Ad-hoc MANET

Set II

Unit 1

1. Define MANETs ? Explain important characteristics of the MANET?

MANETs (Mobile Ad-hoc Networks) are decentralized wireless networks composed of mobile devices (nodes) that communicate directly with each other without relying on a central infrastructure like routers or access points. Each device in a MANET can act as a host and a router, forwarding data for other devices in the network. MANETs are used in situations where a fixed network infrastructure is unavailable or impractical, such as disaster recovery, military operations, or temporary networks.

Characteristics of MANET

- **Dynamic Topologies:** Network topology which is typically multihop may change randomly and rapidly with time, it can form unidirectional or bi-directional links.
- **Bandwidth constrained, variable capacity links:** Wireless links usually have lower reliability, efficiency, stability, and capacity as compared to a wired network
- **Autonomous Behavior:** Each node can act as a host and router, which shows its autonomous behavior.
- **Limited Resources**: Devices in a MANET typically have limited battery life, processing power, and bandwidth, requiring efficient resource management to sustain network operations.

- **Scalability**: MANETs can vary in size from small to large networks. However, as the number of nodes increases, managing the network and ensuring efficient communication becomes more challenging.
- **Less Human Intervention:** They require minimum human intervention to configure the network, therefore they are dynamically autonomous in nature.

Advantages of MANET

- Separation from central network administration.
- Each node can play both the roles ie. of router and host showing autonomous nature.
- Self-configuring and self-healing nodes do not require human intervention.
- Highly scalable and suits the expansion of more network hub.

Disadvantages of MANET

- Resources are limited due to various constraints like noise, interference conditions, etc.
- Lack of authorization facilities.
- More prone to attacks due to limited physical security.
- High latency i.e. There is a huge delay in the transfer of data between two sleeping nodes.

Unit II

1. Explain about Broad cost storm problem?

Broadcast in networking refers to the process of sending a message or data from one source to all devices in a network

The **Broadcast Storm Problem** occurs in mobile ad-hoc networks (MANETs) and other types of wireless networks when multiple nodes simultaneously rebroadcast a packet, leading to excessive and redundant transmissions, collisions, and network congestion. This problem is more pronounced in MANETs due to their dynamic topology, lack of infrastructure

Key Issues in the Broadcast Storm Problem:

Redundant Transmissions:Since multiple nodes may receive the same broadcast message, they may rebroadcast it simultaneously, leading to redundant transmissions. These redundant broadcasts offer no new information but increase traffic load.

Network Congestion: As the same packet is rebroadcast repeatedly, the network becomes congested with traffic, slowing down overall communication and wasting bandwidth.

Increased Collisions: Multiple nodes attempting to rebroadcast simultaneously can lead to packet collisions, which reduces the successful delivery of packets and increases the need for retransmissions.

Energy Wastage: In MANETs, where nodes are often battery-powered, repeated transmissions drain energy unnecessarily, shortening the network's operational lifetime.

Example Scenario:

In a densely populated MANET, when a node sends a broadcast message, nearby nodes immediately rebroadcast the message. Since those nodes are close to one another, their transmissions overlap, causing redundant packet propagation, congestion, and collisions.

Unit III

Routing in **ad-hoc networks**, such as MANETs (Mobile Ad-hoc Networks), is a challenging task due to the dynamic topology, lack of fixed infrastructure, and limited resources. To manage routing efficiently, various approaches have been developed over time. These approaches are broadly classified into the following three categories:

1. Proactive (Table-Driven) Routing Protocols

In **proactive routing**, each node continuously maintains up-to-date routing information to every other node in the network, even if no communication is required. Each node stores routing tables that are updated periodically, ensuring that routes to all nodes are pre-calculated and available when needed.

Key Features:

- **Routing tables** are maintained at each node.
- Periodic updates are broadcast to keep the tables consistent.
- Routing information is ready for immediate use, leading to low latency when sending data.
- Suitable for networks with low mobility and small node counts.

Advantages:

- Low latency in data transmission as routes are pre-established.
- Route setup time is minimal.

Disadvantages:

- High overhead due to constant routing updates, even when no communication is needed.
- Not scalable for large or highly mobile networks.

Examples of Proactive Routing Protocols:

- **Destination-Sequenced Distance Vector (DSDV)**: Each node maintains a routing table with information about every other node and the shortest path to it.
- **Optimized Link State Routing (OLSR)**: Uses link-state information to calculate routes and reduces overhead by using selected nodes (MPRs, or Multipoint Relays) to broadcast messages.

2. Reactive (On-Demand) Routing Protocols

In **reactive routing**, routes are discovered only when they are needed. When a node wants to send data to a destination, it initiates a route discovery process. The route is then established dynamically and maintained as long as it is needed.

Key Features:

- Routes are created only when required (on-demand).
- No need to maintain routing tables for all nodes at all times.
- Suitable for networks with frequent topology changes and low node density.

Advantages:

- Reduces overhead since routes are not constantly maintained or updated.
- Better suited for larger, more dynamic networks.

Disadvantages:

- Higher latency in data transmission, as routes must be established before data can be sent.
- Route discovery process can introduce delays, especially in high-mobility scenarios.

Examples of Reactive Routing Protocols:

- **Ad-hoc On-Demand Distance Vector (AODV)**: Routes are discovered on demand via a route request (RREQ) and route reply (RREP) mechanism.
- **Dynamic Source Routing (DSR)**: Uses source routing, where the entire route is included in the packet header. Routes are cached and reused if possible.

3. Hybrid Routing Protocols

Hybrid routing combines the advantages of both proactive and reactive approaches. It uses proactive routing within certain zones (usually local or close neighbors) and reactive routing for distant nodes. The goal is to reduce the overhead of proactive routing while minimizing the delay of reactive routing.

Key Features:

- Nodes maintain routes to nearby nodes proactively (within a specific range or zone).
- For distant nodes, routes are discovered on-demand, reducing the need for network-wide updates.
- Suitable for large-scale networks where a balance between overhead and delay is required.

Advantages:

- Balances the trade-off between the overhead of proactive protocols and the latency of reactive protocols.
- Efficient in large networks with diverse node densities and mobility patterns.

Disadvantages:

- Complexity in maintaining different routing strategies for local and distant nodes.

- More complicated to implement compared to purely proactive or reactive protocols.

Examples of Hybrid Routing Protocols:

- **Zone Routing Protocol (ZRP)**: Divides the network into zones. Proactive routing is used within a zone, while reactive routing is used for nodes outside the zone.
- **Hybrid Ad-hoc Routing Protocol (HARP)**: Combines the efficiency of proactive routing for frequently used routes and the flexibility of reactive routing for other routes.

Summary of Routing Approaches:

- **Proactive routing** ensures immediate route availability at the cost of higher overhead due to constant updates.
- **Reactive routing** reduces overhead but introduces delays as routes must be discovered before data transmission.
- **Hybrid routing** balances the strengths and weaknesses of both approaches, using proactive routing for nearby nodes and reactive routing for distant ones.

These approaches aim to provide efficient routing solutions tailored to the dynamic and resource-constrained nature of ad-hoc networks.

Short

Here are the answers to the questions shown in the image:

1. **Brief about the Ad hoc network:** An ad hoc network is a type of wireless network that does not rely on any fixed infrastructure like routers or access points. Instead, each device in the network acts as a node that can send, receive, and relay data. These networks are self-configuring and can be set up quickly, making them ideal for situations where a traditional network infrastructure is unavailable, such as in disaster recovery, military operations, or temporary setups.
2. **Write about the DSDV approach:** Destination-Sequenced Distance-Vector (DSDV) is a routing protocol for ad hoc networks. It is a table-driven protocol, meaning that each node maintains a routing table that lists all available destinations and the number of hops required to reach them. Each route entry is tagged with a sequence number, which helps to avoid routing loops and to determine the freshness of the route. DSDV helps in maintaining consistent and up-to-date routing information across the network.
3. **Define Broadcast storm problem:** A broadcast storm occurs in a network when there are excessive broadcast messages being sent, causing network congestion and potentially leading to network failure. This can happen in ad hoc networks when nodes indiscriminately broadcast messages, causing redundant transmissions,

collisions, and delays. Effective broadcast management techniques are necessary to mitigate this issue.
4. **Describe Probability-based methods:** Probability-based methods in networking involve making decisions based on probability to optimize routing or broadcasting in networks. For instance, in ad hoc networks, probability-based algorithms can be used to reduce the likelihood of broadcast storms by probabilistically determining whether a node should forward a message based on factors like its distance from the source or its connectivity degree.
5. **Define Geocasting:** Geocasting is a networking technique where messages are delivered to a specific geographic area rather than to specific nodes or addresses. In an ad hoc network, a message is sent to all nodes within a defined geographic region, which is useful for applications like location-based services, emergency alerts, and environmental monitoring.

Let me know if you need further explanations or details on any of these topics!

(or)

Here's a concise version of the answers suitable for a 2-mark response:

1. **Ad hoc network:** An ad hoc network is a wireless network without fixed infrastructure, where each node can independently connect and communicate with other nodes, forming a dynamic and self-configuring network.
2. **DSDV approach:** DSDV (Destination-Sequenced Distance-Vector) is a table-driven routing protocol for ad hoc networks, where each node maintains a routing table with the shortest path to every other node, updated using sequence numbers to prevent loops.
3. **Broadcast storm problem:** A broadcast storm occurs when excessive broadcast messages in a network lead to redundant transmissions, collisions, and network congestion, commonly seen in ad hoc networks.
4. **Probability-based methods:** Probability-based methods use probabilistic algorithms to make decisions like forwarding packets in ad hoc networks, helping to reduce congestion and improve efficiency.
5. **Geocasting:** Geocasting is the delivery of messages to nodes within a specific geographic area in a network, useful for applications like location-based services or emergency alerts.

SET I

1) Challenges of MANETs (Mobile Ad-Hoc Networks)

MANETs, or Mobile Ad-Hoc Networks, are networks that consist of wireless mobile devices communicating with each other without any fixed infrastructure or centralized administration. While they offer flexibility and ease of deployment, MANETs face several challenges:

1. **Dynamic Topology**: Nodes in a MANET are mobile, which leads to a constantly changing network topology. Maintaining routes between nodes becomes challenging as nodes frequently move, join, or leave the network.
2. **Limited Bandwidth**: The wireless communication medium has limited bandwidth, and as the number of nodes increases, the available bandwidth per node decreases. This can result in increased network congestion and packet collisions.
3. **Energy Constraints**: Mobile devices often operate on battery power, making energy efficiency a critical concern. High power consumption can lead to shorter device lifetimes and network instability.
4. **Security Threats**: The open and decentralized nature of MANETs makes them vulnerable to various security threats, such as eavesdropping, spoofing, denial of service attacks, and man-in-the-middle attacks.
5. **Routing Complexity**: Traditional routing protocols are not suitable for MANETs due to their dynamic nature. MANETs require specialized routing protocols that can adapt to the changing topology, handle frequent route updates, and minimize control overhead.
6. **Scalability**: As the number of nodes in the network increases, the routing and resource management complexity grows. Ensuring efficient communication in a large-scale MANET is a significant challenge.
7. **Quality of Service (QoS)**: Providing consistent QoS is difficult due to variable link quality, node mobility, and limited resources. This can impact real-time applications like voice and video communication.
8. **Interference and Signal Fading**: Wireless signals in MANETs are subject to interference, multipath fading, and path loss, which can degrade the communication quality and reduce the effective transmission range.
9. **Network Partitioning**: Due to node mobility, parts of the network may become isolated, leading to network partitioning where nodes in one partition cannot communicate with nodes in another.
10. **Synchronization Issues**: Maintaining synchronization between nodes, particularly in time-sensitive applications, is challenging due to the decentralized nature of MANETs.

Geocasting

1. **Definition**: Geocasting refers to the distribution of data to a specific geographical area. It is a form of broadcasting where the data is sent to all nodes or devices located within a defined geographic region.
2. **Target Area**: The target of geocasting is a geographic region or area, such as a city, neighborhood, or specific coordinates on a map.
3. **Applications**: Commonly used in location-based services such as emergency alerts, traffic updates, and location-based advertising. For instance, a geocast can notify all mobile devices within a particular area about an emergency situation or a special event.
4. **Routing**: Geocasting requires routing protocols that can handle spatial information and deliver data based on the location of nodes. Geographic routing protocols are often used for this purpose.

5. **Scope**: The scope of geocasting is determined by the geographic boundaries rather than the identity of the devices. Devices within the defined area receive the data.

Multicasting

1. **Definition**: Multicasting involves sending data to a specific group of recipients who have expressed interest in receiving that data. Unlike broadcasting, where data is sent to all nodes, multicasting targets a predefined set of nodes.
2. **Target Group**: The target of multicasting is a specific group of nodes identified by a multicast group address. Only nodes that are members of this group will receive the data.
3. **Applications**: Often used in applications such as video conferencing, streaming media, and online gaming, where data needs to be efficiently sent to multiple interested recipients without flooding the network with unnecessary data.
4. **Routing**: Multicasting uses multicast routing protocols like Protocol Independent Multicast (PIM) or Distance Vector Multicast Routing Protocol (DVMRP) to manage and route data to the intended group of nodes.
5. **Scope**: The scope of multicasting is determined by the membership of the multicast group. Only nodes that have joined the multicast group will receive the data, regardless of their geographic location.

Summary of Differences

- **Target**: Geocasting targets a geographic area, while multicasting targets a specific group of nodes.
- **Routing**: Geocasting requires geographic-based routing protocols, whereas multicasting uses multicast routing protocols.
- **Applications**: Geocasting is used for location-based services, while multicasting is used for group communication in applications like streaming and conferencing.
- **Scope Determination**: In geocasting, the scope is defined by geographical boundaries, whereas in multicasting, the scope is defined by multicast group membership.

These differences highlight how geocasting and multicasting cater to different communication needs based on geographic location and group membership, respectively.

Here’s a comparison of geocasting and multicasting in tabular form:

Aspect	Geocasting	Multicasting
Definition	Distributing data to a specific geographic area.	Sending data to a specific group of recipients.
Target Area	Geographic region or coordinates.	Multicast group identified by address.

Applications	Emergency alerts, traffic updates, location-based advertising.	Video conferencing, streaming media, online gaming.
Routing Protocols	Geographic routing protocols.	Multicast routing protocols (e.g., PIM, DVMRP).
Scope Determination	Based on geographic boundaries.	Based on multicast group membership.
Data Recipients	All nodes within the defined geographic area.	Only nodes that are members of the multicast group.
Example Use Case	Sending a weather alert to all devices in a city.	Streaming a live video to all devices subscribed to the channel.

This table summarizes the key differences and applications of geocasting and multicasting.

Explain GeoTORA in detail

GeoTORA (Geographical Temporally-Ordered Routing Algorithm) is an extension of the Temporally-Ordered Routing Algorithm (TORA) designed to work in ad hoc networks with geographical positioning information. GeoTORA integrates location-based routing with the reactive nature of TORA to improve the efficiency and scalability of routing in mobile ad hoc networks (MANETs).

Key Concepts of GeoTORA:

1. **TORA Basics:**
   - TORA is a reactive, on-demand routing protocol that establishes routes only when needed.
   - It uses a link reversal algorithm to maintain routes by creating a Directed Acyclic Graph (DAG) rooted at the destination.
   - TORA focuses on maintaining multiple routes to a destination and ensuring quick adaptation to topological changes without flooding the network.
2. **Incorporation of Geographical Information:**
   - GeoTORA utilizes geographical positioning information (e.g., GPS coordinates) to enhance TORA's routing decisions.
   - The geographical information helps in optimizing the path selection by considering nodes' physical locations, reducing the number of route updates and control message overhead.
3. **Operation of GeoTORA:**

    - **Route Discovery:** GeoTORA uses geographical information to limit the search space during route discovery. It prioritizes nodes that are geographically closer to the destination, reducing unnecessary network-wide broadcasts.
    - **Route Maintenance:** When a link break occurs, GeoTORA updates routes using TORA's link reversal method but restricts updates to a smaller geographic region, making the network more efficient.
    - **Route Erasure:** Like TORA, GeoTORA also has mechanisms to erase invalid routes but does so in a geographically confined manner to minimize network disruption.
4. **Advantages of GeoTORA:**
    - **Reduced Overhead:** By incorporating geographical information, GeoTORA reduces the control message overhead compared to traditional TORA.
    - **Improved Scalability:** The use of location data helps GeoTORA to scale better in large networks as it minimizes the routing scope.
    - **Faster Route Convergence:** GeoTORA achieves faster route establishment and recovery due to its geographically-informed route maintenance.
5. **Applications:**
    - GeoTORA is particularly useful in environments where nodes are aware of their geographic positions, such as in vehicular ad hoc networks (VANETs), military operations, and emergency response scenarios.

Limitations:

- **Dependence on GPS:** GeoTORA relies heavily on accurate positioning information, which might not be available or reliable in all scenarios.
- **Energy Consumption:** GPS usage and routing updates may lead to increased energy consumption, which is a critical consideration in battery-operated nodes.

In summary, GeoTORA combines TORA's reactive, on-demand routing mechanism with geographical information to enhance routing efficiency in mobile ad hoc networks. It optimizes route discovery and maintenance by leveraging the physical positions of nodes, leading to reduced overhead and improved scalability.

1. Discuss the geocast routing protocol proposed foruse in MANETs?

Geocast is a specialized routing protocol designed for mobile ad hoc networks (MANETs) that focuses on delivering data packets to nodes within a specific geographic area rather than to a particular node identified by a unique address. This geographic area, known as the "geocast region," is defined by its geographical coordinates.

Key Concepts of Geocast Routing Protocol

1. **Geographic-Based Delivery**:
    - Unlike traditional routing protocols that target specific node addresses, geocast routing protocols aim to deliver packets to all nodes located within a

predefined geographic area. This is particularly useful in applications like disaster relief, environmental monitoring, and location-based services.

2. **Geocast Regions**:
   - A geocast region is defined by its geographic boundaries, which can be a circle, rectangle, or any other polygonal shape. Nodes within this region are the intended recipients of the data packets.
3. **Routing Mechanism**:
   - **Source Node**: The source node initiates a geocast request, specifying the destination geographic region.
   - **Forwarding Nodes**: Intermediate nodes forward the packet based on their position relative to the geocast region.
   - **Destination Nodes**: Nodes that fall within the specified geographic area receive the packet.

Types of Geocast Routing Protocols

1. **Proactive Geocast Protocols**:
   - **Position-Based Geocast**: Nodes maintain a geographic routing table that helps in determining whether they are within the geocast region. Examples include the Geographic Forwarding Protocol (GFP) and Geocast with Zone-Based Hierarchical Routing (GZHR).
2. **Reactive Geocast Protocols**:
   - **On-Demand Geocast**: Routes are discovered and established only when needed. The protocol dynamically determines the route to the geocast region when a data packet is generated. Examples include the Geocast Routing Protocol (GRP) and the Geographic-Location-based Geocast (GLG).

Example Protocol: Geocast Routing Protocol (GRP)

GRP is a commonly referenced geocast routing protocol used in MANETs. Here's a brief overview of how it works:

1. **Initialization**:
   - Nodes are equipped with GPS or other location services to determine their geographic coordinates.
2. **Geocast Request**:
   - The source node generates a geocast request specifying the geographic region (e.g., a rectangular area) where the data should be delivered.
3. **Forwarding Mechanism**:
   - **Forwarding**: Nodes within or near the geocast region forward the packet towards the region. Nodes outside the region drop the packet.
   - **Localization**: Intermediate nodes use their geographic information to determine if they are within the region or if they can forward the packet closer to the region.
4. **Packet Reception**:
   - **Within Region**: Nodes inside the specified geographic area receive the packet and process it.

    - **Outside Region**: Nodes outside the region do not process the packet and drop it.
5. **Route Maintenance**:
    - **Dynamic Adjustment**: GRP adjusts dynamically based on the movement of nodes and changes in the geocast region. This helps in maintaining effective delivery as nodes move in and out of the region.

Advantages of Geocast Routing Protocols

1. **Efficient Data Delivery**:
    - Geocast protocols focus on delivering data to nodes within a specific geographic area, reducing the need for global or broad-based routing.
2. **Reduced Overhead**:
    - By targeting geographic regions, geocast protocols often reduce the amount of routing control traffic and overhead compared to traditional routing protocols.
3. **Scalability**:
    - Geocast protocols can handle large-scale networks more efficiently by segmenting the network into manageable geographic regions.
4. **Application-Specific Use**:
    - Ideal for applications that require data dissemination to a region rather than to specific nodes, such as environmental monitoring and disaster response.

Summary

Geocast routing protocols are designed to deliver data packets to nodes within a specific geographic region in mobile ad hoc networks. By leveraging geographic information, these protocols provide efficient and scalable routing solutions for applications that require region-based data delivery. Protocols like the Geocast Routing Protocol (GRP) demonstrate how geographic-based routing can optimize data dissemination and reduce network overhead in dynamic and large-scale networks

Short ,Set 1

Here are concise answers to the questions based on the image you uploaded:

1. **What is an ad hoc wireless network?**
   An ad hoc wireless network is a decentralized network where devices communicate

directly with each other without relying on a pre-existing infrastructure like routers or access points.

2. **List the characteristics of MANET?**
   - **Decentralized architecture**: No fixed infrastructure.
   - **Dynamic topology**: Nodes can move and change their position frequently.
   - **Self-configuring**: Nodes join or leave the network without needing external control.
   - **Limited bandwidth**: Nodes share the wireless medium, so bandwidth is often limited.
3. **Define Broadcast storm problem?**
   The broadcast storm problem occurs in wireless ad hoc networks when excessive broadcast messages flood the network, leading to high contention, collisions, and network congestion.
4. **Explain about Topology based Routing?**
   Topology-based routing uses the information about the network's topology to determine the routing path. It relies on the network's structure, such as the connectivity between nodes, and updates routes when the topology changes.
5. **Define Multicasting and Geo-casting?**
   - **Multicasting**: A communication method where data is sent from one sender to multiple receivers in a specific group.
   - **Geo-casting**: A location-based communication method where messages are sent to all nodes in a specific geographical region.

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2). Applications of MANETs

Despite the challenges, MANETs have a wide range of applications due to their flexibility and ease of deployment. Some common applications include:

1. **Military Operations**: MANETs are widely used in military operations for secure, reliable communication among soldiers, vehicles, and command centers without relying on fixed infrastructure.
2. **Disaster Recovery and Emergency Services**: In disaster-hit areas where existing communication infrastructure is damaged, MANETs provide a quick and flexible communication setup for rescue and relief operations.
3. **Sensor Networks**: MANETs are used in environmental monitoring, wildlife tracking, and other sensor network applications where data needs to be collected from distributed sensors.
4. **Vehicular Ad-Hoc Networks (VANETs)**: MANETs are employed in intelligent transportation systems for vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, enhancing road safety and traffic management.
5. **Mobile Computing**: MANETs enable communication in mobile computing applications, such as conferences, meetings, and collaborative work environments, without needing a fixed infrastructure.

6. **Smart Devices and IoT**: In the Internet of Things (IoT), MANETs allow smart devices to communicate directly with each other, forming self-organizing networks for various applications like smart homes and smart cities.
7. **Remote and Rural Communication**: In remote or rural areas lacking conventional communication infrastructure, MANETs provide connectivity for communities, education, and healthcare services.
8. **Personal Area Networks (PANs)**: MANETs facilitate communication between personal devices like smartphones, tablets, laptops, and wearables, forming a personal network on the fly.
9. **Robotics and Swarm Intelligence**: In robotics, MANETs are used for coordinating groups of robots, drones, or autonomous vehicles in tasks like exploration, mapping, and surveillance.
10. **Entertainment and Gaming**: MANETs support multiplayer gaming and entertainment applications by allowing devices to connect and interact without centralized servers.

Geocasting and multicasting are both methods of distributing data to multiple recipients, but they operate in different contexts and have distinct characteristics: