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Wireless mesh network: A survey.

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***Abstract*-For next generation wireless networks, wireless mesh networks have become the basic technology. WMNs consist of mesh router and mesh client. WMNs provide broadband internet access, wireless local area network coverage and network connectivity for both mobile and stationary nodes. Routing are used in mesh networks in order deliver packets from source to destination efficiently. Mainly 3 types of routing protocols are used in WMNs. Proactive, reactive and hybrid protocol. In which hybrid protocol are the best protocols when compared to others.This paper presents a survey of wireless mesh networks.**

***Index Terms*—Routing, architecture, routing protocols.**

I. INTRODUCTION

For providing broadband internet access for the community, WMNs have become a practical solution because of the explosion of internet. WMNs are the communication networks, which made up of mesh node, mesh router, gateway and mesh client. They are composed as a mesh topology. Laptops, cellphones and other wireless devices are the examples of mesh clients. Mesh router used to transmit data to and from the mesh gateways. A WMN is a self-organized and self-configured network. With the help of nodes, it can automatically establish and maintain network connectivity. Advantages of WMNs such as low cost, easy network maintenance, robustness, and reliable service coverage. WMN is the best wireless technology, it can support numerous applications, e.g., broadband home networking, community and neighborhood networks, enterprise networking, building automation, hospitality, educational field, disaster management etc.[5]

Wireless mesh networks (WMNs) are the most efficient wireless technology when compared with the existing networks like ad-hoc, sensor networks etc. because of their advantages like automatic establishing and maintaining network connectivity, rapid deployment etc, it can be used in numerous applications. WMNs, are composed of mesh routers and mesh clients. Mesh routers have mobility and form the mesh backbone for mesh clients.

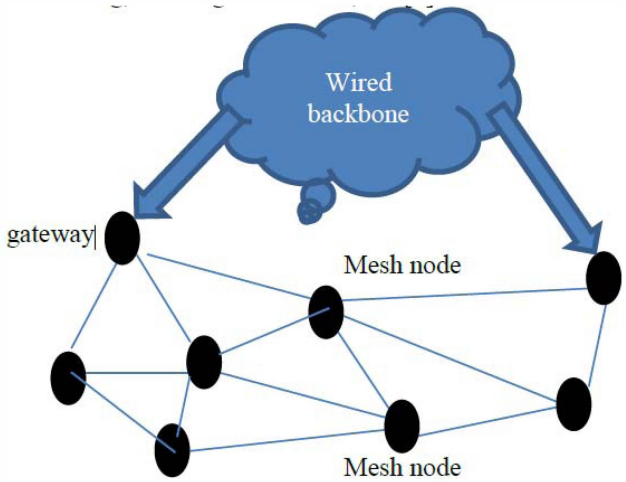

Fig 1 :WMNs

II. NETWORK ARCHITECTURE OF WMNS.

The architecture of WMNs can be classified into three types:

A. Infrastructure/Backbone WMNs:

Here infrastructure for mesh client are formed by using mesh router. The mesh routers develop self-configuring, self-healing links within themselves. By using gateway Mesh routers can be connected to the Internet . This method, also known as infrastructure meshing, it act as a backbone for conventional clients. WMNs can be integrated with existing wireless networks, with the help of gateway/bridge in mesh routers [1].

B. Client WMNs:

In this architecture, in order to perform routing and configuration functionalities client nodes form the actual network and also providing end-user applications to customers. Here , a mesh router is not required .Only one type of radios on devices are used for the formation of client WMNs[1]

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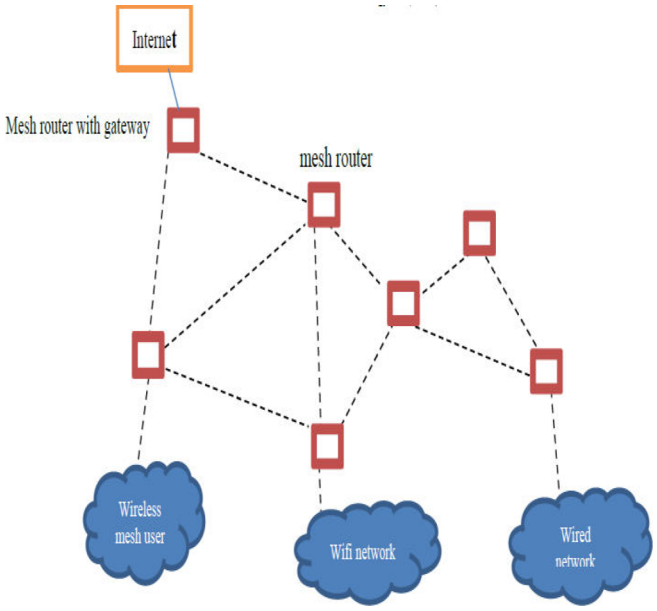

Fig 2 : Infrastructure WMNs

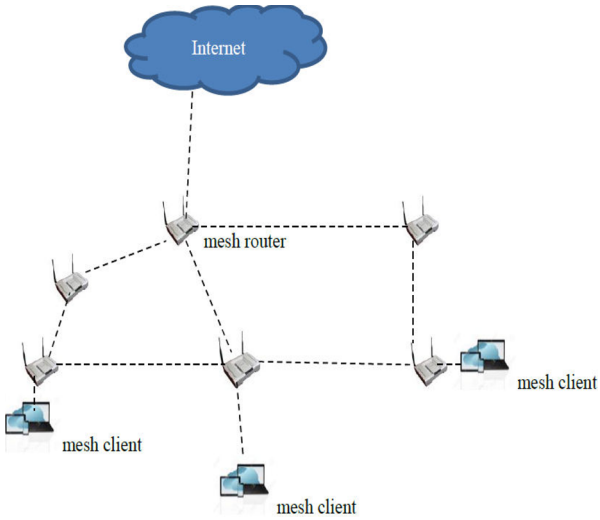

Fig 3:client WMNs.

C. Hybrid WMNs:
This architecture is the combination of both infrastructure and client meshing. By using mesh routers, mesh client can access the network and also directly connecting with other mesh clients.it will also provides connectivity to other networks such as the Internet, Wi-Fi, WiMAX, cellular, and sensor networks etc.

III. CHARACTERISTICS OF WMN.

The characteristics of WMNs are explained as follows:

•Dynamic self-configuration and self-organization feature: The self-configuring feature provides easy and rapid deployment of WMNs and it also support self-organization.
•Adaptation: WMNs can adapt to the changes in the environment and it can reroute the data if any link failure occur.
•Fault tolerance and robustness: Mesh networks are redundant and hence it can provide a high level of fault tolerance and robustness.
•Multi-hop wireless network: WMNs will increase the coverage range of current networks without making any problem to channel capacity. It can provide non-line of sight connectivity within users without actual direct line of sight between them.
•WMNs have the capability of self-forming, self-healing, and self-organization and also support ad-hoc networking: WMNs increases the network performance, because of better network architecture, easy maintenance and configuration, fault tolerance, and robustness.
•Mobility dependence : Mesh routers have minimal mobility, while mesh clients can be stationary or mobile nodes.
•Multiple types of network access: WMNs support multiple types of network access. WMNs can be integrated with other wireless networks and providing services to end-users.
•Dependence of power-consumption constraints on the type of mesh nodes.
• With existing wireless networks it can provide Compatibility and interoperability [2].

IV.CRITICAL DESIGN FACTORS OF WMNs.

The critical factors influencing the performance of WMNs are summarized as follows.

- Scalability: scalability is the important factor of WMNs. Without the scalability, network performance degrades when network size increases.
- Ease of use: In order to perform network autonomous as possible, protocols are used. Network management tools are used in order to maintain the operation, performance monitoring, and properly configure the parameters of WMNs. These tools, along with the autonomous mechanisms within networking protocols, provide rapid and easy placement and utilization. of WMNs.
- Compatibility and Inter-operability**:** WMNs are compatible with traditional mesh nodes. WMNs can be integrated with other wireless networks in order to achieve better performance.

- Mesh Connectivity: Mesh connectivity is a crucial factor of WMNs**.** In order **t**o achieve efficient mesh connectivity, network self-organization is necessary.

V. CHALLENGES IN WMNs.

In the context of WMNs, the issues in different layers which affect their performance have been characterized below:

a) Physical layer:

- Mobility: WMNs are capable of supporting user mobility.
- Multiple transceiver : WMNs must support multiple transceiver. Simultaneous transmissions are possible by using multiple transmitters.
- Transceiver performance: transceiver should be able to switch between transmitter & receiver mode. It must provide synchronizations.

b) Data link layer:

Designing of MAC protocol in data link layer is an important challenge.

- Channel assignment: In which channels are assigned for data transmission. It will increase the network capacity.
- MAC layer for smart antennas: Smart antennas can change the direction .It can perform between different neighbors and track the position of mobile users.

c) Network layer:

The main objective of the networking layer is to transfer the packets properly and efficiently from sender to the receiver node.

- Link scheduling: Scheduling link transmissions in order to achieve better congestion-free transmission schedule.
- Network connectivity: Network connectivity is a valuable network property that directly depends on network survivability. This is because Network connectivity limits the number of alternative paths between a pair of Nodes.
- Network capacity: Due to interference between simultaneous multiple transmissions, total capacity reduces.
- Security: User data travels through multiple wireless hops and router, so the clients will be careful about the Privacy of their Information. Security of User data should be ensured while transmitted between WMN routers.
- Routing: Routing is used for the efficient transmission of packets from source to destination. Selecting the routing path in order to achieve end-to-end traffic demands between nodes.
- Load balancing: Main objective of WMNs is to share the network resources between various users. When WMN experiences congestion, then data should not be routed through that particular routing path.
- Scalability: In a large network , setting up a routing path may take long time. So it will increase the end to end delay. Thus, the scalability of a routing protocol is critical in WMNs.

d) *Transport layer*:

TCP is most commonly used transport protocol. which perform poorly. Because it's transmission rate decreases depending on the transmission errors.

One of the main challenges of WMNs is routing.Which is given below.

VI. ROUTING.

Routing is used for the efficient transmission of packets from source to destination. Selecting routing paths to acieve end-to-end traffic demands between nodes.

There are mainly 4 types of routing,

i. Multi-path routing.
ii. Hierarchical routing
iii Geographic routing
iv. Multi radio routing.

i) Multi-Path Routing

The important objective of multi-path routing are, which will provide better load balancing and large level of fault tolerance and robustness. Here multiple paths are selected between sender and receiver node. Here data is transmitted through multiple path. When a link is broken on a path , another path can be selected. So, there is no need to wait for constructing a new routing path,. Hence the end-to-end transmission delay is reduces, and achieve better throughput, and fault tolerance.

ii). Hierarchical Routing.

In hierarchical routing, network nodes are grouped into clusters. Each cluster has one or more cluster heads. Nodes in a cluster can be one or more hops away from the cluster head. Connectivity between clusters is needed, some nodes can communicate with more than one cluster and work as a gateway. When the node density is very high, hierarchical routing protocols provide better performance because of less overhead, shorter average routing path, and quicker set-up of routing path.

iii). Geographic Routing.

Only by using the position information of nodes in the vicinity and the destination node, geographic routing transmits packets. Thus, if any changes in the topology does not affect the geographic routing when compared to other routing protocols.

iv). Multi radio routing.

Here multiple radios are used for transmission and reception.so simultaneous transmission and reception are possible. Multiple radios also improve the network capacity.[6]

VII. ROUTING PROTOCOLS.

Routing protocols are used to provide some functions like detecting and responding to changes in network topology and services, providing management, constructing and selecting routes, maximizing the capacity of the network and minimizing the packet delivery delays, minimizing end to end delay. Find and maintain routes between source and destination nodes, is the one of the main function of routing protocol in order to forward data.[2]

Mesh routing protocols can be classified into three types which is given below:

a. Proactive Routing protocol.
b. Reactive Routing protocol.
c. Hybrid Routing protocol.

a) PROACTIVE ROUTING PROTOCOL.

Proactive routing protocol always maintain route whether there are any data to send or not. Proactive routing protocols are based on continuous information obtained from routing table .Information about any change in the network is sent at time periods continuously. Up to date information is always maintained in routing table. So it can provide route selection in most efficient way. Some of the proactive routing protocols are Destination- Sequenced Distance-Vector Routing (DSDV), Cluster Head Gateway Switch Routing (CGSR), Optimized Link State Routing Protocol (OLSR).[7]

b) REACTIVE ROUTING PROTOCOL

Reactive routing protocols always search route based on demand. Reactive protocol search route whether there are any data to send. When a route is obtained, it is stored and used until the destination is obtained. The mostly used reactive protocols are DSR and AODV.[7].

c) HYBRID ROUTING PROTOCOL

A hybrid protocol combines the strength of both proactive and reactive routing protocols in order to provide most efficient path. Hybrid protocol act as both proactive and reactive based on the environment conditions. As a reactive routing protocol, it will provide the path on demand, based on up-to-date information. Examples of hybrid routing protocols are ZRP (zone routing protocol), HSLS (hazy sighted link state routing protocol).[3].

Another 4 types of routing protocols in mesh networks are,

i)Ad-hoc based routing protocol: ad-hoc based protocols are proactive, reactive or hybrid. They calculate link quality variations.[8]

ii).Controlled flooding based routing protocol: which will reduce overhead by controlled flooding technique. In order to transmit data to destination, it will calculate minimum nodes.

iii).Traffic aware routing protocol: In which for their performance evaluation, this are based on the effect of traffic on the link. Here only based on demand the routes are set up and maintaining only active routes.

iv). Opportunistic routing protocols: It based on broadcasting nature of wireless networks for routing. Here, node is selected only after forwarding packets.

VIII. APPLICATION SCENARIOS:

- *Education :*
  Many colleges, institutions and universities are using Wireless mesh network .WMNs provide broadband Network coverage and high bandwidth.so students can Easily downloads large files fast.

- *Healthcare :*
  WMNs are often used in healthcare applications.so Signals can transmit within shortest distance. Doctor Can update patient information, test results etc.

- *Hospitality:*
  Wireless mesh networks are used in medical field.

- *Warehouses:*
  Wireless mesh networks can provide connectivity throughout a huge warehouse structure with minimum effort.

- *Metropolitan area networks.*
  In metropolitan area, WMNs have various advantages. By using WMNs. It can send data with high speed when compared to cellular networks.

- *Home Networking*:
  WMN has greater impact on home networking. Commonly used home networking devices are television, personal computer etc. WMNs provide broadband internet connectivity. The whole devices can connect to the internet through a single gateway.

- *Disaster Management and Rescue Operations* :
  WMNs can be used in situations where immediate internet connectivity is needed. WMNs are used in disaster management and rescue operations. In rescue operations, mesh routers are placed in rescue devices.so it can provide internet connectivity to the networks.so peoples can communicate each other through mobile phones in case of difficult situations. WMNs can be easily build up within minimum time.

IX. CONCLUSION

This paper presented an overview of wireless mesh network. WMNs are an efficient technology for next generation wireless networking. In mesh network each network user act as a provider, forwarding data to the next node. The self-organization capability in WMNs reduces the complexity of network deployment and maintenance. So by using WMNs , user can access internet connectivity at anywhere at any time.

It can also enhance the reliability of the mobile ad hoc network of mesh clients. WMNs can be integrated with the multiple wireless networks in order to provide better performance. Many application scenarios are using its rapid development. However, to strengthen the market penetration and ensure the success of WMNs, more research is needed.

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