A Review of Pro-Active and Re-Active Routing protocols for Mobile Ad-hoc Network

T. Sivaraman,
Department of Computer Science,
Thiruvalluvar University Arts & Science College,
Thiruvennainallur. Tamilnadu, INDIA

Dr. E. Karthikeyan
Department of Computer Science,
Govt. Arts College, Udumalpet – 642 126,
Tamilnadu, INDIA

ABSTRACT

A mobile Ad-hoc Network is a Wireless Communication Network. The Multipath routing Protocols establish multiple routes between source to destination. The multipath routing protocols establish multiple routes between nodes. The construction of multiple routes should be done with minimum overhead and bandwidth consumption. The Proactive and Reactive protocols are selected for survey due to edges their over hybrid Ad-hoc routing protocol in various aspects load balancing. The purpose of this article is to analysis the characteristics of different multipath routing protocols.

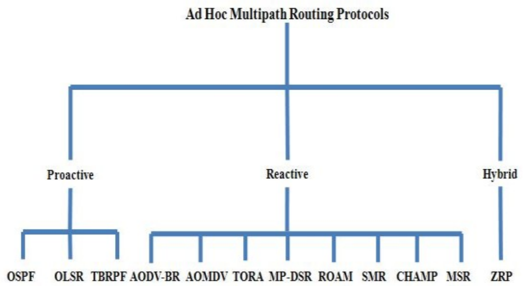
Index terms : route failure, load balancing, multi hop, mobility, reactive protocols, proactive protocols, **MANET, AODV, AOMDV, OLSR.**

I. INTRODUCTION

The Multi Path routing protocols are used to provide multiple paths from source to destination node. Several Protocols have partial backup of routes, while the remaining protocols provide multiple complete routes from source to destination. The AODV-BR and AOMDV Protocols are implemented from the AODV protocol Whereas SMR, MSR and MP-DSR are based on DSR Protocol.

The Ad-hoc multipath routing protocols can be classified in the three types. They are :

i) Pro-Active / Table – driven
ii) Re-Active / On – demand
iii) Hybrid



II. Pro-Active / Table Driven

In proactive routing protocols, each node maintain a routing tables in the network. These protocols update the routing information in routing tables, the routing tables are periodically updated when the nodes are change its place. The proactive family members protocols are OSPF, TBRPF and OLSR.

Open Shortest Path First Protocol (OSPF)

OSPF has two primary characteristics. It is a protocol based on the shortest path first (SPF) algorithm also called as Dijikstra algorithm. The second characteristic is it is an open protocol which means that the specification is public domain. Unlike other protocol which use distance-vector or Bellman-ford technology, the OSPF use line-static or SPF based technology to find the route to destination.

The link state database is formed in the network by flooding the individual link state Advertisement (LSA). The LSA describes small pieces of the routing domain. The link state database is used for each router builds a routing table calculating shortest path tree. In OSPF when exist several equal-cost routes to a destination, the traffic is distributed equally among them. These multiple routes need not be node-disjoint or line disjoin. Each node find its neighbors by the use of Hellow message. These messages are also function as keep-alive packets.

OSPF Properties

i) The OSPF is a based on shortest path first (SPF or Dijikstra algorithm) ii) It is link state protocol iii) The Common link-state database formed by individual link state Advertisement (LSAs) iv) Each node calculate the shortest path from the link state database v) The multiple routes are available from source to destination.

Optimized Link State Routing Protocol (OLRS)

The OLSR is a pure link state protocol. The complete information is flooded through network. It compacts the size of information sent in each message and reduce the retransmission of packet to the network. In OLSR, the multipoint relaying (MPRS) techniques is used to flood it's the control message in the network.

The multipoint relays technique is used to minimize the flooding of broadcast packets in the network by reducing retransmissions in same region. IN OLSR, each node selects a set of 1-hop neighbors called multipoint relays (MPRS) of that node. The neighbors of any node N that are not present in the MPR Set, they read and process packets but not retransmit the broadcast packets received from node N.

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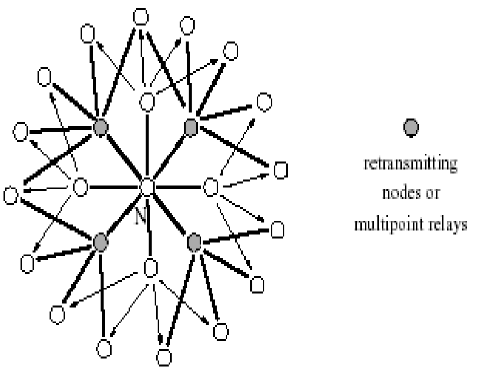
Each node maintains a set of neighbors for retransmission of packets. The multipoint relay set node of N satisfies the following condition: Every node in the two hop neighborhood of N must have a bidirectional link towards other nodes in N. These bidirectional links are periodically broadcasting Hellow messages containing information.



Each node maintains a topology table and routing table. Each entry having a destination address, next-hop address and number of hops to the destination. The routing table in constructed based on neighbors node table and topology table.

Properties

i) OLSR is a optimization of pure Link-State Protocol. The neighbors are discovered via HELLOW message. ii) Routes are created from multipoint relays. iii) MPRs are 1-hop neighbors via a bi-directional covering all 2-hop neighbors iv) Multiple routes to the destination is possible v) No complete routes known by the source

C) Topology Broadcast Based on Reverse Path Forwarding (TBRPF)

The TBRF use the concept of reverse path forwarding to broadcast link-state updates in the reverse direction along the spanning tree formed by minimum-hop path from all nodes to the source. It computes minimum-hop path from the tree. The TBRPF generates last update traffic than pure link-state routing algorithm. In TBRPF, each node maintains a list of its neighbors and topology table. In topology table, each entry contains the most recent cost and sequence number associated with the link. Each node has the following information.

Topology table which consists of link-states stored at the nodes. A list of neighbor nodes. Each node contain a present node, a list of children and sequence number of the most recent link state update.

Properties

i) Each node has a topology table contains all link-states stored at the node ii) A list of neighbor node iii) For each node, a parent (next node on the minimum-hop path to the source), a list of children and the sequence no of the most recent link-state update.

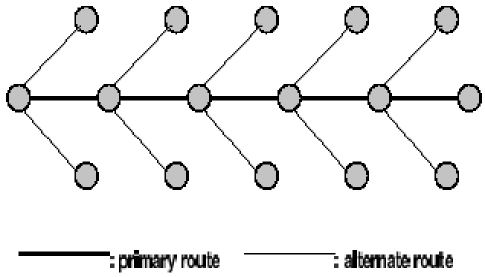
III. Re-Active Multipath Routing Protocol

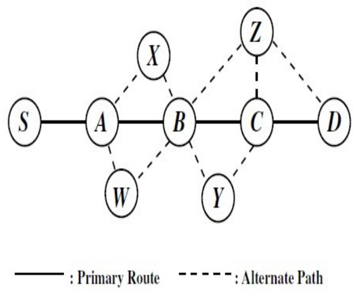
Re-active or On-demand multi path routing protocols are reducing the path Compare with proactive multi path protocols. The routes are maintained and determined whenever the nodes want to send data to destination. The route discovery process happened. It sends a route reply packet back to the source using link reversal.

AODV-BR Protocol

The AODV-BR protocol is implemented from the AODV protocol. Its route construction process is same as AODV. When a source needs send data to destination, and there is no route to destination then its search rules a route by flooding a route request (RREQ) packet. Each of these RREQ packets has unique ID. The intermediate nodes can detect and drop duplicates.

When an intermediate node receiver a RREQ Packets, it records the previous hop and source node information then sends a route reply (RREP) packet back to the source node if route to the destination is known. The destination sends a RREP via the selected route. When the source receive the first RREQ or latter RREQ then find out the better route.





For example, the node Z forwords the packet from B directly to the destination D without sending it through node C if the link between nodes B and C fails. Hence the packet is delivered through the path <S-A-B-Z-D>

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has the same hop length as the primary route <S-A-B-C-D> as shown in Figure.

All the nodes have an alternate route to the destination in their alternate route table.

Properties

The properties of AODV-BR (1) implementation of AODV (2) floods RREQ with unique ID, so duplicate can be discarded (3) Multiple complete route is not available (4) Source does not known complete route (5) Alternative routes used when primary route fails. (6) Each node maintain backup route in alternative route table.

Ad-hoc On-demand Multipath Distance Vector Routing Protocol (AOMDV)

The AOMDV uses the basic concept of AODV route construction process. It creates multiple loop free, link-disjoint paths. It eliminate frequent link failures and route breaks in network.

Two rules will be followed during route discovery process :

i) To establish and maintain multiple loop-free paths at each node
ii) Find a link-disjoint paths

The link failure may occur node failure, congestion in traffic packet collision and etc. When a source needs to send information to the destination, it initiates a route discovery process. It sends RREQ Route request packet to destination through network. The RREQ packets identified by unique sequence number. So the duplicate packets can be discarded. When an intermediate node receiving non-duplicate RREQ packets, it records previous hop and check valid fresh route entry to the destination in routing table. The node sends back RREP to the source. The node sends back RREP to the source, if not it rebroadcast the RREQ.

A node updates its routing information and propagates the RREP upon receiving further RREPs only if a RREP contains either a larger destination sequence number or a shorter route found. In AOMDV each RREQ, respectively RREP arriving at a node potentially defines an alternate path to the source or destination. When a node *S* floods a RREQ packet in the network, each RREQ arriving at node via a different neighbor of *S* node-disjoint path to destination.

Properties

The properties of AOMDV are i) Implementation of AODV ii) RREQ from different neighbors of the source are accepted at intermediate nodes. iii) Multiple link-disjoint routes are created. iv) Multiple routes are find out in single route discovery process. v) Source does not known complete route information

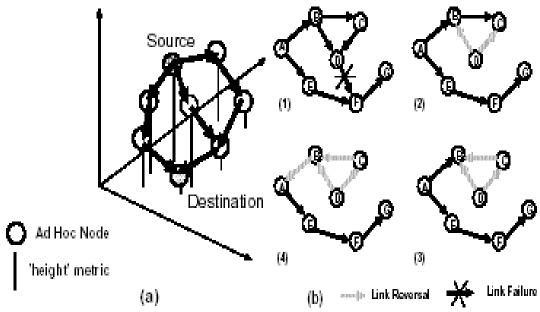
Temporally-Ordered Routing Algorithm (TORA)

TORA is a highly adaptive, distributed routing algorithm based on the link reversal. It has multiple loop free paths from source to destination. TORA has three basic functions

i) Route Creation
ii) Route maintenance
iii) Route Erasure

In route discovery process, TORA creates a directed-acyclic graph (DAG) Which is based on a "height" metric. This height differ per destination. The height of the destination is always zero, where as the height of the other intermediate nodes increased by 1 towards source node.

In TORA, a node to initiate a route discovery process, it broadcast QUERY to neighbors node. The node re-broadcast the query packet through the network until it reaches the destination. This node replies an UPDATE Packet with height respect to the destination. Each node receiving the UPDATE sets its own height to one greater than that of the neighbor that sent it.



The CLR (Clear) Packet is used for erase the invalid routes to destination. Timing is important one in TORA, because the "height" metric is time dependent. The all nodes having common clock pulse.

properties

i) The routes are created by using directed a-cyclic graph (DAG) ii) QRY are sent and reply UPD packets to create DAG. iii) DAG is formed using height metric iv) The links go down nodes get new reference level (heights) and lines are reversed to the source. v) All nodes have common clock. vi) provide multiple paths

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to destinations vii) Source does not known the complete route to destination.

Multi path Dynamic Source Routing Protocol (MP-DSR)

MD-DSR is a multi path source routing protocol, based on Dynamic Source Routing Protocol (DSR). It creates and finds the routes based on QOS metric, end-to-end reliability. The DSR computes a set of routes a minimum end-to-end reliability requirement. It creates a multiple node disjoint path for sent the information from source to destination.

When source needs a route to a destination, it initiate a route discovery process by flooding a RREQ packet in the network. A route record will be contained in the header of each RREQ in which the sequence of hops that the packet passes through is recorded. When the RREQ reaches the destination, RREP will sent by node or destination through this route.

MP-DSR for route discovery it supplies a minimum end-to-end requirement, based on which the protocol determines the number of paths needed (m_0)and the lowest path reliability (Π_{lower}) requirement that each path needs to provide. The relationship between m_0 and Π_{lower} is simple: when there are fewer paths between a source and a destination (m_0 is low), more reliable paths are needed (Π_{lower} is higher) to ensure the end-to-end reliability.

Properties

i) Implementation of DSR ii) The packet contain complete route in their header iii) Source has complete route information iv) QOS awareness having a successful transmission between two nodes in the network with in a specific period v) Provide multiple route to destination vi) The destination sends RREPs to the source along the node disjoint paths vii) The source known the complete route to destination

Split Multipath Routing Protocol (SMR)

The Split Multipath Protocol (SMR) provides to determine the disjoint path. The paths are maximum disjoint. The protocol minimize the number of common nodes. The multiple routes are discovered on demand, the shortest delay path will be selected.

When a source node needs sent a packet to a destination, if there is no route in route chache then it floods a RREQ packet on the network. The destination then elects multiple disjoint paths and sends RREP Packet back via the route. The destination needs to select disjoint path, source routing is used.

The complete route information is available in the RREQ Packets. The intermediate nodes are not allowed to send RREPS, even when they have route information to the destination. The RREQ, Packet contains the source ID and sequence number uniquely identify the packet. So the duplicate RREQ are discard red. The destination then selects multiple disjoint route for send RREP to the source node. The source known complete route information to the destination in the header of RREQ packet.

The destination select the two routes that are maximally disjoint with the shortest delay path taken by the first RREQ the destination receives. When the first RREQ is received, the destination sends RREP to the source via this path. The RREP includes entire path. After sent the first RREP, the destination waits a certain amount of time to receive more RREQS and determine all possible routes. The destination then sends second RREP to the source along the first path.

Properties

The properties of SMR are : i) The source known complete routes to destination ii) provide two paths iii) Routes are selected by destination iv) RREQ contain the source ID and unique sequence number v) The shortest delay path is selected my destination.

Multipath Source Routing Protocol (MSR)

The MSR is an extension of On-Demand DSR protocol. Which consists a scheme to distribute load among the multiple paths in a network. The MSR use the same route creation process of DSR but it creates multiple routes instead of only one path as in DSR. When a source need a route to destination, if it has the route in the cache, it initiates a route discovery by broadcasting RREQ packet for the entire network. The RREQ Packet header contains a route record which records the sequence of hops that the packet process through the intermediate node in the network. Each intermediate node appends its own address to the route record during the route discovery process. When the destination receive the RREQ, then it send the RREP to the source via this route. It has loop free paths. When a loop is detected it will be immediately eliminated. Since source routing is used in MSR. The intermediate node forward the packet according to the route in the packet header.

Properties :

i) It provide multiple path to the destination ii) Loop free and disjoint paths iii) The load is distributed based on delay in the network iv) The source known complete route to the destination.

Caching and Multipath Routing Protocol (CHAMP)

The CHAMP is a protocol which uses co-operative data caching and shortest multipath routing to reduce packet loss due to frequent route breakdowns Every node maintains a small buffer for caching

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packets that passes through it. When a down stream node encounters a forwarding error, an upstream node with the pertinent data in its buffer and alternative route can retransmit the data. The shortest multipath routes are selected based on minimizing delay. In CHAMP every node maintain a route cache for forwarding information and route request cache containing recently received and processed route request. The route cache contains destination identifier, the distance to the destination, next hop node for the destination. When a node has no route to the destination, it creates a route discovery by flooding RREQ through network to establish a DAG routed at the source. When destination receives a RREQ, it sends RREP. The count is first initialized by o (source) and increased by 1 for every retransmission.

Properties

i) The source does not known complete route to destination ii) Multiple routes are available to destination iii) Selects shortest multipath routes vi) The load traffic is distributed among the multipath v) The temporal caching to reduce packet losses.

Comparison of Re-Active protocols:

Protocol / properties	AODV-BR	AOMDV	TORA	MPDSR	SMR	CHAMP	MSR
Implementation	AODV	AODV	TORA	DSR	DSR	NO	DSR
Source flood packet	RREQ	RREQ	QUERY	RREQ	RREQ	RREQ	RREQ
Destination floodspacket	RREP	RREP	UPDATES	RREP	RREP	RREP	RREP
Multiple routes	No	Yes	Yes	Yes	Yes	Yes	Yes
Loop free paths	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route known by source	No	No	No	Yes	Yes	No	Yes
Disjoint path	No	Link disjoint	No	Node disjoint	Node disjoint	Node disjoint	Node disjoint

Comparison of Pro-Active protocol

Protocol/properties	OSPF	OLSR	TBRPF
Implementation	OSPF	OLSR	TBRPF
Route known by source	Yes	Yes	Yes
Loop free paths	Yes	Yes	Yes
Multiple routes	Yes	Yes	Yes
Node Disjoint path	No	No	No

Comparison

Provide Complete Path

The AODV-BR, OLSR, OSPF and TSRPF do not provider multiple complete routes from source to destination where as the remaining protocol AOMDV, TORA, MPDSR, SMR, MSR and CHAMP are provide multiple complete route from source to destination.

Provide Loop Free Paths

All protocols provide loop free path from source to destination. MSR, SMR and MP-DSR have the complete routes consists of in the packet header. So they can easily identify and remove the loops. In AOMDV and AODV-BR uses sequence number to avoid the loops. The TORA and CHAMP use directed a-cyclic graph to create loop free path. TBRPF, OLSR and OSPF are create route by the topology. So the loops can be avoided.

Complete Route Information is known the source :

The complete route information is known by the source in MP-DSR, SMR, OLSR, OSPF, TBRPF and MSR. The AODV-BR, AOMDV are distance vector protocol. So its known only the next hop to the destination. The TORA and CHAP also find out the next hop in network.

Provide node-disjoint paths :

OLSR, OSPF, TBRPF, CHAMP and AODV-BR do not provide node disjoint paths. So these protocols are not provide multiple complete route. The SMR provides two maximum disjoint paths.

Common Clock Required

TORA must require a Common Clock at all nodes. The others are not used the Common Clock.

Implementation

The AODV-BR and AOMDV Protocol are implemented from AODV. The MP-DSR, SMR and MSR are based on DSR Protocol. The implementations of OLSR, OSPF, TORA and TBRPF are also available in Linux.

Conclusion

The routing protocol is needed to provide multiple complete route from source to destination. The proactive multipath routing maintains the network connectivity positively. The Re-active multipath routing determine routes dynamically when the route needed. The hybrid multipath routing employs both proactive and reactive properties. The comparison of Pro-active and Re-active protocols are described in table.

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Bibliography

T. Sivaraman is working as an Assistant Professor in the Department of Computer Science, Thiruvalluvar University College of Arts & Science, Thiruvennainallur, Tamilnadu, India. He is guiding students towards M.Phil. programme. He attended many conferences in both national and international levels and his area of interest is Mobile Ad hoc Networks Routing Protocols Design and Development. He is now pursuing Ph.D. from Manonmaniam SundaranarUniversity, Tirunelveli.

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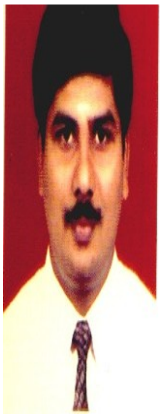

Dr.E.Karthikeyan born in 1974 at Dharapuuram completed PG degree in the year 1996 and Ph.D from Gandhigram University, Dindigul, India in 2008. He is guiding students towards Ph.D. programme and his area of research is Network Security and Cryptography and Advanced Networking. He has published 12 papers in International Journals and more than 15 conferences National and International level. He has also published a book entitled "Text Book on C: Fundamentals, Data structures and Programming" by PHI. He delivered lectures and conducted workshops in various colleges. He is a life member of CSI, CRSI, IASCT etc. He is a Editor-in-Chief for an International Journal of Advanced Networking and Applications.

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