Novel Approach for Routing in MANET:NARM

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ABSTRACT
Mobile device users use their devices any time anywhere. Hence there are different constraints we discussed on routing in MANET. Several routing protocols have been proposed in recent years for deployment of MANET. There are three types of MANET routing protocols reactive, proactive and hybrid. In this paper we have analyzed all these approaches and discussed their pros and cons. The practical reason behind failure of these approaches is asymmetric link. From analysis we have proposed Novel Approach for Routing in MANET (NARM) which is combination of three approaches reactive, proactive and zone based.

General Terms
Communication Engineering, Wireless Adhoc networks, MANET.

Keywords
Routing in MANET, reactive, proactive, hybrid, NARM.

1. INTRODUCTION
In next generation of wireless communication systems, there is a tremendous need for the rapid deployment of independent mobile users. Significant examples include emergency search/rescue missions, disaster relief efforts, mine site operations, battlefield military operations, electronic classrooms, conferences, convention centers, [1] etc. A network of such users is referred to as Mobile Ad hoc Network (MANET). Such a network does not have any fixed infrastructure (i.e., no base stations/ routers); nodes arbitrarily change their positions resulting in a highly dynamic topology causing wireless links to be broken and re-established on the-fly. In MANET world devices such as laptops, PC, pda etc with adhoc communication link capability. MANET is infrastructure less multihop network

Routing in ad hoc networks has been an active research area and in recent years numerous routing protocols have been introduced for MANETs. The deployment of such networks still faces challenges, such as limited physical security, node mobility, and limited resources[2,3] (i.e., processor, power, bandwidth, storage). The major issues that affect the design, deployment, and performance of a MANET include: medium access scheme, routing, multicasting, transport layer protocol, pricing scheme, quality of service provisioning, self organization, security, energy management, addressing and service discovery, scalability and deployment consideration. The protocol design issues are inherently related to the underlying ad hoc applications. Routing protocols are designed for purposes such as quality of service provisioning, energy management and security. In this paper, we focus on security aspects of the MANET routing protocols.

In section 2 we will discuss constraints on routing in MANET. In section 3 we discussed existing routing protocols and their pros and cons. In section 4 we proposed NARM. Finally we have drawn conclusion in section 5.

2. CONSTRAINTS ON ROUTING IN MANET
Major challenges that a routing protocol designed for Ad Hoc wireless networks faces include: mobility of nodes, resource constraints, error-prone channel state, and hidden and exposed terminal problems.

Mobility: the network topology in an ad hoc wireless network is highly dynamic due to the movement of nodes and the addition of new nodes to the network. Disruption in service may occur either due to the movement of the intermediate nodes in the path or due to the movement of the end nodes.

Bandwidth constraints: in wireless networks, the capacity of the radio band is limited and hence the data rates it can offer are much less than what a wired network can offer. That is why the routing protocol should use the bandwidth optimally to keep the overhead as low as possible.

Error-Prone Channel state: the wireless links have time-varying characteristics in terms of link capacity and link-error probability. This requires that the ad hoc wireless network routing protocol should interact with the MAC layer to find alternate routes through better quality links.

Hidden terminal problem: refers to the collision of packets at a receiving node due to the simultaneous transmission of those nodes that are not within the direct transmission range of the sender, but are within the transmission range of the receiver. Collations occur when both nodes transmit packets at the same time without knowing about the transmission of each other. Solution to this problem includes the use of Medium Access Collision Avoidance for Wireless MACAW. This protocol requires that the receiver acknowledges each successful reception of data packet. Successful transmission is a four-way exchange mechanism, namely RTS-CTS-Data-ACK.

Exposed terminal problem: refers to the inability of a node to transmit to another node when the wireless channel is not free due to transmission by the nearby transmitting node.

Resource constraints: battery life and processing power are two essential and limited resources that form the major constraint for the nodes in an ad hoc network. Thus ad hoc wireless network routing protocols must optimally manage these resources.

3. EXISTING ROUTING IN MANET

There, are three types of flat routing strategies exist in MANET. These are reactive, proactive and hybrid[4].

3.1 Proactive Routing

Proactive MANET protocols are also called as table-driven protocols and will actively determine the layout of the network. Through a regular exchange of network topology packets between the nodes of the network, at every single node an absolute picture of the network is maintained. There is hence minimal delay in determining the route to be taken. This is especially important for time-critical traffic. When the routing information becomes worthless quickly, there are many short-lived routes that are being determined and not used before they turn invalid. Therefore, another drawback resulting from the increased mobility is the amount of traffic overhead generated when evaluating these unnecessary routes. This is especially altered when the network size increases. The portion of the total control traffic that consists of actual practical data is further decreased. Lastly, if the nodes transmit infrequently, most of the routing information is considered redundant. The nodes, however, continue to expend energy by continually updating these unused entries in their routing tables as mentioned, energy conservation is very important in a MANET system design. Therefore, this excessive expenditure of energy is not desired. Thus, proactive MANET protocols work best in networks that have low node mobility or where the nodes transmit data frequently. Examples of proactive routing protocols are optimized link state routing protocol (OLSR)[5], destination sequenced distance vector routing (DSDV)[6].

3.2 Reactive Protocols

Portable nodes- Notebooks, palmtops or even mobile phones usually compose wireless ad-hoc networks. This portability also brings a significant issue of mobility. This is a key issue in ad-hoc networks. The mobility of the nodes causes the topology of the network to change constantly. Keeping track of this topology is not an easy task, and too many resources may be consumed in signaling. Reactive routing protocols were intended for these types of environments. These are based on the design that there is no point on trying to have an image of the entire network topology, since it will be constantly changing. Instead, whenever a node needs a route to a given target, it initiates a route discovery process on the fly, for discovering out a pathway.

Reactive protocols start to set up routes on-demand. The routing protocol will try to establish such a route, whenever any node wants to initiate communication with another node to which it has no route. This kind of protocols is usually based on flooding the network with Route Request (RREQ) and Route reply (RERP) messages .By the help of Route request message the route is discovered from source to target node; and as the target node gets a RREQ message it send RERP message for the confirmation that the route has been established. This kind of protocol is usually very effective on single-rate networks. It usually minimizes the number of hops of the selected path. However, on multi-rate networks, the number of hops is not as important as the throughput that can be obtained on a given path. Examples of reactive routing protocols are adhoc on demand distance vector (AODV)[8], Dynamic source routing(DSR)[7].

3.3 Hybrid Routing

Since proactive and reactive protocols each work best in oppositely different scenarios, hybrid method uses both. It is used to find a balance between both protocols. Proactive operations are restricted to small domain, whereas, reactive protocols are used for locating nodes outside those domains.

Both methods explained before, only demonstrate good performance under certain conditions. But what if a balance point between proactive and reactive routing is found by adjusting the degree to which route information is propagated proactively versus the degree to which it needs to be discovered reactively? If we combine the advantages of both techniques obtaining as a result a particular routing protocol which is able to adapt himself to the behavior of the network.

By a Hybrid routing protocol the following characteristics must be present

- Adaptive: should be applicable to wide range of network characteristics. Node mobility, traffic patterns should be handled easily.
- Flexible: should enable the optimization. Applications should be able to be adapted to the different application-specific metrics at the routing layer .These goals should be set by the network participants
- Efficient and Practical: The protocol should achieve better performance than pure, non-hybrid, strategies without invoking costly low-level primitives. Such as reliable broadcasts and distributed agreements

Hybrid protocols try to explode the benefits of both Proactive and Reactive protocols.

- The proactive part of the protocol is reduced to a small neighborhood of a node. The network is divided in small networks in order to decrease the problem of delay.
- The reactive part is used for routing across the network. Routing in large scale networks is implemented to reduce the overhead control problem.

The main difference between the Hybrid Adaptive protocols is the way they implement the PRP and RRP, and the way they define the routing zones. Next, we will brifely describe the most known Hybrid protocol, to finally compare them with each other

Example of hybrid protocols are zone routing protocol (ZRP)[9], cluster based routing protocol(CBRP)[10].

Parameter	**AODV**	**DSR**	**DSDV**	**OLSR**	**ZRP**	**CBRP**
Control message	3 types-RREQ,RREP,RERR	3 types-RREQ,RREP,RERR	2 type-HELLO & Update	2 type-HELLO and TC	Hello, Update, for inter zone-RREQ,RREP	HELLO ,RREQ,RREP,RERR
Central Administration	NO	NO	NO	NO	node	Cluster head
Route discover	Each source node broadcast RREQ on demand	Each source node broadcast RREQ on demand	Already have info for all destination	Already have info for all destination	For intra zone have info , but for inter zone broadcast RREQ	For intra cluster have info , but for inter zone broadcast RREQ
Loop free routing	Yes, Due to sequence no.	Yes , due to address in packet header	Yes, due to sequence no.	Yes, due to sequence no.	Yes.	Yes.
Type of routing	Hop by hop	Source routing	Hop by hop	Hop by hop	Hop by hop	Hop by hop, but for inter zone source routing
Link support	Symmetric	Symmetric	Symmetric	Link to MPR-Symmetric, rest can be anything	Symmetric	Supports both Symmetric, Asymmetric
How path is build	By keeping backward pointer and forwards RREQ	Intermediate node insert its address in packer	Next hop is calculated by neighbors routing table	Next hop is calculated by neighbors routing table	Intra zone by routing table, inter zone on demand	Intra cluster by routing table, inter zone on demand
Scalable	Yes but vulnerable to network change	No	No	No	Yes	No
Protocol type	Reactive	Reactive	Proactive	Proactive	Hybrid	Hybrid
Metric	Shortest path	Shortest path	Shortest path	Cost	Shortest path	Shortest path
Advantage	At higher load incur lower delay; Unicast, multicast and broadcast communication possible.	Better in terms of collision; Doesn't flood network with updates; Routes maintained only when communication is done; Single route discovery may result multiple route to same destination	In small network size delay is smallest and throughput is high; Guarantees loop free	Limited broadcasting due to MPR; Being proactive routes to all destination available; Useful in application where less route discovery delay required	It tries to maintain most up to date map of network; Requires less bandwidth ; Mobility of cluster head	Use of clustering to minimize on demand route discovery; Link break locally repaired; Mobility of cluster head
Diadvantage	Collision is high; Route discovery latency in high scale network; Lack of efficient maintenance technique	Access delay increases and throughput decrease as increase in network size; Route maintenance mechanism doesn't locally repair broken link ; Route cache may	Higher delays for large network; Wastage of bandwidth due to unnecessary updates even if no change; Difficult to	Due to periodic update bandwidth is wasted; Maintains route most of which never used	Latency for finding new routes; If node not in any zone cannot communicate	Due to source routing , if network size grows packet size increases; Useful in small cluster only

		stale; Connection set up delay is high; As network grows packet header size grows	determine time delay for advertisement			

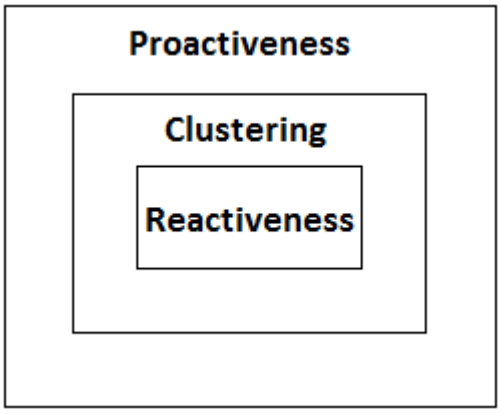
4. NOVEL APPROACH FOR ROUTING IN MANET:NARM

In this section we have proposed a novel mechanism for routing in mobile adhoc network.

In previous section we have already discussed current routing strategies, its advantages and limitations. By analyzing current mechanisms we have proposed novel approach for routing in MANET (NARM) to overcome their limitation. NARM is composed of all three strategies reactive, proactive and zone based.

4.1 Layered Architecture of NRAM

Figure 1.Architecture of NARM



4.1.1 Reactiveness

We have analyzed simulations of various MANET routing protocols which was previously done.From analysis it has been realized that reactive protocols viz.AODV, DSR had performed moderately in different situations of changing parameter.

Hence at the core layer of NARM is reactiveness. A node will build path only when it is required.

4.1.2 Clustering

Any protocol will be successful only if there is proper dissemination of information throughout network. To achieve that dissemination we have defined concept of cluster and there will be corresponding cluster head.

The difference in NARM and zone based routing is that, in NARM cluster heads are responsible for information dissemination, not for routing as in zone based protocol. In NARM cluster head does not perform any kind of calculation as in zone based.So even if cluster head moves or goes sleep, new cluster head has to just collect and disseminate information from other cluster heads. Hence there will be no overhead .

4.1.3 Proactiveness

Cluster heads defined in previous section are always proactive in nature while other nodes are reactive in nature.

4.2 NARM

4.2.1 Starting phase:

First of all there will be cluster formation. Each cluster will have cluster head(CH). Each node broadcasts HELLO packet to its one hope neighbors.No reply will be send to these packets. Each node informs CH about from which nodes it has received HELLO packets. Suppose node A received HELLO packet from node B. This means node A is reachable from node B. So B→A.

Hence cluster head maintains topological information in minimized form. Each cluster head will share this information to other cluster heads.

4.2.2 Communication phase

Suppose node A wants to transfer message no node E. First node A imports topological information from its corresponding CH. Based on information it constructs unidirectional graph. Sending node attach intermediate nodes address in packet and forward message.

Here as nodes are constructing unidirectional graph, problem of asymmetric link will be resolved. There is issue regarding scalability because intermediate nodes address will be in packet. To deal with this issue, we limit the number of intermediate node address in packet. When address number of address requires more than limit, the last intermediate node in packet will repeat procedure according to receiver. Suppose node A wants to send data to node P. If last intermediate node in packet is node G. Then node G has responsibility to deliver packet to node P.

As this is adhoc network we have different constraints as discussed in previous section. So to have proper communication intermediate node has to perform this operation.

4.2.3 Network Updates

Updates are generated due to mobility of nodes , new incoming nodes etc. Suppose a node did not received HELLO packet from a certain node from specific period of time or it receives HELLO packet from new node. It informs to corresponding cluster head about this updates. Each CH shares this information. On demand these updates are send to node.

4.3 NARM vs. Existing Strategies

4.3.1 NARM vs Reactive protocols

Basic idea behind NARM is- "protocol is on demand, but there should be a node near to sender node which gives topological info to sender as fast as possible". Also routes calculation are done locally. Hence there will be no messages overhead as in existing reactive protocols. In existing reactive protocols there is too much message overhead., to get small information networks is flooded with many control packets. In case NARM , route calculation is done locally. Information is

gathered from CH. So there is not too much messages over heads.

4.3.2 NARM vs. Zone Based Protocols

NARM is different than zone based protocol. In zone based protocol CH are responsible for routing overheads. In NARM cluster heads are responsible only for information dissemination. So even if CH moves, new incoming head does not have to perform any calculation .So there is no overhead involved in CH mobility.

4.3.3 NARM vs. Proactive protocols

In NARM only cluster heads are proactive in nature. All cluster heads are in frequent contact with each other.

4.4 Assessment of NARM on Quality Metrics

4.4.1 Loop freedom

NARM is free from loops.Protocol plots unidirectional graph. It will definitely helps to keep packe free from loops.

4.4.2 On demand behavior

Every node except CH are on demand in nature. At the core of NARM is on demand behavior. Everything is established on demand.

4.4.3 Proactive behavior

CH are proactive in nature. There should be appropriate dissemination of information throughout network hence these node are proactive.

4.4.4 Uni directional link support

Major reason behind failure of existing approaches is no support for unidirectional link. In existing protocols it is assumed that links are symmetric. But in practical scenario it is not true. Links may be asymmetric. NARM supports asymmetric link.

4.4.5 Scalability

NARM is scalable. Routing task is logically divided. As discussed in previous section last intermediate nodes performs in packet performs further operation.

5. CONCLUSION AND FUTURE WORK

From analysis of drawbacks of current routing approaches we have proposed novel approach for routing in MANET (NARM). This approach is combination of reactive, proactive and zone based strategy. Theoretically we prove that NARM is much better than any existing approaches on basis on its quality metrics.

Future work of this approach is to integrate scheme with security mechanisms.

6. REFERENCES

[1] P. Michiardi and R. Molva,, "CORE: A Collaborative Reputation Mechanism to Enforce Node Cooperation in Mobile Ad Hoc Networks," *IFIP-Communication and Multimedia Security Conf. 2002* .

[2] Mobile Ad hoc Networks: Challenges and Future, Kavita Taneja, B. Patel2, National Conference on Challenges & Opportunities in Information Technology (COIT-2007) RIMT-IET, Mandi Gobindgarh. March 23, 2007.

[3] MANET: Vulnerabilities, Challenges, Attacks, Application,Priyanka Goyal,Vinti Parmar, International Journal of Computational Engineering & Management, Vol. 11, January 2011

[4] A Survey of Secure Mobile Ad Hoc Routing Protocols, Loay Abusalah, Ashfaq Khokhar, and Mohsen Guizani IEEE COMMUNICATIONS SURVEYS & TUTORIALS, VOL. 10, NO. 4, FOURTH QUARTER 2008.

[5] Georgios Kioumourtzis, "Simulation and Evaluation of Routing Protocols for Mobile Ad Hoc Networks", Thesis, Master of Science in Systems Engineering and Master of Science in Computer Science**,** *Naval Postgraduate School*, Monterey, California, 2005.

[6] C. E. Perkins and P. Bhagwat, "Highly dynamic destinationsequenced distance vector routing (DSDV) for mobile computers", *Proceedings of ACM SIGCOMM 94*, pp. 34–244, 1994.

[7] D. B. Johnson, D. A. Maltz, Y.C. Hu, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)", *IETF Internet Draft*, 2003.

[8] A. Kush and S. Taneja, "A Survey of Routing Protocols in Mobile Adhoc Networks", *International Journal of Innovation, Management and Technology*, Vol. 1, No. 3, pp 279-285, 2010.

[9] Performance Evaluation of ZRP over AODV and DSR in Mobile Adhoc Networks Using Qualnet, European Journal of Scientific Research, SreeRangaRaju , Jitendranath Mungara,2010

[10] Comparative Analysis of CBRP, DSR, AODV Routing Protocol in MANET,Mukesh Kumar, Rahul Rishi ,International Journal on Computer Science and Engineering 2010.