fig,1: Data Transmission in the DTR protocol

When a source node wants to transmit a message stream to a destination node, it divides the message stream into a number of partial streams called segments and transmits each segment to a neighbor node. Upon receiving a segment from the source node, a neighbor node locally decides between direct transmission and relay transmission based on the QoS requirement of the application.

The neighbor nodes forward these segments in a distributed manner to nearby BSes. Relying on the infrastructure network routing, the BSes further transmit the segments to the BS where the destination node resides. The final BS rearranges the segments into the original order and forwards the segments to the destination. It uses the cellular IP transmission method to send segments to the destination if the destination moves to another BS during segment transmission. Our DTR algorithm avoids the shortcomings of ad-hoc transmission in the previous routing algorithms that directly combine an ad-hoc transmission mode and a cellular transmission mode. Rather than using the multi-hop ad-hoc transmission, DTR uses two hop forwarding by relying on node movement and widespread base stations.

The data routing process in DTR can be divided into two steps: uplink from a source node to the first BS and downlink from the final BS to the data's destination.

The uplink routing, a source node initially divides its message stream into a number of segments, then transmits the segments to its neighbor nodes. The neighbor nodes forward segments to BSes, which will forward the segments to the BS where the destination resides

When choosing neighbors for data forwarding, a node needs the capacity information (i.e., queue size and bandwidth) of its neighbors. Also, a selected neighbor should have enough storage space for a segment. To keep track of the capacity and storage space of its neighbors, each node periodically exchanges its current capacity and storage information with its neighbors. In the ad-hoc network component, every node needs to periodically send "hello" messages to identify its neighbors. Taking advantage of this policy, nodes piggyback the capacity and storage information onto the "hello" messages in order to reduce the overhead caused by the information exchanges. If a node's capacity and storage space are changed after its last "hello" message sending when it receives a segment, it sends its current capacity and storage information to the segment forwarder. Then, the segment forwarder will choose the highest capacity nodes in its neighbors based on the most updated information.

When a source node sends out message segments, it chooses the neighbors that have enough space for storing a segment, and then chooses neighbors that have the highest capacity. In order to find higher capacity forwarders in a larger neighbor hood around the source, each segment receiver further forwards its received segment to its neighbour with the highest capacity. That is, after a neighbor node m_i receives a segment from the source, it uses either direct transmission or relay transmission. If the capacity of each of its neighbours is no greater than itself, relay node uses direct transmission. Otherwise, it uses relay transmission. In direct transmission, the relay node sends the segment to a BS if it is in a BS's region. Otherwise, it stores the segment while moving until it enters a BS's region. In relay transmission, relay node m_i chooses its highest capacity neighbour as the second relay node based on the QoS requirement. The second relay node will use the direct transmission to forward the segment directly to a BS. As, a result the number of transmission hops help to increase the capacity of the network and reduce the channel contention in ad-hoc transmission.

According to DTR, if the source node has the highest capacity in its region, the segments will be forwarded back to the source node itself. The source node then forwards the segment directly to the BSes. This is due to the three hop limit. This case occurs only when the source node is the higher capacity node in its two hop neighborhood.

By distributing the message segments to different nodes which will lead to forwarding of segments in different direction. This will reduce the congestion in the network.

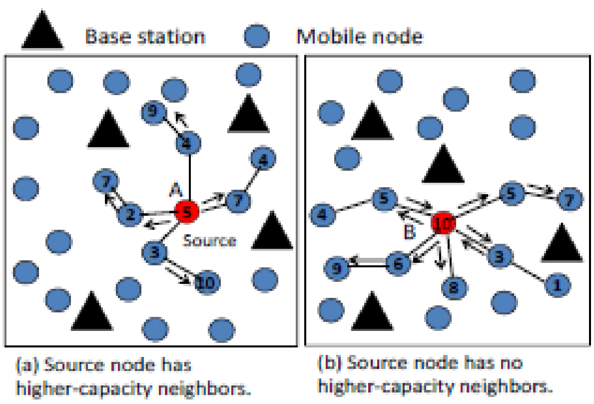


Fig.2: Neighbor node selection process in DTR[1]

The source node has the highest capacity among the nodes in its two-hop neighborhood. After receiving segments from the source node, some neighbors forward the segments back to the source node, which sends the message to its BS. Thus, DTR always arranges data to be forwarded by nodes with high capacity to their BSes. DTR achieves higher throughput and faster data forwarding speed by taking into account node capacity in data forwarding.

The figure 2 shows the neighbor node selection process in DTR. The value in the node represents its capacity. The figure 2(a) shows the neighbor node selection when the source node has the higher capacity neighbor nodes and figure 2(b) shows the condition when the source node has the highest capacity than its neighbor nodes.

After a BS receives a segment, it will forward the segment to the destination BS. After the destination BS receives the segments of the message, it rearranges the segments into the original message and then sends it to the destination mobile node. If a segment has not arrived at the final BS, its subsequent segments will wait until its arrival.

For arranging the segments in the correct order to form the original message, DTR specifies a segment structure format. Each segment contains eight fields: (1) source node IP address, S; (2) destination node IP address, D; (3) message sequence number, m; (4) segment sequence number, s; (5) QoS indication number, q; (6) data; (7) length of data; (8) checksum.

DTR significantly reduces overhead due to short path lengths and the elimination of route discovery and maintenance. DTR also has a congestion control algorithm to avoid overloading base stations. Theoretical analysis and simulation results show the superiority of DTR in comparison with other routing protocols in terms of throughput capacity, scalability and mobility resilience. The results also show the effectiveness of the congestion control algorithm in balancing the load between base stations. Data splitting based on Chinese remainder theorem will reduce data loss and lost data can be recollected.

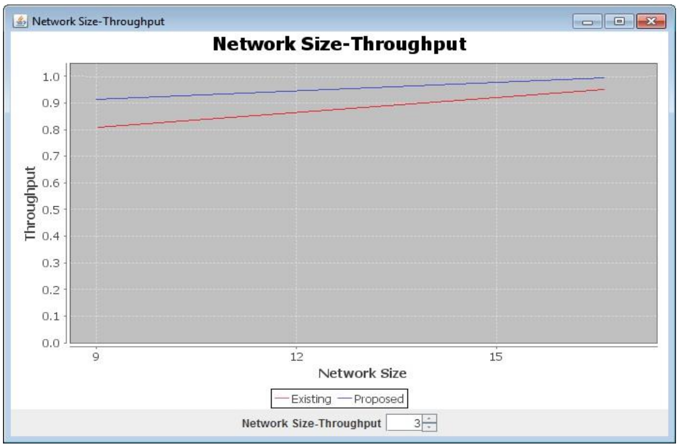
V PROTOCOL EVALUATION

This section includes the comparison of the performance of the existing and the proposed scheme.

The parameters for evaluation are:

1. Throughput:

The figure 3 is the network size vs throughput graph. The graph shows that the throughput increases as the network size increases. The throughput for the proposed system is more than the existing system. When number of nodes and BS increases packet loss can reduce



Fig,3: Comparison of Network size and Throughput

The figure 4 is the number of BS vs Throughput graph. The graph shows that the throughput remains constant for the proposed system but is more than the existing system.When number of BS increases the throughput will increases and packet loss can be reduce.

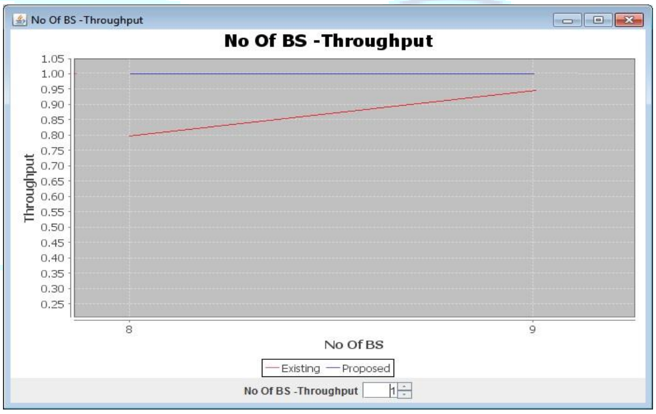


Fig.4: Comparison of Number of Base station and Throughput

2. Delay:

The figure 5 is the number of BS vs delay graph. The graph shows that the delay decreases as the number of BS in the network increases. The delay for the proposed system is less than the existing system.

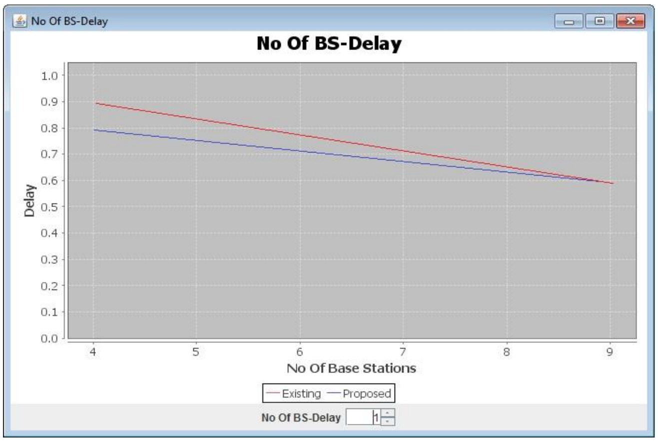


Fig.5: Comparison of Number of Base station and Delay

The figure 6 is the network size vs delay graph. The graph shows that the delay decreases as the network size increases in the proposed scheme. The delay for the proposed system is less than the existing system. When number of nodes and base station combines delay will reduce.

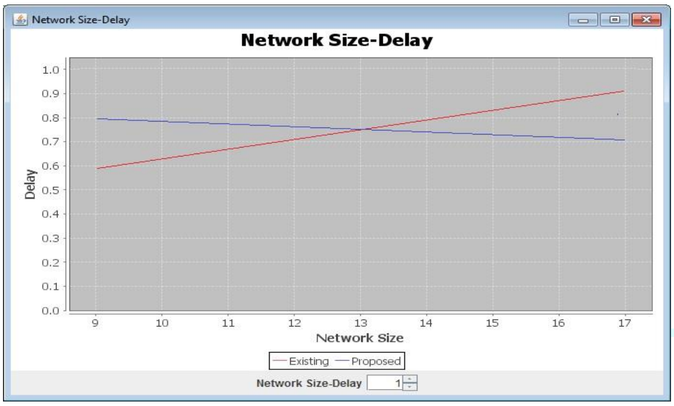


Fig.6: Comparison of Network size and Delay

VI. CONCLUSION

In DTR, a source node divides a message stream into segments and transmits them to its mobile neighbors, which further forward the segments to their destination through an infrastructure network. DTR limits the routing path length to three, and always arranges for high capacity nodes to forward data. Unlike most existing routing protocols, DTR produces significantly lower overhead by eliminating route discovery and maintenance. In addition, its distinguishing characteristics of short path length, short-distance transmission, and balanced load distribution provide high routing reliability and efficiency. DTR also has a congestion control algorithm to avoid load congestion in BSes in the case of unbalanced traffic distributions in networks. Theoretical analysis and simulation results show that DTR can dramatically improve the throughput capacity and scalability of hybrid wireless networks due to its high scalability, efficiency, and reliability and low overhead. Data splitting based on Chinese remainder theorem will reduce data loss. The lost data can be recollected.

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