

An Efficient Data Routing Protocol for WSN with high Network Capacity and Scalability

Radhika BG¹, Shalini S²P.G. Student, Department of Computer Science, AMC College of Engineering, Karnataka, India¹Assistant professor, Department of Computer Science, AMC College of Engineering, Karnataka, India²

ABSTRACT:An efficient data routing protocol is important to the reliable communication between end users in wireless networks. However, the infrastructure wireless networks and ad-hoc wireless networks suffer from channel congestion in routings, failing to guarantee high transmission reliability This paper presents a Distributed Three-Hop Routing Protocol (DTR) for hybrid wireless networks. To take full advantage of the widespread base stations, DTR divides a message data stream into segments and transmits the segments in a distributed manner. 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.

KEYWORDS:Hybrid wireless networks, Routing algorithm, Load balancing, Congestion control etc.

I. INTRODUCTION

A hybrid wireless network consists of both an infrastructure wireless network and a mobile ad-hoc network (MANETs). 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. The data is routed to its destination through the intermediate nodes in a multi-hop manner. In the mobile ad-hoc network, with the absence of a central control infrastructure. In multi-hop routing the messages are transmitted in wireless channels and through dynamic routing paths and this kind of routing needs on-demand route discovery or route maintenance. For local area data transmission mobile ad-hoc networks are suitable.

To increase the throughput capacity of a wide-area wireless network a hybrid wireless network [1-6], combines together an infrastructure wireless network and a mobile ad- hoc network to use their advantages and overcome their shortcomings. A routing protocol is a critical component that affects the through- put 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 [7-10] 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 in bits/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.

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

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1.1 Hot Spots

Since the most traffic goes through the same gateway, and the flooding employed in mobile ad-hoc routing to discover routes may exacerbate the hot spot problem. Hot spots are generated due to, mobile nodes only use the channel resources in their route direction, which may while leave resources in other directions under-utilized. Hot spots lead to and high data dropping rates, low transmission rates and severe network congestion

1.2 High Overhead

The wireless random access medium access control (MAC) required in mobile ad-hoc networks, which utilizes control handshaking and a back-off mechanism, increases the overhead. Route discovery and maintenance encounter high overhead.

1.3 Low reliability

Noise interference and neighbour interference during the multi-hop transmission process cause a high data drop rate. Dynamic and long routing paths lead to unreliable routing. Long routing paths increase the probability of the occurrence of path breakdown due to the highly dynamic nature of wireless ad-hoc networks.

In achieving high throughput capacity and scalability in hybrid wireless networks. These problems become an obstacle

Taking advantage of this feature, we propose a 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 neighbour mobile node. Based on the QoS requirement, these mobile relay nodes choose between direct transmission 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 [11]. To overcome the aforementioned shortcomings, DTR tries to limit the number of hops. The first hop forwarding distributes the segments of a message in different directions to fully utilize the resources, and the possible second hop forwarding ensures the high capacity of the forwarder. DTR also has a congestion control algorithm to balance the traffic load between the nearby BSes in order to avoid traffic congestion at BSes.

DTR significantly increases the throughput capacity and scalability of hybrid wireless networks by overcoming the three shortcomings of the previous routing algorithms. Using self-adaptive and distributed routing with high-speed and short-path ad-hoc transmission, it has the following features:

- Hot Spot Reduction - It reduces the traffic congestion at mobile gateway nodes while makes full use of channel resources through a distributed multi-path relay
- Low overhead in a dynamic environment, it eliminates overhead caused by route discovery and maintenance in the ad-hoc transmission mode.
- High reliability. Because of its small hop path length with a short physical distance in each step, it reduces noise and neighbour 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.

II. DISTRIBUTED THREE-HOP ROUTING PROTOCOL

2.1 Assumption and Overview:

Since BSEs are associated with a wired spine expect that there are no transmission capacity and force imperatives on transmissions between BSEs. We utilize transitional hubs to mean transfer hubs that capacity as doors interfacing an infrastructure wireless network and a mobile ad-hoc network. We accept each mobile hub is double mode; that is, it has ad-hoc network interface such as a WLAN radio interface and infrastructure network interface, for example, a 3G cellular interface.

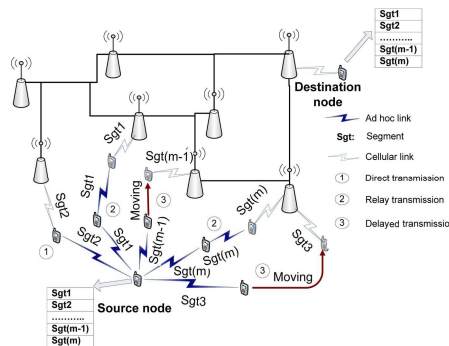


Figure. 2: Data transmission in the DTR protocol.

DTR intends to move the routing trouble from the adhoc network to the infrastructure network by taking advantage of widespread base stations in a half and half wireless network. Instead of utilizing one multi-jump way to forward a message to one BS, DTR utilizes at most two bounces to transfer the fragments of a message to various BSEs in a disseminated way, and depends on BSEs to join the fragments. We improve the routings in the infrastructure network for clarity.

As appeared in the figure, when a source hub needs to transmit a message stream to a destination hub, it partitions the message stream into various halfway streams called fragments what's more, transmits every portion to a neighbour hub. Upon accepting a portion from the source hub, a neighbour hub locally settles on direct transmission and hand-off transmission in view of the QoS prerequisite of the application. The neighbour hubs forward these portions in a circulated way to close-by BSEs. Depending on the infrastructure network routing, the BSEs further transmit the portions to the BS where the destination hub dwells. The last BS adjusts the fragments into the unique request and advances the portions to the destination. It utilizes the cellular IP transmission strategy to send portions to the destination if the destination moves to another BS amid portion transmission.

2.2 Uplink Data Routing:

In this work, we take throughput and routing speed as samples for the QoS prerequisite. We utilize a data transfer capacity/line metric to reflect hub limit in throughput and quick information sending. The metric is the proportion of a hub's channel transfer speed to its message line size. A bigger data transfer capacity/line esteem implies higher throughput and message sending velocity and the other way around.

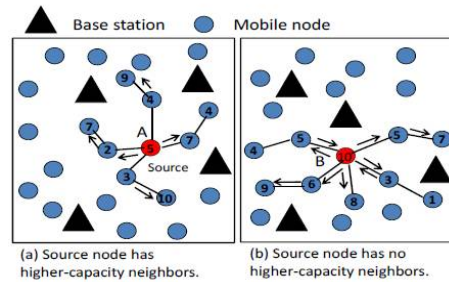


Figure. 2: Neighbour selection in DTR.

Figure. 2 indicates illustrations of neighbour determination in DTR, in which the source hub is in the transmission scope of a BS. In the figures, the worth in the hub speaks to its ability. In situation (a), there exist hubs that have higher limit than the source hub inside of the source's two-jump neighbourhood. In the event that a routing calculation straightforwardly give a source hub a chance to transmit a message to its BS, the high routing execution can't be ensured subsequent to the source hub might have low limit. In DTR, the source hub sends sections to its neighbours, which further forward the sections to hubs with higher limits.

In situation (b), the source hub has the most elevated limit among the hubs in its two-bounce neighbourhood. Subsequent to getting fragments from the source hub, a few neighbours forward the fragments back to the source hub, which sends the message to its BS. Along these lines, DTR dependably masterminds information to be sent by hubs with high capacity to their BSes. DTR accomplishes higher throughput what's more, quicker information sending speed by considering hub limit in information sending. DTR uses two phases of algorithm as mentioned below. Phase1 is the Algorithm 1 which describes the pseudo-code for neighbour node selection and message forwarding in DTR.

Phase 2 is the Algorithm 2 which describes the Pseudo-code for a BS to reorder and forward segments to destination nodes.

Algorithm 1

Pseudo-code for neighbour node selection and message forwarding.

```

1: ChooseRelay( ) {
2: //choose neighbours with sufficient caches and bandwidth/queue (b/q) rates
3: Query storage size and QoS requirement info. from neighbours
4: for each neighbour n do
5: if n.cache.size>segment.length&& n.b/q>this.b/q then
6: Add n to R = {r1, . . . rm, ...} in a descending order of b/q
7: end if
8: end for
9: Return R
10: }
11: Transmission( ) {
12: if it is a source node then
13: //routing conducted by a source node
14: //choose relay nodes based on QoS requirement
15: R=ChooseRelay( );
16: Send segments to {r1, . . . rm} in R
17: else
18: //routing conducted by a neighbour node
19: if this.b/q  $\square$  b/q of all neighbourthen
20: //direct transmission
21: if within the range of a BS then

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22: Transmit the segment directly to the BS
23: end if
24: else
25: //relay transmission
26: nodei=getHighestCapability(ChooseRelay( ))
27: Send a segment to nodei
28: end if
29: else
```

Algorithm 2

Pseudo-code for a BS to reorder and forward segments to destination nodes.

```
1: //a cache pool is built for each data stream
2: //there are n cache pools currently
3: if receives a segment (S,D,m,s,q) then
4: if there is no cache pool with msg sequence num equals m then
5: Create a cache pool n + 1 for the stream m
6: else
7: //the last delivered segment of stream m has sequence num i - 1
8: if s == i then
9: Send out segment (S,D,m,s,q) to D
10: i++;
11: else
12: Add segment (S,D,m,s) into cache pool m
13: end if
14: end if
```

2.3 Downlink Data Routing and Data Reconstruction:

As said over, the message stream of a source hub is separated into a few fragments. After a BS gets a segment, it needs to forward the fragment to the BS, where the destination hub dwells (i.e., the destination BS). We utilize the mobile IP convention to empower BSes to know the destination BS. In this convention, every mobile hub is connected with a home BS, which is the BS in the hub's home network, paying little heed to its present area in the network. The home network of a hub contains its enlistment data distinguished by its place of residence, which is a static IP address allocated by an ISP. In a Hybrid wireless network, every BS intermittently emanates reference point signs to find the mobile hubs in its reach.

At the point when a mobile hub m_i moves far from its home BS, the BS where m_i right now dwells recognizes m_i and sends its IP address to the home BS of m_i . At the point when a BS needs to contact m_i , it contacts the home BS of m_i to discover the destination BS where m_i right now lives at. Nonetheless, the destination BS recorded in the home BS may not be the most forward destination BS since destination mobile hubs switch between the scope locales of various BSes amid information transmission to them. For example, information is transmitted to BS B_i that has the information's destination, however the destination has moved to the scope of BS B_j before the information lands at BS B_i .

To manage this issue, we adopt the Cellular IP convention for following hub areas. With this convention, a BS has home specialists and remote operators. The remote specialists monitor mobile hubs moving into the scopes of different BSes. The home specialists blocks in-coming sections, recreates the first information, and re-courses it to the remote specialists, which then advances the information to the destination mobile hub. After the destination BS gets the sections of a message, it reworks the sections into the first message and afterward sends it to the destination mobile hub. A basic issue is ensuring that the sections are consolidated in the right request. For this reason, DTR indicates the fragment structure group. Every section contains eight fields, including: (1) source hub IP address (signified by S); (2)

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destination hub IP address (signified by D); (3) message succession number (indicated by m); (4) portion succession number (signified by s); (5) QoS sign number (signified by q); (6) information; (7) length of the information; and (8) checksum. Fields (1)- (5) are in the portion head. The part of the source IP address field is to educate the destination hub where the message originates from. The destination IP address field shows the destination hub, and is utilized to find the last BS. In the wake of sending out a message stream to a destination, a source hub might convey another message stream to the same destination hub.

The message arrangement number separates the distinctive message streams started by the same source hub. The portion arrangement number is utilized to discover the right transmission arrangement of the portions for transmission to a destination hub. The information is the real data that a source hub needs to transmit to a destination hub. The length field determines the length of the DTR portion incorporating the header in bytes. The checksum is utilized by the beneficiary hub to check whether they got information has blunders. The QoS sign number is used to demonstrate the QoS necessity of the application.

Hybrid wireless networks have been accepting expanding consideration as of late. A half and half wireless network joining an infrastructure wireless network what's more, a mobile ad-hoc network influences their advantages to build the throughput limit of the framework. Be that as it may, current Hybrid wireless networks essentially consolidate the routing conventions in the two sorts of networks for information transmission, which keeps them from accomplishing higher framework limit. In this paper, we propose a Conveyed Three-jump Routing (DTR) information routing convention that incorporates the double components of cross breed wireless networks in the information transmission process. In DTR, a source hub partitions a message stream into fragments and transmits them to its mobile neighbours, which encourage forward the fragments to their destination through an infrastructure network. DTR limits the routing way length to three, and dependably masterminds high-limit hubs to forward information. Dissimilar to most existing routing conventions, DTR creates essentially bring down overhead by killing course disclosure and support. In addition, its recognizing attributes of short way length, short-remove transmission, and adjusted load appropriation give high routing unwavering quality and effectiveness. DTR likewise has a blockage control calculation to keep away from load blockage in BSes on account of uneven movement disseminations in networks. Hypothetical examination and re-enactment results demonstrate that DTR can drastically enhance the throughput limit and adaptability of half and half wireless networks because of its high adaptability, effectiveness, and dependability and low overhead.

III. CONCLUSION

Hybrid wireless networks have been accepting expanding consideration as of late. A half and half wireless network joining an infrastructure wireless network what's more, a mobile ad-hoc network influences their advantages to build the throughput limit of the framework. Be that as it may, current Hybrid wireless networks essentially consolidate the routing conventions in the two sorts of networks for information transmission, which keeps them from accomplishing higher framework limit. In this paper, we propose a Conveyed Three-jump Routing (DTR) information routing convention that incorporates the double components of cross breed wireless networks in the information transmission process. In DTR, a source hub partitions a message stream into fragments and transmits them to its mobile neighbours, which encourage forward the fragments to their destination through an infrastructure network. DTR limits the routing way length to three, and dependably masterminds high-limit hubs to forward information. Dissimilar to most existing routing conventions, DTR creates essentially bring down overhead by killing course disclosure and support. In addition, its recognizing attributes of short way length, short-remove transmission, and adjusted load appropriation give high routing unwavering quality and effectiveness. DTR likewise has a blockage control calculation to keep away from load blockage in BSes on account of uneven movement disseminations in networks. Hypothetical examination and re-enactment results demonstrate that DTR can drastically enhance the throughput limit and adaptability of half and half wireless networks because of its high adaptability, effectiveness, and dependability and low overhead.

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