International Journal of Scientific & Engineering Research, Volume 4, Issue 12, December-2013 256
ISSN 2229-5518

An Overview on Mobile Ad Hoc Wireless Network & Types of Routing Protocols

Miss. Utkarsha Govindwar, Miss Sakshi Tundulwar

Abstract— A mobile ad hoc network (MANET) is a self-configuring infrastructureless network of mobile devices connected by wireless. Ad hoc is Latin and means "for this purpose".[1] Or it is a collection of mobile nodes that are dynamically and arbitrarily located in such a manner that the interconnections between nodes are capable of changing on a continual basis. In order to facilitate communication within the network, a routing protocol is use to discover routes between nodes. The primary goal of such an ad hoc network routing protocol is correct and efficient route establishment between a pair of nodes so that messages may be delivered in a timely manner. MANET nodes are typically distinguished by their limited power, processing, and memory resources as well as high degree of mobility.In this course we will focus our attention on overview on MANET and its current routing protocols which provides connectivity in mobile Ad Hoc networks.

Index Terms— Ad hoc wireless networks,Ad Hoc routing protocols, Table driven protocol,source initiated protocol.

1 Introduction

WITH the recent advances in technology, it is very common place to find portable computing devices such as computer notebooks and Personal Digital Assistants (PDA) that have wireless interfaces that allows communication with other such mobile users. Such wireless interfaces include BlueTooth and wireless LANs. Currently the common mode of wireless communication is one with a mobile device connected to the internet via a wired router i.e. the wireless communication is only the last hop. Sometimes it is not practical or physically possible to set up a fixed wired infrastructure. Some examples include military uses where personnel needs to communicate with one another in a territory where there are no fixed networks available or business associates who need to share files with each other in places such as airport terminals or public meeting places. In such situations, the mobile hosts should be able modify to the form a temporary network without any established infrastructure or administration. This type of network is known as an *ad hoc network*

The mobile Ad Hoc networks Infrastructureless networks have no fixed routers; all nodes are capable of movement and can be connected dynamically in an arbitrary manner. Nodes of these networks function as routers which discover and maintain routes to other nodes in the network. Example applications of ad hoc networks are emergency search-and-rescue operations, meetings or conventions in which persons wish to quickly share information, and data acquisition operations in inhospitable terrain. This article examines routing protocols designed for these ad hoc networks and then overview of these protocols.

• *Utkarsha Govindwar is currently pursuing bachelor degree program in Computer Science and engineering in JDIET, Yavatmal, India, E-mail:*
• *Sakshi Tundulwar is currently pursuing bachelor degree program in Computer Science and engineering in JDIET, Yavatmal, India, E-mail:*

2 Routing Protocols

Although in an ad hoc network, two hosts may not be within transmission range of each other, but they can still communicate via other hosts that will then act as routers to direct the messages to and fro these two hosts. Hence some form of routing protocol is necessary to determine which router would pass the message on such that the message reaches its intended recipient. The routing protocol would then have two main functions, the selection of routes for the various source-destination pairs and the delivery of messages to the correct destination.

Conventional routing protocols such as link state and distance vector routing have proven their effectiveness in the realm of wired fixed networks. However, they are designed to work best in a static topology network. But mobile ad hoc networks, as stated above, have dynamic topologies due to the mobile nature of the hosts. This will lead to problems when the protocol tries to converge to a steady state. **[4]**

Another shortcoming of conventional routing protocols under an ad hoc network environment is the need for periodic control messages. This means that every mobile host has to broadcast updates every now and then and this is very costly on the already limited resources that each mobile host has, be it bandwidth or power source.

IETF (Internet Engineering Task Force) has a working group called MANET that aims to standardize IP routing protocol functionality for wireless routing within static and dynamic topologies [9]. Currently it aims to promote a few protocol specifications to experimental RFC status before introducing them to the Internet Standards track. Currently they have a few drafts of some routing protocols of which we are going to discuss some of them later.

2.1 Desirable Properties

To be considered an efficient routing protocol, it must have certain desirable properties. Below is a list of desirable qualitative properties that an ad hoc routing protocol should have [4]:

Distributed operation - Since in an ad hoc network there is no centralized administration, any host or node can leave on enter the network as and when it pleases. Hence routing of messages cannot depend on a master or a small group of master hosts.

Loop free – This property is desired to avoid problems such as a small fraction of packets spinning around in the network for arbitrary time periods. Although there are other ways to solve the problem, having a better structured approach would improve performance.

Demand-based operation – Instead of continuous route maintenance, it is an added advantage to let the routing protocol adapt to the traffic pattern on a need-to basis. This can reduce network traffic and enables the utilization of bandwidth more efficiently.

Proactive operation – This is the opposite of demand-based operation. Although different, this property might be desirable in situations whereby the additional latency that the demandbased operation incurs may be unacceptable.

Unidirectional link support – An ad hoc network is different from a fixed infrastructure network as the direction of data flow may not be bi directional due to physical reasons. Hence the routing protocol must be able to work in situations where data can only be transmitted in one direction.

Security – As stated in the previous section, ad hoc networks are more vulnerable to security problems hence the routing protocol should have sufficient security protection to prevent the modification of protocol operation.

Sleep period operation – The mobile hosts in an ad hoc network are most likely to be running on battery and hence sometimes require to be inactive, or in 'sleep' mode. The routing protocol should be able to accommodate such modes where the hosts may stop transmitting or receiving data for a certain time.

3 Existing Ad Hoc Routing Protocols

Since the advent of Defense Advanced Research Projects Agency (DARPA) packet radio networks in the early 1970s [1], numerous protocols have been developed for ad hoc mobile networks. Such protocols must deal with the typical limitations of these networks, which include high power consumption, low bandwidth, and high error rates. As shown in Fig. 1, these routing protocols may generally be categorized as:

- Table-driven
- Source-initiated (demand-driven)

Solid lines in this figure represent direct descendants, while dotted lines depict logical descendants. Despite being designed for the same type of underlying network, the characteristics of each of these protocols are quite distinct. The following sections gives the overview on all of these routing protocols.

3.1 Table-Driven Routing Protocols

Table-driven routing protocols also known as proactive protocols which keeps up-to-date routing information from each node to every other node in the network. These protocols require each node to maintain one or more tables to store the routing information, they also respond to changes in the network topology by propagating updates throughout the network in order to maintain the consistent network view [1]. There are some existing table driven ad hoc routing protocols:

List of Table-Driven protocols

1. DSDV: Destination Sequenced Distance Vector Routing
2. CGSR: Cluster-Head Gateway Switch Routing
3. WAR: Wireless Anonymous Routing

3.1.1 Destination-Sequenced Distance-Vector Routing

The Destination- Sequenced Distance-Vector Routing protocol (DSDV) described in [2] is a table-driven algorithm based on the classical Bellman-Ford routing mechanism [3]. The improvements made to the Bellman-Ford algorithm include freedom from loops in routing tables. Every mobile node in the network maintains a routing table in which all of the po sible destinations within the net-work and the number of hops to each destination are recorded. Each entry is marked with a sequence number assigned by the destination node. The sequence numbers enable the mobile nodes to distinguish stale routes from new ones, thereby avoiding the formation of routing loops. Routing table updates are periodically transmitted throughout the network in order to maintain table consistency. The mobile nodes maintain an additional table where they store the data sent in the incremental routing information packets. New route broadcasts contain the address of the destination, the number of hops to reach the destination, the sequence number of the information received regarding the destination, as well as a new sequence number unique to the broadcast [2]. The route labeled with the most recent sequence number is always used. In the event that two updates have the same sequence number, the route with the smaller metric is used in order to optimize (shorten) the path. Mobiles also keep track of the settling time of routes, or the weighted average time that routes to a destination will fluctuate before the route with the best metric is received (see [2]). By delaying the broadcast of a routing update by the length of the settling time, mobiles can reduce network traffic and optimize routes by eliminating those broadcasts that would occur if a better route was discovered in the very near future.

3.1.2 Clusterhead Gateway Switch Routing

The Clusterhead Gateway Switch Routing (CGSR) protocol differs from the previous protocol in the type of addressing and network organization scheme employed. Instead of a "flat" network, CGSR is a clustered multihop mobile wireless network with several heuristic routing schemes [4]. The authors state that by having a cluster head controlling a group of ad hoc nodes, a framework for code separation (among clusters), channel access, routing, and bandwidth allocation can be achieved. A cluster head selection algorithm is utilized to elect a node as the cluster head using a distributed algorithm within the cluster. The disadvantage of having a cluster head scheme is that frequent cluster head changes can adversely affect routing protocol performance since nodes are busy in cluster head selection rather than packet relaying.

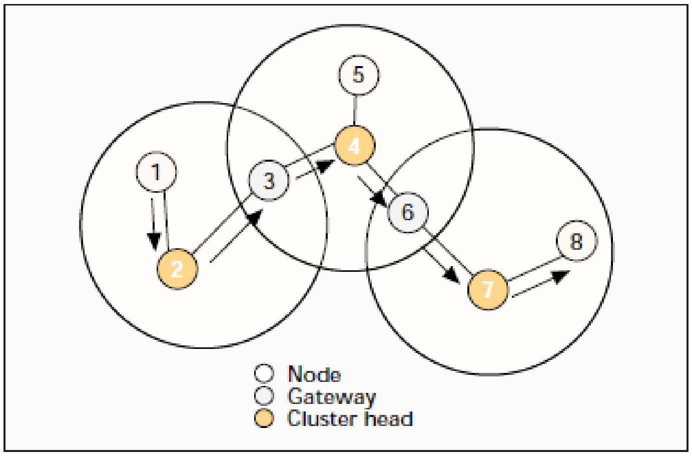


fig. 2 CGSR: Routing from node 1 to node 8

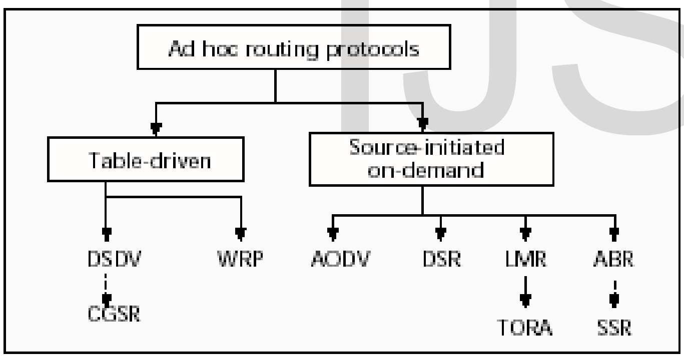


fig. 1 Categorization of ad hoc routing protocols

CGSR uses DSDV as the underlying routing scheme, and hence has much of the same overhead as DSDV. However, it modifies DSDV by using a hierarchical cluster-head-to-gateway routing approach to route traffic from source to destination. Gateway nodes are nodes that are within communicationrange of two or more cluster heads. A packet sent by a node is first routed to its cluster head, and then the packet is routed from the cluster head to a gateway to another cluster head, and so on until the cluster head of the destination node is reached[1]. The packet is then transmitted to the destination. Figure 2 illustrates an example of this routing scheme. Using this method, each node must keep a "cluster member table" where it stores the destination cluster head for each mobile node in the network. These cluster member tables are broadcast by each node periodically using the DSDV algorithm. Nodes update their cluster member tables on reception of such a table from a neighbor.

3.1.3 The Wireless Routing Protocol

The Wireless Routing Protocol (WRP) described in [5] is a table-based protocol with the goal of maintaining routing information among all nodes in the network. Each node in the network is responsible for maintaining four tables:

- Distance table
- Routing table
- Link-cost table
- Message retransmission list (MRL) table

Each entry of the MRL contains the sequence number of the update message, a retransmission counter, an acknowledgment required flag vector with one entry per neighbor, and a list of updates sent in the update message. The MRL records which updates in an update message need to be retransmitted and which neighbors should acknowledge the retransmission [5].

Mobiles inform each other of link changes through the use of update messages. An update message is sent only between neighboring nodes and contains a list of updates (the desti tion the distance to the destination, and the predecessor of the destination), as well as a list of responses indicating which mobiles should acknowledge (ACK) the update. Mobiles send update messages after processing updates from neighbors or detecting a change in a link to a neighbor. In the event of the loss of a link between two nodes, the nodes send update messages to their neighbors. The neighbors then modify their distance table entries and check for new possible paths through other nodes. Any new paths are relayed back to the original nodes so that they can update their tables accordingly.

3.2 Source-Initiated On-Demand Routing

The Source-Initiated On-Demand routing creates routes only when desired by the source node. When a node requires a route to a destination, it initiates a route discovery process within the network. This process is completed once a route is found or all possible route permutations have been examined. Once a route has been established, it is maintained by a route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer desired.

List of Demand-Driven Routing Protocols

1. AODV: Ad hoc On-Demand Distance-Vector routing
2. DSR: Dynamic Source Routing
3. TORA: Temporarily Ordered Routing Algorithm
4. ABR: Associativity Based Routing
5. SSR: Signal Stability Routing

3.2.1 Ad Hoc On-Demand Distance Vector Routing

The Ad Hoc On-Demand Distance Vector (AODV) routing protocol described in [7] builds on the DSDV algorithm previously described. AODV is an improvement on DSDV because it typically minimizes the number of required broadcasts by

ISSN 2229-5518

creating routes on a demand basis, as opposed to maintaining a complete list of routes as in the DSDV algorithm. The authors of AODV classify it as a *pure on-demand route acquisition* system, since nodes that are not on a selected path do not maintain routing information or participate in routing tabl exchanges [7].

When a source node desires to send a message to some destination node and does not already have a valid route t that destination, it initiates a *path discovery* process to locate the other node. It broadcasts a route request (RREQ) packet to its

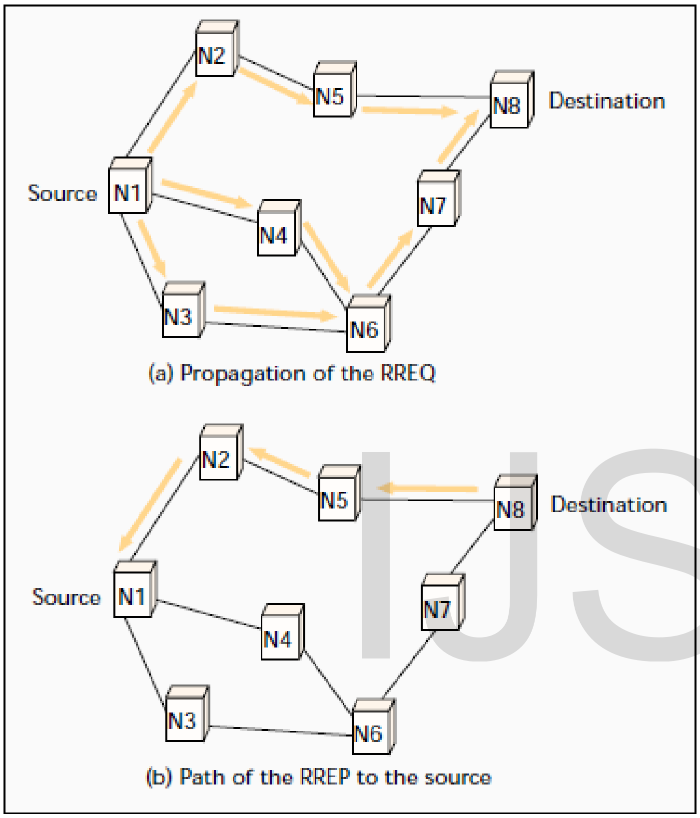


fig. 3 AODV Route Discovery

neighbors, which then forward the request to their neighbors, and so on, until either the destination or an intermediate node with a "fresh enough" route to the destination is located. Figure 3a illustrates the propagation of the broadcast RREQs across the network. AODV utilizes destination sequence numbers to ensure all routes are loop-free and contain the most recent route information. Each node maintains its own sequence number, as well as a broadcast ID. The broadcast ID is incremented for every RREQ the node initiates, and together with the node's IP address, uniquely identifies an RREQ. Along with its own sequence number and the broadcast ID, the source node includes in the RREQ the most recent sequence number it has for the destination. Intermediate nodes can reply to the RREQ only if they have a route to the destination whose corresponding destination sequence number is greater than or equal to that contained in the RREQ.

Routes are maintained as follows. If a source node moves, it is able to reinitiate the route discovery protocol to find a new route to the destination. If a node along the route moves, its upstream neighbor notices the move and propagates a *link failure notification* message (an RREP with infinite metric) to each of its active upstream neighbors to inform them of the erasure of that part of the route [7]. These nodes in turn propagate the *link failure notification* to their upstream neighbors, and so on until the source node is reached. The source node may then choose to reinitiate route discovery for that destination if a route is still desired.

In additional Hello messages can be used to maintain the local connectivity of a node. However, the use of hello messages is not required. Nodes listen for retransmission of data packets to ensure that the next hop is still within reach. If such a retransmission is not heard, the node may use any one of a number of techniques, including the reception of hello messages, to determine whether the next hop is within communication range. The hello messages may list the other nodes from which a mobile has heard, thereby yielding greater knowledge of network connectivity.

3.2.2 Dynamic Source Routing

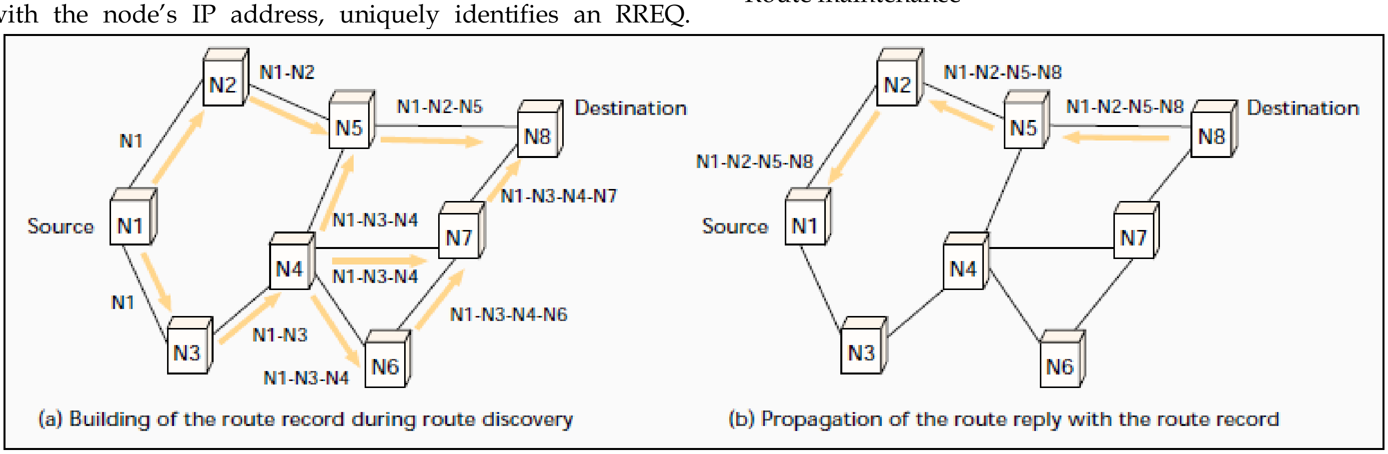
The Dynamic Source Routing (DSR) protocol presented in [8] is an on-demand routing protocol that is based on the concept of source routing. Mobile nodes are required to maintain route caches that contain the source routes of which the mobile is aware. Entries in the route cache are continually updated as new routes are learned.

The protocol consists of two major phases: route discovery and route maintenance

3.2.3 Temporally Ordered Routing Algorithm

The Temporally Ordered Routing Algorithm (TORA) is a highly adaptive loop-free distributed routing algorithm based on the concept of link reversal [10]. TORA is proposed to operate in a highly dynamic mobile networking environment. It is source-initiated and provides multiple routes for any desired source/destination pair. The protocol performs three basic functions:

- Route creation
- Route maintenance



• Route erasure

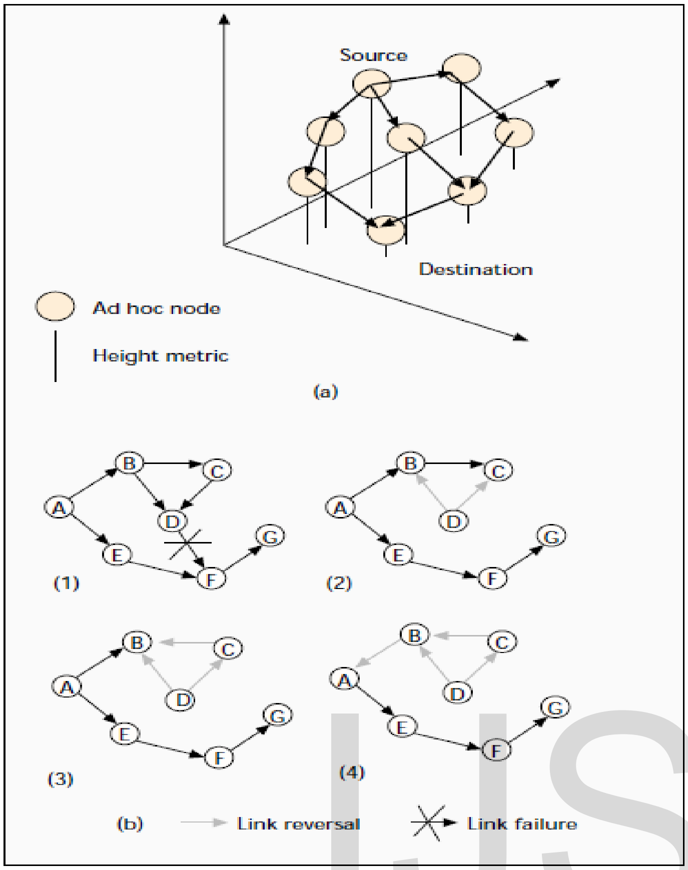


fig. Creation of the route record in DSR. [10]

During the route creation and maintenance phases, nodes use a "height" metric to establish a directed acyclic graph (DAG)rooted at the destination. Thereafter, links are assigned a direction (upstream or downstream) based on the relative height metric of neighboring nodes, as shown in Fig. 5a. This process of establishing a DAG is similar to the query/reply process proposed in Lightweight Mobile Routing (LMR) [11]. In times of node mobility the DAG route is broken, and route maintenance is necessary to reestablish a DAG rooted at the same destination. As shown in Fig. 5b, upon failure of the last downstream link, a node generates a new reference level which results in the propagation of that reference level by neighboring nodes, effectively coordinating a structured reaction to the failure. Links are reversed to reflect the change in adapting to the new reference level. This has the same effect as reversing the direction of one or more links when a node has no downstream links.

Timing is an important factor for TORA because the "height" metric is dependent on the logical time of a link failure; TORA assumes that all nodes have synchronized clocks (accomplished via an external time source such as the Global Positioning System).

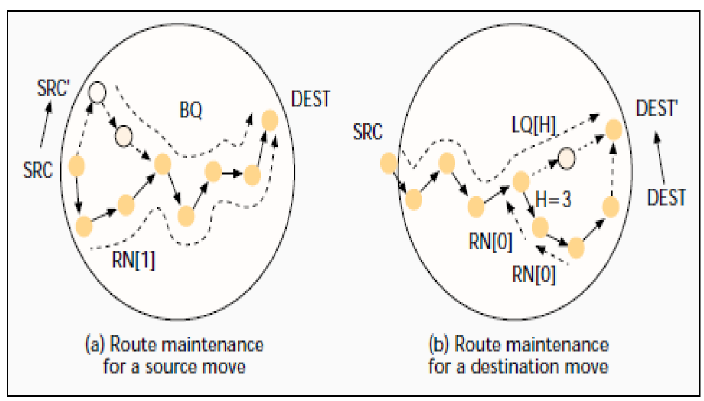
In TORA there is a potential for oscillations to occur, especially when multiple sets of coordinating nodes are concurrently detecting partitions, erasing routes, and building new routes based on each other. Because TORA uses intermodal coordination, its instability problem is similar to the "count-to-infinity" problem in distance-vector routing protocols, except that such oscillations are temporary and route convergence will ultimately occur.

3.2.4 Associativity-Based Routing

A totally different approach in mobile routing is proposed in [12]. The Associativity Based Routing (ABR) protocol is free from loops, deadlock, and packet duplicates, and defines a new routing metric for ad hoc mobile networks In ABR, a route is selected based on the degree of association stability of mobile nodes. Each node periodically generates a beacon to signify its existenceThe three phases of ABR are:

• Route discovery
• Route reconstruction (RRC)
• Route deletion

The route discovery phase is accomplished by a broadcast query and await-reply (BQ-REPLY) cycle. A node desiring a route broadcasts a BQ message in search of mobiles that have a route to the destination. All nodes receiving the query (that are not the destination) append their addresses and their associativity ticks with their neighbours along with QoS information to the query packet. A successor node erases its upstream node neighbors' associativity tick entries and retains only the entry concerned with itself and its upstream node. In this way, each resultant packet arriving at the destination will contain the associativity ticks of the nodes along the route to the destination. The destination is then able to select the best route by examining the associativity ticks along each of the paths. When multiple paths have the same overall degree of associa



tion stability, the route with the minimum number of hops is selected.

fig. Route maintenance for source and destination movement in ABR [10]

The destination then sends a REPLY packet back to the source along this path. Nodes propagating the REPLY mark their routes as valid. All other routes remain inactive, and the possibility of duplicate packets arriving at the destination is avoided.

RRC may consist of partial route discovery, invalid route erasure, valid route updates, and new route discovery, depending on which node(s) along the route move

When a discovered route is no longer desired, the source node initiates a route delete (RD) broadcast so that all nodes along the route update their routing tables.

3.2.5 Signal Stability Routing

Another on-demand protocol is the Signal Stability-Based Adaptive Routing protocol (SSR) presented in [13]. Unlike the algorithms described so far, SSR selects routes based on the signal strength between nodes and a node's location stability. This route selection criteria has the effect of choosing routes that have "stronger" connectivity. SSR can be divided into two cooperative protocols: the Dynamic Routing Protocol (DRP) and the Static Routing Protocol (SRP).

The DRP is responsible for the maintenance of the Signal Stability Table (SST) and Routing Table (RT). The SST records the signal strength of neighboring nodes, which is obtained by periodic beacons from the link layer of each neighboring node. Signal strength may be recorded as either a strong or weak channel. All transmissions are received by, and processed in, the DRP. After updating all appropriate table entries, the DRP passes a received packet to the SRP.

4 Conclusion

In this paper we make a survey on on Mobile Ad Hoc Wireless Network & Types of Routing Protocols. Today many protocols are invented but it is necessary to find the suitable protocol for specific use. The field of MANET is rapidly growing and changing, and while there are still many challenges that need to be met, it is likely that such networks will see widespread use within the next few years.

We have identified possible applications and challenges facing ad hoc mobile wireless networks. While it is not clear that any particular algorithm or class of algorithm is the best for all scenarios, each protocol has definite advantages and disadvantages, and is well suited for certain situations.

References

[1] David B. Johnson and David A. Maltz. "Dynamic Source Routing in Ad Hoc Wireless Networks", Mobile Computing, Kluwer Academic Publishers, 1996

[2] Jie Wu. "An Extended Dynamic Source Routing Scheme in Ad Hoc Wireless Networks". In Proceedings of the 35 th Hawaii International Conference on System Sciences – 2002

[3] David B. Johnson. "Routing in Ad Hoc Networks of Mobile Hosts". In Proceedings of the IEEE Workshop on Mobile Computing Systems and Applications, December 1994

[4] S. Corson. "Mobile Ad hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation Considerations". Network Working Group RFC:2501 January 1999

[5] Larry L. Peterson and Bruce S. Dave. Computer Networks, A System Approach 2nd Ed, pages 274 – 276, 2000, Morgan Kaufmann

[6] S. Murthy and J. J. Garcia-Luna-Aceves, "An Efficient Routing Protocol for Wireless Networks," ACM Mobile Networks and App. J. , Special Issue on Routing in Mobile Communication Networks, Oct. 1996, pp. 183–97.

[7] C. E. Perkins and E. M. Royer, "Ad-hoc On-Demand Distance Vector Routing," Proc. 2nd IEEE Wksp. Mobile Comp. Sys. and Apps. , Feb. 1999, pp. 90–100.

[8] C. E. Perkins and P. Bhagwat, "Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers," Comp. Com-mun. Rev., Oct. 1994, pp. 234–44.

[9] J. Broch, D. B. Johnson, and D. A. Maltz, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks," IETF Internet draft, draft-ietf-manet-dsr-01.txt, Dec. 1998 (work in progress)

[10] R. Dube et al., "Signal Stability based Adaptive Routing (SSA) for Ad-Hoc Mobile Networks," IEEE Pers. Commun ., Feb. 1997, pp. 36–45.