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WIRELESS MESH NETWORK ROUTING: A COMPARATIVE SURVEY

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ABSTRACT: Nowadays, the wireless network technology, as a very cheap alternative Very cheap to create associative networks and unified are under development. Although such networks are economically very affordable and are also numerous operational efficiency, including dynamic capability and comfort give and offer to the end user. Among the networks-based infrastructure, a wireless mesh network (as a set of wireless router are taken at strategic locations, providing total connectivity to the network) also provides flexibility for multi-hop. Therefore, how can efficiently these packages through the wireless network arrive to the destination, is a very important problem. Unlike routing wired networks, wireless routing faces with challenges such as interference, among other transfers and channel variable characteristics. In a wireless network, the routing algorithms are divided in numerous categories ranging from algorithms Geographic routing, Geo-Casting, hierarchical, multi-path, based on the remaining energy and hybrid (combination). In this article, Check routing algorithms are discussed.

KEYWORDS: Wireless Mesh Network, routings, algorithms, nodes, Hybrid Routing Algorithm, Optimized Link State Routing Protocol

1 INTRODUCTION

Among multiple technologies to access the networks, wireless networks are alternative methods to techniques such as network access to wired lines Digital Subscriber (DSL), and cable modems are about transformation. By using wireless networks it doesn't require cabling to the end user in order to send the offline data, so a wired network can reduce the infrastructure cost and can also offer mobility, capacity.

In different wireless networks in order to provide better services a key technology's wireless such as Mesh Networks (WMN) is developed which recently emerged. In Wireless Mesh Networks, nodes included routers mesh and mesh users of each node it means that not only as a host but act like a router, the packages from other wireless nodes that may not be in the range of their direct path destinations but multiple hubs (MULTIHUB) are guided forward. One wireless mesh network is self organizes and self-configured dynamically there is Configuration and the nodes in the network with automatically mesh connection is established and support between themselves. These features lead too many advantages in wireless mesh networks such as easy support for network, robustness and reliable covering service are being confidential.

Common nodes such as desktop computers, laptops, phones, etc. which are equipped by Wireless network interface cards (NIC) can be connected directly to the wireless mesh routers. Customers without a wireless network card can be connected to mesh routers, for example, via Ethernet to a wireless mesh network. So the wireless mesh networks can provide a lot of helps to the users, at any time and places network access for them. As a result, wireless mesh network a promising technology for many applications such as high-bandwidth home networking, neighborhood and community networks, Economic networking, building automation and so on. And routing a mechanism through that package can be transferred from the source to the final destination. According to automatic configuration and self-awareness about the feature wireless mesh network, it is expected that in the wireless mesh network, nodes can automatically decide the best route. Effective connection in wireless mesh networks depends on the routing decision for efficient routing, different routing protocols are used to route network.

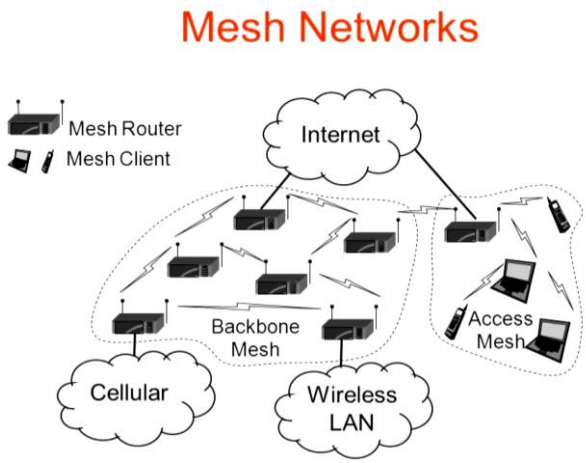


Figure 1 - Structure of mesh networks

2 WIRELESS MESH NETWORK ROUTING (WMN)

Routing a key part of the wireless network, as a total network connection depends on the nodes. Routing mesh network consists of two stages. The first step involves determining the cost of communications, paths and the second stage routing information obtained in the distribution network. In general we can say that the routing of mesh routers are formed from the mesh clients and the mesh received services. Mesh routers are divided into two categories gateways and backbone. Gateway routers are connected to a wired network. The routings supports the addressing operations, an Internet connection and a bridge support. In other words the back bone routers of mesh communication network multi-hop are used from the similar ad hoc networks. It can be said that the similarities between traditional routers and mesh is that both are built on the same hardware infrastructure but The mesh routers can be implemented on special-purpose or all common computers. In other words, we can say they have the least mobility, so are assumed to be constant, hence a wireless building constitutes mesh network and multi stage wireless internet connection is provided for mesh customers. The service of the mesh receivers are divided into two categories, too, routing and none routing capacity. It can be said if the service receiver is able to steer packets can improve network coverage by using more service receivers and connecting them to the router by connected to the router. Software and

hardware infrastructure for mesh routers is much easier. It should be noted that mesh customers can be laptops, phones and other equipment's. Figure 2 having the Internet using the Network Mesh show.

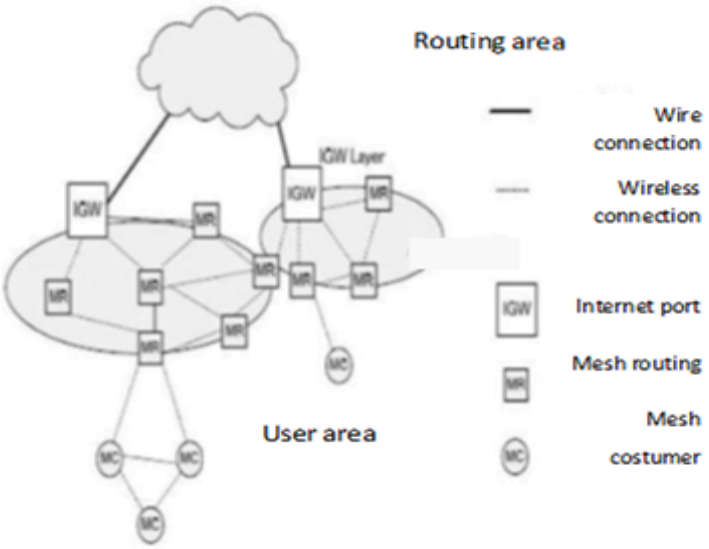


Figure 2 - Having the Internet by using mesh network

Routing, one of the most challenging issues in wireless networks is fluid. A good routing solution should include, being focused such as the ability to self-organize capacity and self-improvement. Meanwhile, the same a routing solution must have conform to limited bandwidth and must use to the characteristics of multi-hop wireless spectrum to better balance the load. Routing also needs to provide an efficient solution in terms of energy consumption for wireless networks. The routing is decentralized when the routing decisions are the responsibility of each node (router) is. In decentralized routing, there is no central node in its decisions must be taken. Self-organization is one of the assessment processes in the time of the development of a new and complex structure. In a wireless a network, if the network cannot organize itself to improve the efficiency, or in case of error to moderate itself, it is said that these networks are self-organizing self. Improvements refer to the recovery process in the event of adverse effects resulting from error; therefore, self-improvement improves network stability against errors. Bandwidth limitations, which are a result of the limited capacity of channels, may be due to limited range of networks, media sharing nature of transfer or transfers which occur simultaneously. Therefore simultaneous transmission on a single channel may lead to a drastic reduction of the bandwidth. When two nodes want to send packets of data going to have the same channel simultaneously, if the nodes are close together, the phenomenon of collisions in the network will accord. It should be considered important in the management and the design of the wireless network. This is because the more interference between the nodes increases, more data to be lost and the overall power of the network goes down. (Multi-hop) or multi-hop also means that it can form a path through several nodes in order to send the data to its destination. In other words, the path between source and destination nodes can be done by several, intermediate nodes. Knowledge of energy in the wireless networks based on dynamic is, proposed in the networks, because in order to increase their output the nodes need to reduce their energy consumption. In this case, the required energy for transport in must be properly determined. Because the reduction transmission energy level reduces the distance that a node can send data through it through may cause to (this distance is called the transmission range). Hence a node may not be able cannot to the remount nodes in the network directly.

2.1 Class fiction of the routing algorithms

According to the reactive proactive combination, initial routing algorithm for wireless networks have been as, the same of the wired network routing algorithms. We call this type of classification, classification of the classic routing algorithms .

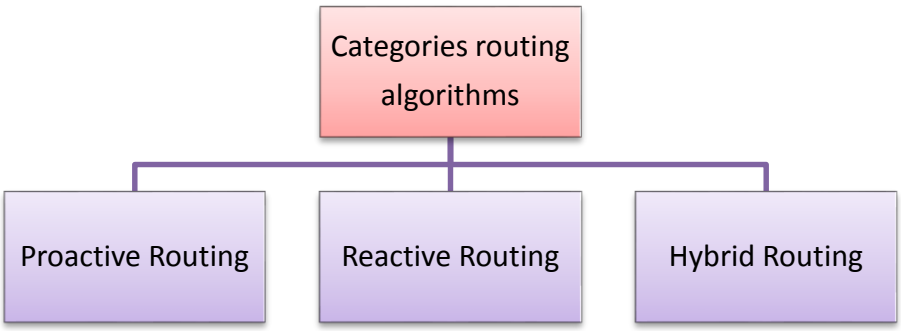


Figure 3 - Class fiction of the routing algorithms

2.1.1 Proactive routing algorithm

Proactive routing is a method in which each router can create its routing information charter on each router (or nodes) that can exchange information to pay to learn. This work can be done by the exchanging the updated of messages between routers periodically. Next, every router looks at its routing table the routing packet from source to destination is occurred. When a node source (or intermediate node) looks at until the routing table, the updated route information is also available and can be used by the node. This is because each router in the network periodically, gets directions by using an updated broadcasting massage. In the transfer method, however, the route information can be obtained quickly, but to update them to the overhead traffic requires a considerable bandwidth.

2.1.2 Reactive routing algorithm (Reactive Routing)

Reactive routing (based on the demand) is a method too in which the routing processes need to discover a route in which every time a packet nodes a route from the source to the destination is received and should be sent there. Here, each node has a routing table which is not already created to use it. Because of the dynamics capacity the nodes in the wireless network, maintaining the current route is an important process . This method, the process of the discovery, of the route is occurred more, but this process requires low control overhead in compare to the proactive methods. So this method has more, scalability than a proactive method. In addition, by using this method, nodes need to wait for the discovery process to send a message every time which it intended. This increases the total delay .

2.1.3 Hybrid *Routing* Algorithm (Hybrid Routing)

In this algorithm, routing starts with a proactive method. These algorithms reduce the control overhead and the delay caused by the route discovery in the protocols. A hybrid algorithm can be considered as a subset of the routing methods of the reactive adaptive routing in which, the real-time allocation of the network routing is done on the basis of characteristics.

2.2 . WIRELESS MESH NETWORK ROUTING PROTOCOLS

Routing protocol determine how data is transferred between two nodes. Routing protocols determine the route from the source to the destination. Some of the important categories protocols in routing reactive - passive and combinations routings are discussed below.

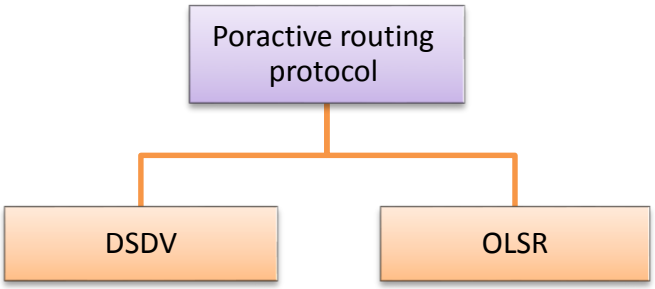


Figure 4 - The routing protocols in proactive routing

2.2.1 The routing protocols in proactive routings

Here are two important protocols are examined:

- Destination Sequenced Distance Vector Routing (DSDV):

This protocol is based on the classical Bellman-Ford algorithm. In this case, each node provides a list of all destinations as well as the number of the jumping is to any destination. Each list entry is numbered with a number in order to reduce the volume of traffic caused by the update route in the network the incremental - packets is used. DSDV needs to regularly update its routing tables, which it is done by using battery power and a small amount of bandwidth even when the network is idle. The only advantage of this protocol is to avoid the creation of routing loops in the networks including routers nodes that already are required to provide the route or not.
Disadvantages: DSDV protocol need parameters such as time limit, updated information and the numbers of the updates.

- Optimized Link State Routing Protocol (OLSR):

This protocol recognizes his neighbors and records their network addresses. Delay or cost to its neighbors are measured and by and creating a package which assumes all information are obtained exchange the information.
In OLSR first points (Multipoint Relays) MPR or sending multi points, are identified and these points are the only points which, MPR allowed to broadcast information in the network and reduces network overhead and case to reduce the control, too. Packets OLSR first task is to identify his neighbors which is done by sending Hello packets to neighbors around each node. In this way, each node detects the surrounding nodes by the obtained information, each node made a table for itself which the nodes relations are included in the table, which is a truth table in the table. Next, each of the nodes their data with sequence number in the form TC packet sends to the surrounding nodes, of course TC packets transfer can only be done through MPR nodes. In this way, all existing nodes in the network are aware of the available connections and how to communicate with each node and relevant information stored in the tables for each node. Then, in the following phase each note of the information which is collected must choose the best route to each node. The best route selection by the Dkstra algorithm, is done after this phase each node holds routing table which has the best route to nearby nodes. In this case the network reaches stability. By changing the nodes place the above operation is repeated and the tables are updated.

2.2.2 The routing protocols in the reactive routings

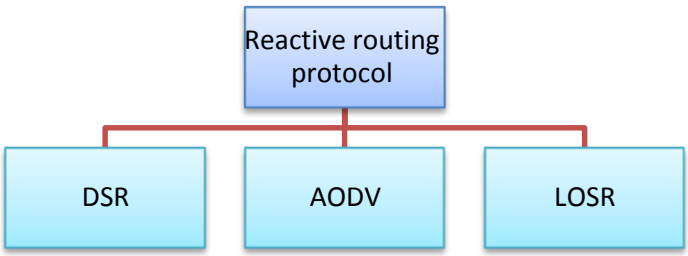


Figure 5 - The routing protocols in the reactive routings

In here three important protocols are examined:

2.2.2.1 Destination Reactive routing Source Routing (DSR):

DSR protocol is a reaction routing in which a node will only issue request the route when has a data to send the route. Requests must to be injected into the network, and each node that receives the request adds its, address to that and again issued the request. Each request includes a unique identifier that can be used to ensure its issue once. The request issuer, issues new requests to the same destination, then sends an exponential increase back-off time the route requests in order, to minimize the scope and cost of the injection in to the network are issued by increasing TTL values.

2.2.2.2 Ad-Hoc on Demand Distance Vector Routing Protocol (AODV):

The AODV routing Protocol is a reactive routing protocol in which all the routers all are discovered only when needed, and only during the time that are used they are kept. Theroutes are discovered during a flooding process during which the network nodes are in the searching process and are in the destination direction. When a node discovered by route, that

route is to track it back to ninety reported to back route and the origin node which requested the route. AODV is designed to achieve the following objectives:

- Minimal controlling overhead
- Minimal processing overhead
- Multi-step routing capacity
- To play dynamic maintenance
- Freedom from loop

AODV have simple structure and require little computing's. In and a hoc network the sources and destinations may be located outside the scope of direct communication because of the limited field sending wireless equipment therefore. The AODV enable the nodes in order to be able to use the multiple steps toward the destination. And these routes are kept until the network topologies constantly are changed. And also they strongly resist against the routing loops, because they are costly in any network, especially in a wireless network that signaling capacity and processing power node is limited. AODV in every nodes is used the sequence numbers in order to prevent routing loops.

This protocol consists of two phases:

- Route discovery
- Route Maintenance

- Route discovery:

AODV defines the following types of messages:
Route Request (RREQ)
Route Reply (RREP)
Route Error (REER)
Route Reply Acknowledgment (RREP-ACK)
When a source node needs a route and a destination node and it doesn't have a valid route in the routing table, a source node broad cast a route request packet (RREQ) to the all distributed destination node. When each node receives RREQ, created an entry in the reverse direction to the source node and Create or update routing and if it doesn't have a valid outer in the routing table, toward the destination node RREQ is broadcast all distribution again. When the Flooding packets of RREQ is reached from the source node to the destination node, ninety input are created or updated a reverse direction and a closed route (RREP) that has an increased sequence number and it's distributed in a reverse direction. When RREP is reached to the source node the along the reverse route, create, a forward route to the destination or updates, and communication starts.

- The process of route maintenance

Each node periodically broadcast a Hello packet for all distribution local connections and RREP is all distributed with TTL=1, such as Hello packets. When a node doesn't receive a packet from a neighbor and in a few seconds, assumes that the connection to the neighbor has been broken and therefore when a node has a broken connection a neighbor based on a MAC layer a failure on the route to the destination node detects that the next step of the route is the same neighbor nodes. When a node which detects the connection failure and it, is close to the destination node (it mean the number of the steps to destination node is much less than the number of steps to source node) there needs to be new route to this destination which as local repair is called.

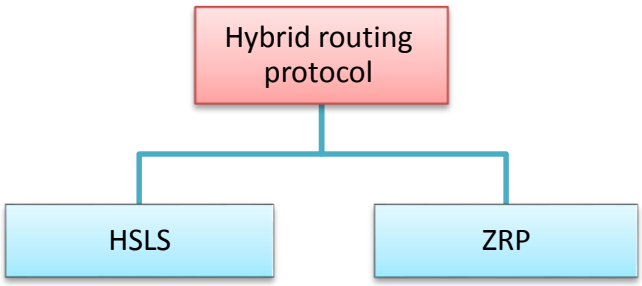
2.2.2.3 Link Quality Source Routing Algorithm (LQSR):

Link Quality Source Routing (LQSR) is based on a performance of the DSR basis, Such as route discovery process and keeping the route. LQSR as a link state routing protocol must be considered, since the link information is stored instead. Of the route information unlike DSR, implementing LQSR 2 and 5 instead layer 3-layer. Quality Metric - symmetric link as a cost is posed link in LQSR. Each LQSR node occasionally sends linked information massage. This information carry, recent metric for all links along the route (each node which receives the link date).

2.2.2.4 Routing Protocol in hybrid Routing (Hybrid Routing):

In here two important protocols are examined:

Figure 6 - Routing Protocol in hybrid Routing (Hybrid Routing)



- Hazy Sighted link State Routing (HSLS):

This type of routing protocol is fuzzy and vague and it's a kind of connective routing this is a kind of mixed routing which is the combination of proactive and reactive routing. In the NSLR and DSLR limited number tries to find routing information. If you approach suddenly to the nodes it shows reactivity and reactive routing find a new route for routing. HSLS to provide good routes and scalability route.

- Zone Routing Protocol (ZRP):

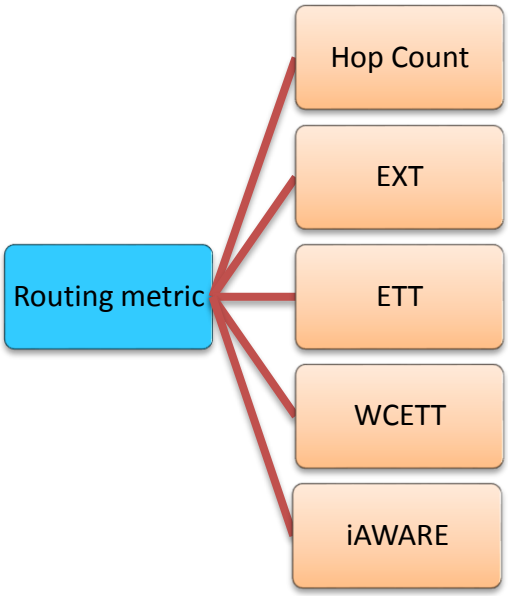
ZRP protocol is an example Combined protocol. ZRP divides the network into different areas which we call that routing area and in that area the radius of the area is expresses based on the number of jumps. ZRP protocol routing within the area is in the form of proactive for which is called IARP. And routing

between the areas is a kind of reactive which for a reaction is called IERP. For a specific network, ZRP is designed to adjust the radius of the area.

2.3 ROUTING METRICS:

Routing retries are designed to calculate the best routing. Wireless mesh network routing metrics are to increase the efficiency of the error rate, delay and power. Different routing metrics are flowing:

Figure 7 - Routing metric



2.3.1 Hop Count:

The number of hops is, one of the simplest routing metrics. The concept of hop-count means the numbers of intermediate routers that a gram data travels from source to destination nodes. Hop-count metric used to show the relative closeness of encore nodes. The proposed algorithm for the nodes which in wireless networks and ad-hoc that have limited resources, computationally can be done and show appropriate accuracy computing. But it has a disadvantage that cannot manage the interference subject between the different links and its benefit is, having low power and the ratio of the packet loss.

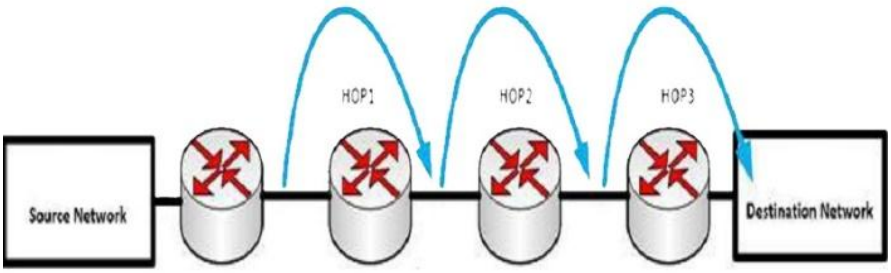


Figure 8- Hop Count

2.3.2 Expected transmission count metric (ETX):

This metric of select rout by the expected least number to reach the chosen destination (including retransmission as well), the aim of designing this metrics to find a rout with high throughput of the packet loss.

ETX of a link is the number of is the data transfer which are needed to send a package via the link, which includes retransmissions as well. The route EXT sum of ETX links which are existed in the route. ETX is a link which is calculated by the cost of link sending and receiving. The cost transmitted packet sending delivery df is equal to the probability that a data packet is reached to its destination successfully, reverse delivery case of Dr is equal to the probability that the ACK packet is received successfully. The likelihood that the message has been successfully completed and verified is: df *dr, When the transmitter try to perform the retransmitting that has not been successfully approved. Since any attempt to send the packet can be thought of as the Bernoulli distribution, the expected number of transmissions is:

P= 1-(1-Pf) (1-Pr)
(1)

2.3.3 Expected Transmission Time (ETT):

Expected time of transition in their calculations in addition to the above parameters the link bandwidth is also involved.
ETT =ETX * S ÷B
S: Package size
B: Bandwidth for sending the packet.

2.3.4 Weighted Cumulative Expected Transmission Time (WCETT):

WCETT is an interference-aware routing metric that consider the links with a heavy load in the network and assigned the high costs to them. This is a proposed solution for wireless networks, multi-frequency / multi-channel, respectively.
WCETT is composed of two main parts: The sum of all link costs along the route, and bottleneck channel which has the highest ETT sum. WCETT, consider in-stream interference (Overlapping between nodes in the same route), and not the interference between the flow (Interference between the nodes different routes).

$$WCETT_P - (1-a)^0 \sum ETT + a^0 MAX_J$$
(2)

$$X_j = \sum_{hops\ on\ chanel\ j}^{n} EET_j \ 1 \leq j \ \leq k$$
(3)

2.3.5 Interference Aware Routing Metric (iAWARE):

Pouting aware of metric interference in the loss of the rate of theirs the link, difference in the cost of the transition and between the current and the interference in the flow the interference ratio for a U-node in a link is: i = (u, v)

$$IR_i(u) = \frac{SINR_i(U)}{SNR_i[U]} \qquad (4)$$

The ration of the signal interference and noise is related to the link. Metric which is aware of the interference on a link is as follow:

$$iAWARE_j = \frac{ETT_j}{IR_j} \qquad (5)$$

2.4 . PARAMETERS FOR CALCULATING METRICS:

Because of the channel bandwidth in wireless communications is limited, routing design is an important metric. The existing routing metrics can be categorized in terms of the distance, the time of the delay, traffic load, error rate, multi-sectional the channel and multi-metric.

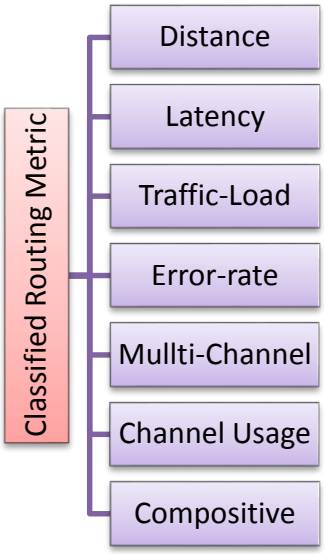


Figure 1 - Parameters for calculating metrics

RELATED WORK ON THIS TOPIC:

a. Muhammad Shoaib Siddiqui:

The combination protocol that connect multi-route security, which increases the stability of the wireless mesh networks the protected routings and other effective methods in other router when a route in wireless mesh networks uses other unwanted protocols to provide a secure multi-route and then by reviewing the combined architecture to provide a multi-sectorial routing scheme Where the motivation for the excellent result is provided to use different routing protocols For various network segments have been combined and security mechanisms of routing discussed some of the congestion, overhead and control Security by using Diffie-Hellman algorithm to authenticate share secret between the router and the client node is reduced. The simulation and analytic over view by comparing the overhead in the routing, the pure energy in each node and the date.

b. Irini Reljin , Branimir Reljin:

Wireless mesh network routing and its routing protocols, The about hybrid routing protocol that is based on Artificial intelligence based proposal neural networks is mesh routing that depends on the routing layer. This is a hybrid routing protocol which is used to avoid flooding and create new routing metric by considering bandwidth, delay and the number of nodes. This protocol is in neural network and its technology by using from two neural network and Hopfield. The first one is used from Hopfield to distribute changes in the network which are accompanied as possible via mobile phone. The

other Hopfield is used to choose to the decisions based on the previous information by the routing protocol. According to the logic of artificial intelligence proposed protocol for complete use of the network resources and also shows network performance by providing routing information is related to providing the routing protocol on sustained demand efficient. The protocol send only the change parameters from the routing table and hot send the entire routing table, but the routing decision is calculated based on previous information. This protocol has used from the data and multi-protocol metric for selecting the best route. The proposed protocol on all network restrictions and metrics is focused to provide improved performance. It can use the computer to simulate and can be used in any real-time network and dynamically in order to create a network topology.

2.5 . ROUTING CLASSIFICATION IN WIRELESS MESH NETWORKS

Here points out to four classifications (classes):

2.5.1 Ad-hoc based routing protocols:

The wireless mesh networks of Ad-hoc protocols are routing protocols to contrast with quality link changes. Routers continually update their -LINK output metrics and publish them to the other routers. Source routing protocol by link quality (LQSR) is a combination of active routing algorithm with the response strategy from the *Ad-hoc networks* which this protocol is described in the above section.

2.5.2 Controlled flooding routing Protocols

In wireless mesh networks the active protocols are designed to reduce overhead by using flood control method were introduced which using Algorithms to minimize the joint performance by reductive overhead for sending the information and Routing to all destinations in the network. Using an algorithm based on Feedback (OLSR) for each node is to minimize adaptive routing overhead and to maximize the distance of broad casting the control messages.

2.5.3 Traffic Aware Routing Protocols:

Traffic-aware routing protocols are commonly known in terms of traffic on the link, to assess performance in routing has a temporary existence. AODV is the most common distance demand which is from this group, which this protocol described above.

2.5.4 Opportunistic routing (OR) protocols:

Opportunistic routing is apart usage of the networks for routing. Unlike traditional routing protocols, the first optimal route is choosing and then the packets are sent in that direction. In the other hand the routing protocol, which sent the first packet and then the next node is selected, Opportunistic routing protocols by using a coordinated approach whether the forward overhead is closed and runs or not, and then it runs. This method may incur high decided that and poor performance wireless links needs time to recover from their defeat. Protocol (EXOR) is a group since the of10-100 packed transmission which is grouped in a category and then they must be transferred. ROMER Protocol a combination of the shortest route with minimal time delay in long routes and opportunistic routes for transporting flexible routes and for contrasting with shorter changes in the medium Quality.

3 CONCLUSION

By the growing interest in the development of wireless network technology, which expect more and better services for user who can be more accessible anywhere and anytime, by combining the technologies of the mesh wireless networks associated with multi-hope services these services are provided. The backbone of the Wireless Mesh networks user for accessing the Internet in anytime and anywhere is easy. Low cost, high quality and reliable multi-hop wireless mesh network provides communication and as well as have performance and better services in compare to traditional wired networks.

Routing in wireless mesh networks is challenging for researchers. A difficult process because of the involvement of multiple-hop communications, for transferring a packet from a node to other node it is used from routing protocols which have an important role in the performance of the Wireless mesh networks. For the effective performance a routing protocol based on network constraints is selected.

A classification of routing metrics is summarized in the table:

Table1-classification of routing metrics is summarized

class	Protocols	Metrics	Metric Category
Ad hoc based	LQSR	ETX	Error-rate
Controlled flooding	OLSR	Hop, ETX or ETT	Distance
Traffic-aware	AODV	ETX or ETT	Distance
Opportunistic	ExOR	ETX	Error-rate
	ROMER	Hop or delay	Error-rate

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