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A Comprehensive Study on Wireless Ad-Hoc Networks

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ABSTRACT: This paper propounds a concise inspection of Wireless Ad-Hoc networks, namely – MANET, VANET and FANET. This paper also presents a brief insight into the routing protocols of each Ad-Hoc network. A comparative analysis of infrastructure based and Ad-Hoc networks is proposed. This paper further gives a comparative interpretation between MANET, VANET and FANET with respect to various parameters.

KEYWORDS: Ad-Hoc Networks, MANET, VANET, FANET, Routing Protocol, Infrastructure-based Networks.

I. INTRODUCTION

Infrastructure based wireless networks faced challenges such as limited scalability, ease of installation, high maintenance, low mobility, high energy and hidden node problem. The proposed solution to overcome these drawbacks is the development of a network which is infrastructure-less, dynamic in topology, energy-efficient, robust, self-organising and universal.[1] This ushered the evolution of Ad-Hoc networks. Ad-hoc networks are distinctive due to the dynamic, homogeneous/heterogeneous, mobile and independent nature of the nodes. Wireless Ad-Hoc networks are classified based on the nature of the nodes as MANET, VANET and FANET.[2]

In this paper, MANET, VANET, and FANET along with their routing protocols have been analysed and explained briefly. The paper is composed of five sections. Section II focuses on MANET, Section III on VANET, Section IV on FANET, Section V on Comparison of MANET, VANET and FANET, Section VI on Comparison of Infrastructure-based Networks and Ad-Hoc Networks and Section VII on Conclusion and Future Scope.

II. MANET

Mobile Ad-Hoc Network (MANET) is an infrastructure-independent form of wireless Ad-Hoc network. This network comprises of mobile phones acting as independent routing nodes in the network for data propagation between any two arbitrary nodes in the network. These nodes are dynamic in position and exist universally. Optimized consumption of battery and prolonging the life of the network are the foremost concerns of MANET. This necessitates the MANET to improve the service area of the network, provide wireless connectivity to regions with weak or no connection. MANET allows a symmetrical configuration wherein each node in the network can act either as a router or a host or both simultaneously, disseminating via single or multiple hops.[8, 10] MANET is majorly concerned by issues like large overheads, jitter, inefficient bandwidth utilization, reduced packet-delivery ratio, mobility challenges, substantial node-to-node delay and latency.[9]

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ROUTING PROTOCOLS:

Routing protocols are crucial in creating a path between source node and destination node where the source starts a route-finding process which is acknowledged by its neighbours. [9] The two functional criteria for MANET are optimized routing and minimum delay of data transmission between the end-to-end nodes. The different routing protocols in MANET are categorized on the basis of routing information as Proactive Protocols, Reactive Protocols and Hybrid Protocols.

A. *Proactive Routing Protocol*

This type of protocol employs the table-driven method where each node in the network has prior knowledge of the routing information of every mobile node. The nodes in the network update their routing table information periodically and broadcast it to the network facilitating every other node in the network to update its routing table. This allows every node to be prepared with a pre-updated route for any transmission path prior to request. The only overhead is the maintenance of routing information by every node and its periodic update. This protocol proves efficient in a small, less dynamic network with consistent overhead routing information. [8]

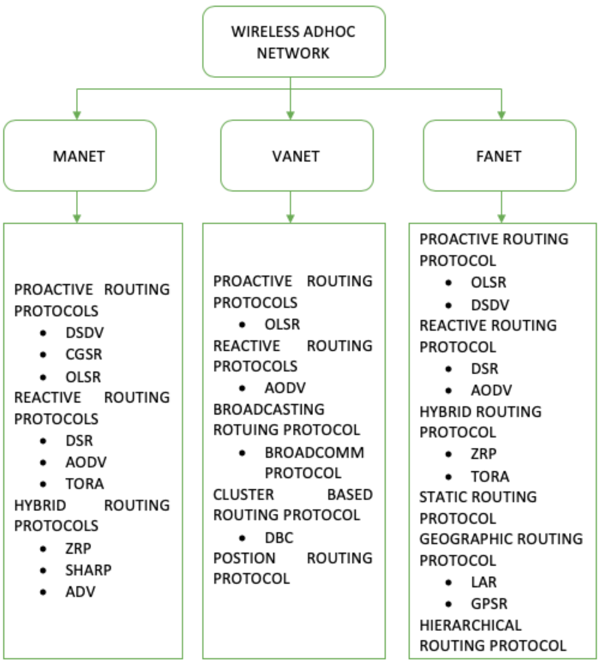

Figure: Various Routing Protocols

A.1. Dynamic Sequence Distance Vector (DSDV):

This protocol follows the algorithm of Bellman Ford. It employs the use of sequentially updated routing tables of every node in the network. DSDV uses two update messages known as a full dump and incremental dump. The low frequency full dump message carries the complete routing table information of a node to its neighbouring nodes at regular intervals. The high frequency incremental dump message carries only the updated routing information, since the previous update, using the sequence number. These two update messages facilitates maintenance of information such 'destination node', 'next hop', 'hop count' and 'sequence number'. [8]

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A.2. Cluster-head Gateway Switch Routing (CGSR):
This protocol divides the whole network into clusters of nodes without hierarchy. Every cluster selects a mobile cluster head using distributed cluster head selection algorithm and serves for all inter-cluster communication. The message is routed to the neighbouring cluster using cluster-member table and routing table through a designated gateway node which can be accessed by both the respective cluster heads. This process reiterates until the destination cluster is found. This protocol has lesser routing overhead as each node maintains its routing information only with the cluster head.[8]

A.3. Optimised Link State Routing (OLSR):
This protocol uses the link-state routing approach. Each node selects a MPR known as 'Multipoint relay' by analysing all 2-hop neighbours using the broadcast of 'Hello' messages. Each node has multiple MPR nodes which enables it to reach any node in the network. An optimised route for any transmission starts from the source node and is routed through the sequence of MPRs and reaches the destination node. The downside to this protocol is that the link quality is not tested before transmission and it is power consuming. [9]

B. Reactive Routing Protocol:
This protocol is an on-demand natured routing protocol. It maintains all the active communicating routes of the nodes in the network. Routing is established by broadcasting the packets throughout the network.[3,5]Reactive protocols are categorized as (a) source routing where each data packet follows the whole route from source to the destination, (b) hop-to-hop routing where the destination address and next hop address are present in each data packet. With the help of routing table, intermediate hop forwards data to the next hop until the destination is reached.[6] The key factor of reactive routing protocols is relatively minimised routing overhead, while the introduction of route acquisition latency is its drawback.[5]

B.1. Dynamic Source Routing (DSR):
This routing protocol is a link-state routing algorithm which creates lesser traffic, facilitates loop-free routing and rapid response to variations or node collapses. DSR uses source routing. Each node banks the routing information in the cache memory about all known routes and hence, requires a large memory. Continuous routing overhead is not present as the packet carries complete routing information.[5, 11]

B.2. Ad-hoc On-demand Distance Vector Routing (AODV):
AODV is self-initiating multi-hop protocol. It does not maintain non-active route information but dynamically obtains new efficient destination routes with minimum control overhead. It provides both unicast and multicast routing.[4,5] The route is found by broadcasting RRQP(Route Request Packet) to reach an intermediate node having destination route information or to reach the destination with the highest sequence number. As the RRP (Route Reply Packet) traces back to the source, the routing table is updated with required information from all the nodes along the path avoiding routing loops. The primary concern here is locating route and its maintenance.[5] The link collapses and variations in network topology are handled by the mobile nodes promptly.[4]

B.3. Temporary Ordered Routing Protocol (TORA):
This protocol is a reactive protocol which maintains and creates the Directed Acyclic Graph (DAG) and uses it for routing. TORA does not rely on the shortest path discovery but instead follows the longer paths which are already established so that it saves time in route discovery. The three chief processes followed by TORA are route construction, route conservation and route elimination.[13]

C. Hybrid Routing Protocol:
This protocol merges the standards of proactive and reactive protocols.[7] This protocol has very less traffic control compared to proactive and reactive with moderate memory overhead.[11,9] It provides hierarchical routing and is characterised by large memory and high power consumption as each node has more routing information.[10]

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C.1. Zone Routing Protocol (ZRP):

ZRP protocol adapts to the behaviour of users and topology of network having flat routing structure. The routes are readily available within the zone whereas non-existing zones are benefited by route discovery process locating multiple routes to destination.[7] The routing in this protocol reduces network congestion and overhead, also allowing border casting.[7, 9] The enhancement is minimised latency in reactive protocol and controlled overhead in proactive protocol.[12] The drawback is the overlapping of zones.[11]

C.2. Scalable Hierarchical Aggregation and Reduction Protocol (SHARP):

SHARP uses proactive and reactive algorithms to broadcast the routing information of the neighbouring nodes leading to efficiency and analytical tractability. Overhead is reduced by providing adaptability and flexibility to each application to have different quantitative metrics as well as better performance. It can be used to control jitter delay.[11,12]

C.3. Adaptive Distance Vector (ADV):

ADV responds to node mobility conditions and network load by altering frequency and size of the routing updates. This reduces overhead and avoids loops by using sequence number.[8] The variation in size is acknowledged by connection initiation and termination, once for each connection that exists in the network. It has higher reliability compared to other protocols.[7]

III. VANET

Vehicular Ad-Hoc Network (VANET) is a variant of MANET. In this network, nodes are substituted by mobile vehicles provisioned with wireless and data sharing intelligent modules. These intelligent modules generate a spontaneous and dynamic network via which data propagation takes place. The dissemination is established between either two vehicles (V2V)via short range wireless technologies, viz. WAVE and Wi-Fi or vehicles and Road Side Units (RSU) without the aid of an infrastructure (V2I)via long range wireless technologies, viz. Wi-Fi, GPRS/3G, and Wi-Max. V2V communication enables a direct propagation path between two mobile vehicles V2I communication enables a propagation path between a vehicle and RSU A cross-breed of V2V and V2I architecture is also employed to allow a vehicle to connect to a RSU and vice-versa.[14,15]The end goal of VANET is to establish an organised network for data transmission. This necessitates the VANET to have characteristics like application specific routing protocol and design, rigorous and demanding delay constraints, recurrent disconnections, dynamic topology, high mobility, predictable mobility patterns, secure, elevated speed, frequent real-time and time-sensitive information exchange, reduced latency, illimitable network size and economical.[13]

ROUTING PROTOCOLS:

A broad categorization of the protocols are: topology-based, broadcast-based, cluster-based and geographical-based routing protocols.[15]

A. Topology-based Routing Protocol:

Each node manages routing information in this protocol. The entries of the table are destination node address, next hop node, number of hops, destination sequence number, active neighbouring nodes and expiration date. This protocol is further classified into proactive and reactive routing protocol. [14]

A.1. Proactive Routing Protocol:

The fundamental principle followed here is same as MANET (Section II, A). Examples of proactive routing protocol are Destination Sequenced Distance Vector Routing (DSDV), Fisheye State Routing (FSR), Optimized Link State Routing (OLSR), etc.[15]

A.1.1. Optimized Link State Routing (OLSR):

This protocol overcomes the drawbacks of Link State Routing i.e., generation of many duplicates of the link state causes an overly large overhead in the network. OLSR operates with the help of "HELLO" and Topology Control (TC)

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messages. Specific nodes are chosen as Multipoint Relays (MPRs) using HELLO messages. MPR nodes are the only nodes authorized to resend link states consequently, reducing the network overhead and the duplicates generated in the network.[21] Topology information is provided by the TC messages and only MPRs can transmit a TC message.[22] There is low latency initially and network resource optimization is increased. [14]

A.2. Reactive Routing Protocol:

The fundamental principle followed here is same as MANET (Section II, B). Examples of reactive routing protocol are Ad Hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR), etc. [15]

A.2.1. Ad-Hoc On-Demand Distance Vector (AODV):

This protocol employs the help of a route locating mechanism and route preservation technique. In route locating mechanism, the sender node commences a route discovery using broadcast packets. A broadcast packet known as the Request Route (RRQ) packet is sent to the neighbouring nodes which entail details like source address, source sequence number, broadcast ID, destination address, destination sequence number and hop count. The most recent route between two nodes is used for route discovery mechanism and is handled by the destination sequence number.[19] In route preservation, "HELLO" messages are used to discover link collapses and is notified through Route Error (RERR) message sent to the other nodes in the network. The source reinitiates the route locating mechanism but the destination sequence number has to be incremented.[20] This protocol has large latency initially but the bandwidth is efficiently utilized and overhead is a prominent factor only when RRQ is generated.[14]

B. Broadcasting Routing Protocol:

The protocol is employed to transfer data to a distant destination well outside the source transmission range by flooding every node in the network with the data. However, bandwidth is inefficiently utilized as duplicates of the data are generated. The performance of broadcast is improved in a reduced node framework. Broadcast routing protocol is employed for data sharing and exchange, advertisements, announcements, delivery of information in an acute and critical environment. Examples of broadcast routing protocols are Broadcomm, Urban Multi-hop Broadcast Protocol (UMB), Distributed Vehicular Broadcast Protocol (DV-CAST), etc. [13, 23]

B.1. Broadcomm Protocol:

This protocol is a hierarchical network. Expressway is grouped into virtual cells which form the clones of mobile vehicles. The nodes located at the nucleus of the cell are called cell reflectors. The nodes in the network are split into two phases of hierarchy. The lower phase comprises of all the nodes in the cell. The higher phase consists of the cell reflectors. Cell reflectors take up the role of cell head for a small interval of time and broadcast messages incoming from nodes of the same or neighbouring cells. The working of this protocol is similar to flooding a network leading to data collisions, interference and overlooked hidden nodes. UMB Protocol overcomes these downsides and has a higher success rate of performance. [16]

C. Cluster-based Routing Protocols:

There are two types of clusters namely Dynamic clusters and Static clusters. Each cluster is delegated with a cluster head. The cluster head makes all decisions pertaining to communications within and outside the cluster. Traffic and data collisions is efficiently subjugated by cluster-based routing protocols. Clustering for Open IVC Networks (COIN),Density Based Clustering (DBC), Hierarchical Cluster-based Routing, etc. are the examples for this protocol. [13, 15]

C.1. Density Based Clustering (DBC):

Development of durable and stable clusters is the defining and distinctive feature of this protocol. Link quality, traffic, and density of connectivity graph is considered by the complex cluster metric to form clusters. Each node defines the number of connections it can support and based on this number, it is classified as either a dense or sparse node. History of communication is used to analyse the stability and operation of a node before it is made a part of a cluster and stable links are chosen from the existing links for transmission. [15, 24]

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D. Position/Geographical-based Routing Protocol:

This protocol provides the geographical location of every vehicle in the network. It relies on GPS, via which every node in the network realizes self, neighbour's and destination's location. Greedy Forwarding is utilized: data is propagated to every neighbouring node closer to the destination. Local Optimal is a challenge that arises when a node is unable to successfully discover a neighbour node near the vicinity of the destination. This protocol is optimal in highways. Examples of this protocol are Connectivity-Aware Routing (CAR), Vehicle Assisted Data Delivery (VADD), etc. [16]

IV. FANET

FANET is an anomaly from the conventional MANET in the matter of networking, application, mobility, dynamics of the topology, data routing, battery consumption, disconnections, network fragmentation, etc. FANET has a wide spectrum of applications like high voltage power lines inspection, real time surveillance, rescue ops, fire monitoring systems, observation missions, inspection of unreachable or hazardous sites and locations, deliveries. The fields in which it has a large scope of applications are military, agriculture, remote sensing, medical emergencies, natural calamities, etc. [26, 30, 31, 32]FANET has to include characteristics like accurate, quick, adaptive routing protocols, dynamic, large control signal, rapid delinks and relinks, scalable, low density of the network, data loss, overhead, latency, transmission delays. [32]

ROUTING PROTOCOLS:

Routing protocols are broadly categorised as: Static, proactive, reactive, hybrid, geographic-based and hierarchical protocol.

A. Static Routing Protocols:

This protocol employs a routing table which is uploaded to the UAV nodes prior to engaging in a mission. The information and data cannot be updated or modified during the flight of the UAV mission. The downside of the protocol is that it is biased to faults, link failure, changes in the topology culminating in the disintegration of the protocol.[28] The examples of static routing protocols are Data Centring Routing, Multi-level Hierarchical Routing and, Load Carry and Delivery Routing.

B. Proactive Routing Protocol:

Refer to MANET Proactive Routing Protocol (Section II, A). Furthermore, the routing protocol for the network is chosen based on the update mechanism used to periodically modify the routing table. The response time of the protocol is very high when the topology is highly dynamic in nature or link failures are encountered.[39]

B. 1. Optimised Link State Routing (OLSR):

Refer to VANET Proactive Routing Protocol (Section III, A.1.1). MPR node constructs a topology map and provides link information thereby, allowing the other nodes connected to the MPR to accurately enumerate the closest path to the destination. The number of MPRs increase the overhead. [36] The probability of increased link failures or traffic is huge due to frequent topology updates. [39] Another variant is DOLSR which overcomes network overhead and reduces TC messages. [36]

B. 2. Destination Sequenced Distance Vector:

This protocol is hinged on the algorithm of Bellman-Ford. The routing table in this protocol can be updated in two ways: Periodic – at intervals of 15s, and Triggered update – sent when a node receives an update. The routing table also includes the damping and sequence number of every node contained within the network. The destination node designates a sequence number for transmission. The route with a higher sequence number is chosen for routing [25]. This protocol is primarily focused on quashing loops and unnecessary updates with the aid of sequence number and damping. The downside of the protocol is the origination of advancing overhead due reiterating exchange of contents of the routing table [34].

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C. Reactive Routing Protocol:

The sender node discovers and formulates a route strictly when a transmission request is initiated [33]. Two distinct messages are employed to establish a route - Route Request Message and Route Reply Message [26]. The route request message is broadcasted and the destination responds with a route reply message according to which the route is determined. The only routes maintained are the active routes. [28] The hurdle of bandwidth optimization and overhead is resolved in this protocol. The downside is the substantial latency generated owing to the effect of route discovery.

C. 1. Dynamic Source Routing:

This protocol is formulated for wireless mesh networks. Since multiple Route Request messages are present in the network, distinctive request IDs are employed by the sources to avoid mix-ups and collisions.[25] Each node also relies on a cache memory used to store the routes that it has already learned.[27] Route Repair mechanism is stimulated when a source is unable to employ the current route. The conundrum faced in this protocol is the discovery of the route.

C. 2. Ad Hoc On-Demand Distance Vector Protocol (AODV):

This protocol includes two main kinds of messages, path discovery packets that are broadcasted only when needed and 'Hello' messages which are used when connectivity is needed or for detection of link.[27] Rather than maintaining multiple entries for each destination like in the DSR, it maintains only one record for a destination. There are three stages to this protocol - Route discovery, Data packet transmission and Route maintenance.[25]

D. Hybrid Routing Protocol:

This protocol is a cross breed of Proactive and Reactive Protocol which takes full advantage of the credits of both the protocols. The networks are classified into two zones - intra and inter zones. Intra zone utilizes proactive routing whereas inter zone utilizes reactive routing.[39]

D.1. Zone Routing Protocol (ZRP):

This protocol is pivoted on the notion of zones. Zones are a cluster of nodes with a predefined radius 'R' causing the zones to intersect.[39] Reactive routing is utilized in inter zones rather than proactive routing because the latter induces an overhead. The former routing induces latency and hence, proactive routing is used in intra routing.[25]

D. 2. Temporarily Ordered Routing Algorithm (TORA):

This routing protocol maintains the information about adjacent nodes. It strives to repress the initiation of many control signals.[26] It primarily utilizes reactive protocol but it also utilizes proactive routing protocol offhandedly. A directed acyclic graph is plotted and maintained indicating the source and destination. Longer routes are incorporated rather than shorted path key to mitigate overhead.[39] The system is loop free owing to a factor called 'height'. Each node is assigned a particular height. Data propagates due to difference in heights.[25]

E. Geographic based Routing Protocol:

In this protocol, each node receives its location update by one of the positioning facilities generally GPS. This protocol reduces the latency and complexity. There is no caching of the routing table and broadcast information includes node ID and navigation information.[35] The sender node uses the GPS or forwarding approach using position information of the network to track the position of the destination node.[30] This protocol proves effective in attenuating the link interruption due to the high mobility of UAVs.[32]

E.1. Location Aided Routing (LAR):

This protocol was initially meant to be integrated with topology-based protocols. Location updates are received by using the beaconing mechanism. The forwarding process is based on the position information of the current node, neighbouring nodes, and the destination node. LAR minimises the propagation zone of packets into a rectangular zone containing source and destination node positions.[30]

E.2. Greedy Perimeter Stateless Routing (GPSR):

GPSR protocol chooses the next hop as the node, which is closest to the destination.[30] This protocol is used when many UAVs are involved with the area of operation being small. To make GPSR more reliable, face routing,

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triangulation techniques, and other sophisticated strategies can be integrated with this protocol. It is also vulnerable to local minima problem where the protocol fails when no nearest neighbour node in the destination direction is found.[35]

F. Hierarchical Routing Protocol:

The nodes in this protocol are divided into different hierarchical levels. The lower hierarchical levels communicate using reactive protocols and the higher hierarchical levels have predefined proactive routes. The protocol is complex in nature (and addressing scheme which responds to traffic demand, as a result, it hangs the interconnecting aspects). Example is Mobility Prediction Clustering, Clustering Algorithm, etc. Mobility Prediction clustering - the UAVs in this protocol maintains a constant cluster database by predicting the network topology updates based on the Tri-structure calculation algorithm and link termination time mobility model.[28]

V. COMPARISON BETWEEN MANET, VANET AND FANET

Wireless ad-hoc networks are classified centred on the applications, design, positioning, communication, cost reliability, security and assignment intentions as MANET, VANET and FANET. The most challenging issue is the design and security as movement of MANET nodes is restricted to a fixed territory, VANET nodes to highways and roads whereas FANET nodes in the sky. [48, 56]The parameters to compare the networks are: Mobility, Node mobility, Delay, Throughput, Network range, Loss Ratio, Network Topology, Node density, Routing Overhead, etc. The average node-to-node delay is the average time interval between generation of data packet and its timely delivery where there can be queuing due to network traffic or invalid routes between the nodes. This delay is less for MANET when compared to VANET and FANET.[45] Packet loss ratio describes the application nature. It is the ratio of packet delivery figure to the packet transmission figure and usually the loss is due to overload in network routes. Here, MANET has a lower loss ratio when compared to the other two ad-hoc networks.[47, 49] Throughput is an effective measure of the packet delivery rate in the network. VANET has a better throughput than MANET and FANET.[46] Node density is the node population figure in the established network. The routing overhead is used to measure the functionality of the protocols with several nodes in different environments like high traffic or small bandwidth. A large number of routing packets leads to an increase in the delay at the transmission interface, congestion, the possibility of packet collisions and the node's power consumption in the network. The overload keeps varying in all MANET, FANET and VANET networks making it difficult to choose the better network. [51]

In spite of the better performance and mobility in FANETs, there are huge concerns in design and communication as the location of the nodes keeps varying by adapting to the network requirement which must be equipped with expensive hardware for communication. Hence, due to the various operations in FANETS, different routing techniques are necessary to avoid unreliable data loss when compared to MANET and VANET.[49] The performance parameters used to analyse the routing protocols are Packet Loss Ratio, Throughput, Normalized Routing Overload. In FANETs, the best protocol that can be utilized in the frequent network topology change is the Hybrid Wireless Mesh Protocol (HWMP).[49] As there are vehicular nodes in VANETs, their rapid movement causes data exchange issues which indirectly has an impact on routing protocols. The routing protocols developed by researchers like AODV, DSDV, OLSR, DSR, etc. cannot be used directly due to the rapid variation in link connectivity among the high speed nodes.

AODV and OLSR perform better than the other protocols. [50] MANETs, having a low throughput, require a protocol with the ability to maintain the connection by periodic information exchange. Based on certain research and simulation, we conclude that among DSDV, AODV, OLSR and DSR protocols, DSR showed a better performance than AODV in terms of Packet Delivery Ratio and Routing Overload; AODV performance is improved with better average delay as overload increases with mobility.[50, 51] In terms of scalability, both AODV and DSR show important drawbacks which needs further research to improve them.[53] All the routing protocols, in ad-hoc networks perform well with a wireless network whereas Reactive Protocol shows a better performance in VANET and MANET with good path maintenance and stability.[52]

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VI. COMPARISON BETWEEN INFRASTRUCTURE BASED AND AD - HOC NETWORKS

Infrastructure based networks have a defined architecture as its backbone. Any communication process takes place through a central access point which routes the messages accordingly. It is a well-defined topology and reliable. Ad-hoc networks are characterised by contradicting properties where there is an absence of a defined architecture. Ad-hoc networks lacks a central access point and hence each node acts as a router or a host as require. Ad-hoc networks have a dynamic topology and hence support mobility of nodes.[41]

Both these architectures have their advantages and limitations which make them feasible to use for separate applications. Ad-Hoc networks support mobility, scalability and are robust, but they are impractical to use in a large-scale commercial environment. This impracticality is accounted by various factors such as:

Security: Ad-hoc networks rely on independent nodes without any monitoring access point for its communication which puts a stress on Integrity, security and reliability. The required AAA (Authentication, Authorization and Accounting) criterion is not satisfied.

Routing Overhead: With increase in network size, the cost of routing overhead increases as the broadcast messages for path discovery become more frequent and occupy more channel bandwidth.

Traffic: As the network size increases, the number of nodes increases and hence increases the traffic in the network and this reduces the efficiency of long transmission and the SNR ratio fades with distance and number of hops.[44]

Infrastructure based network architecture is characterised by reliability, security, low interference and it is not constrained by factors such as power consumption and network size. This network architecture proves efficient in a large scale environment due to its characteristic features. However, there are some challenges which needs to be tackled by:

Scalability: This network architecture is not easily scalable for a growing population as the infrastructure supports only a limited amount of traffic and users.

Coverage: This network can be deployed on a large scale but it faces difficulty in reaching to areas with low wireless connectivity as the access points cannot reach them.

Interference and Percolation: As this network depends on the longer distanced transmission, it suffers loss due to the obstructions in the path such as buildings, vegetation and also gets corrupted due to interference in air with other background signals. [43]

There is a need for integration of ad-hoc and infrastructure based architecture for networking efficiency and to achieve practical and commercial goals. The lack of large scale feasibility of Ad-hoc architecture is fulfilled by Infrastructure based architecture which acts as the backbone for the integrated network architecture which controls the long-distance transmission and connectivity. The end-user communication between devices of the same subnet can be carried out by Ad-hoc architecture which ensures speed, scalability and mobility. To integrate these two architectures, we need a Gateway device to connect the global Infrastructure based network to the local subnet Ad-hoc network. This integrated network design overcomes the individual challenges of both architectures and will prove to be practical and efficient. [42]

VII. CONCLUSION AND FUTURE SCOPE

Scientific research in the field of Ad-Hoc networking is progressing and expanding for the past decade and yet proves to be fairly new in the field of research. The precise understanding of Ad-Hoc networks is still not fully accomplished which highly restricts the physical deployment of such networks. This major deficit of Ad-Hoc practicality is accounted by factors such as: Unfitting paradigm between wired and wireless networks, insufficient realistic research methodology and Lack of stochastic research model. To achieve lasting progress in Ad-Hoc network research, researchers need to chase beyond the existing design norms and methodologies to achieve a feasible practicality in Ad-Hoc network deployment

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