UNIT V - ROUTING PROTOCOLS

Ad Hoc networks, localization, MAC issues, Routing protocols, global state routing (GSR), Destination sequenced distance vector routing (DSDV), Dynamic source routing (DSR), Ad Hoc on demand distance vector routing (AODV), Temporary ordered routing algorithm (TORA), QoS in Ad Hoc Networks, application.

NETWORK PROTOCOLS

INTRODUCTION

Since the ad hoc wireless network consists of a set of mobile nodes (hosts) that are connected by wireless links, the network topology in such a network may keep changing randomly. Hence a variety of routing protocols for ad hoc wireless networks has been proposed.

ISSUES IN DESIGNING A ROUTING PROTOCOL FOR AD HOC WIRELESS NETWORKS

The major challenges that a routing protocol designed for ad hoc wireless networks faces are:

Mobility

- Network topology is highly dynamic due to movement of nodes. Hence, an ongoing session suffers frequent path breaks.
- Disruption occurs due to the movement of either intermediate nodes in the path or end nodes.
- Wired network routing protocols cannot be used in adhoc wireless networks because the nodes are here are not stationary and the convergence is very slow in wired networks.
- Mobility of nodes results in frequently changing network topologies
- Routing protocols for ad hoc wireless networks must be able to perform efficient and effective mobility management.

Bandwidth Constraint

- Abundant bandwidth is available in wired networks due to the advent of fiber optics and due to the exploitation of wavelength division multiplexing (WDM) technologies.
- In a wireless network, the radio band is limited, and hence the data rates it can offer are much less than what a wired network can offer.
- This requires that the routing protocols use the bandwidth optimally by keeping the overhead as low as possible.
- The limited bandwidth availability also imposes a constraint on routing protocols in maintaining the topological information.

Error-prone shared broadcast radio channel

- The broadcast nature of the radio channel poses a unique challenge in ad hoc wireless networks.

- The wireless links have time-varying characteristics in terms of link capacity and link-error probability.
- This requires that the adhoc wireless network routing protocol interact with the MAC layer to find alternate routes through better-quality links.
- Transmissions in ad hoc wireless networks result in collisions of data and control packets.
- Therefore, it is required that ad hoc wireless network routing protocols find paths with less congestion.

Hidden and exposed terminal problems

- The hidden terminal problem refers to the collision of packets at a receiving node due to the simultaneous transmission of those nodes that are not within the direct transmission range of the receiver, but are within the transmission range of the receiver.
- Collision occurs when both nodes transmit packets at the same time without knowing about the transmission of each other.

Ex: consider figure 3.1. Here, if both node A and node C transmit to node B at the same time, their packets collide at node B. This is due to the fact that both node A and C are hidden from each other, as they are not within the direct transmission range of each other and hence do not know about the presence of each other.

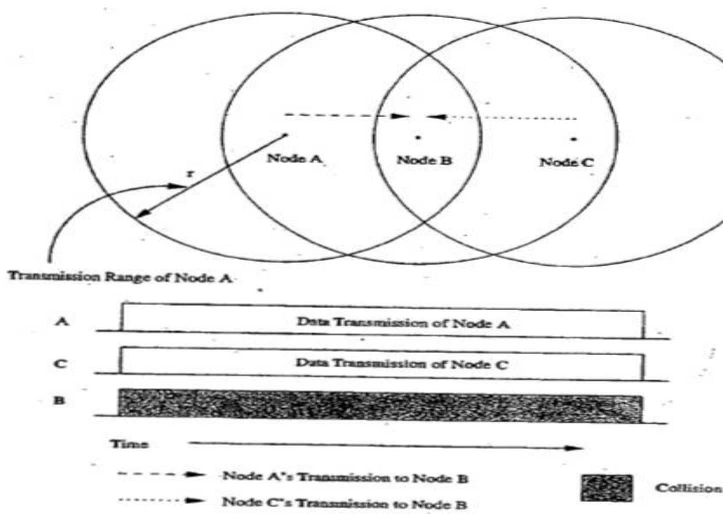


FIG: 3.1 Hidden Terminal Problems

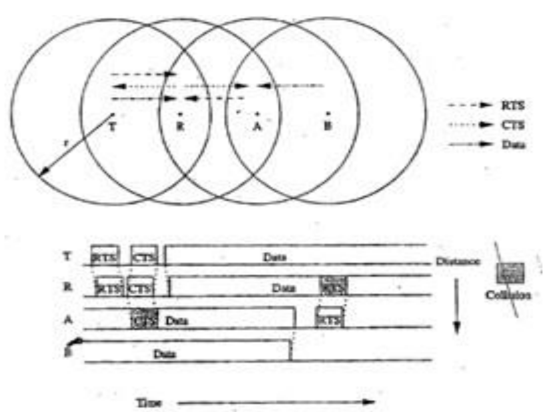
•Solution for this problem include medium access collision avoidance (MACA):

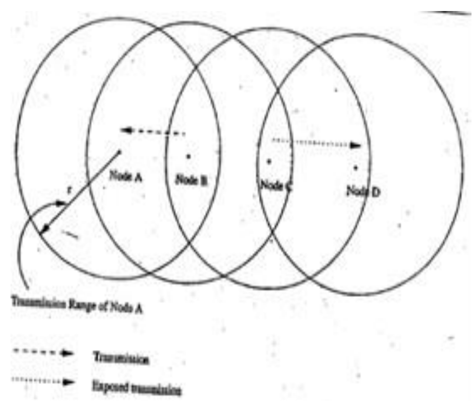
Transmitting node first explicitly notifies all potential hidden nodes about the forthcoming transmission by means of a two way handshake control protocol called RTS-CTS protocol exchange.

- This may not solve the problem completely but it reduces the probability of collisions.

•Medium access collision avoidance for wireless (MACAW):

- An improved version of MACA protocol.
- Introduced to increase the efficiency.





- Requires that a receiver acknowledges each successful reception of data packet.

Figure: 3.2 Hidden Terminal problem with RTS-CTS **Figure: 3.3 Exposed Terminal Problem**

•Successful transmission is a four-way exchange mechanism, RTS-CTS-Data-ACK, as illustrated in figure Other solutions include floor acquisition multiple access (FAMA) and Dual busy tone multiple access (DBTMA).

•The exposed terminal problem refers to the inability of a node which is blocked due to transmission by a nearby transmitting node to transmit to another node.

•Ex: consider the figure 3.3. Here, if a transmission from node B to another node A is already in progress, node C cannot transmit to node D, as it concludes that its neighbor node B, is in transmitting mode and hence should not interfere with the on-going transmission. Thus, reusability of the radio spectrum is affected.

Resource Constraints

•Two essential and limited resources are battery life and processing power.
•Devices used in adhoc wireless networks require portability, and hence they also have size and weight constraints along with the restrictions on the power source.
•Increasing the battery power and processing ability makes the nodes bulky and less portable.

Characteristics of an Ideal Routing Protocol for ad hoc wireless networks

A routing protocol for ad hoc wireless networks should have the following characteristics:

•It must be fully distributed as centralized routing involves high control overhead and hence is not scalable.
•It must be adaptive to frequent topology changes caused by the mobility of nodes.
•Route computation and maintenance must involve a minimum number of nodes. Each node in the network must have quick access to routes, that is, minimum connection setup time is desired.
•It must be localized, as global state maintenance involves a huge state propagation control overhead.
•It must be loop-free and free from state routes.
•The number of packet collisions must be kept to a minimum by limiting the number of broadcasts made by each node. The transmissions should be reliable to reduce message loss and to prevent the occurrence of state routes.
•It must converge to optimal routes once the network topology becomes stable. The convergence must be quick.
•It must optimally use scarce resources such as bandwidth, computing power, memory, and battery power.
•Every node in the network should try to store information regarding the stable local topology only. Changes in remote parts of the network must not cause updates in the topology information maintained by the node.
•It should be able to provide a certain level of quality of service (QoS) as demanded by the applications, and should also offer support for time-sensitive traffic.

CLASSIFICATIONS OF ROUTING PROTOCOLS

A classification tree is shown below:

The routing protocol for adhoc wireless networks can be broadly classified into 4 categories based on

- Routing information update mechanism
- Use of temporal information for routing
- Routing topology
- Utilization of specific resources

Based on the routing information update mechanism

Ad hoc wireless network routing protocols can be classified into 3 major categories based on the routing information update mechanism. They are:

•Proactive or table-driven routing protocols:

- Every node maintains the network topology information in the form of routing tables by periodically exchanging routing information.

•Ex: Destination sequenced distance vector routing protocol (DSDV), wireless routing protocol (WRP), source-tree adaptive routing protocol (STAR) and cluster-head gateway switch routing protocol (CGSR).

Destination sequenced distance-vector routing protocol (DSDV)

•It is an enhanced version of the distributed Bellman -Ford algorithm where each node maintains a table that contains the shortest distance and the first node on the shortest path to every other node in the network.
•It incorporates table updates with increasing sequence number tags to prevent loops, to counter the count-to-infinity problem, and for faster convergence.
•As it is a table-driven routing protocol, routes to all destinations are readily available at every node at all times.
•The tables are exchanged between neighbors at regular intervals to keep an up -to-date view of the network topology.

•The table updates are of two types:

Incremental updates: Takes a single network data packet unit (NDPU). These are used when a node does not observe significant changes in the local topology.

Full dumps: Takes multiple NDPUs. It is done either when the local topology changes significantly or when an incremental update requires more than a single NDPU.

•Table updates are initiated by a destination with a new sequence number which is always greater than the previous one.
Consider the example as shown in figure 3.4(a). Here node 1 is the source node and node 15 is the destination. As all the nodes maintain global topology information, the route is already available as shown in figure 3.4 (b). Here the routing table node 1 indicates that the shortest route to the destination node is available through node 5 and the distance to it is 4 hops, as depicted in figure 3.4(b)
•The reconfiguration of a path used by an on-going data transfer session is handled by the protocol in the following way.
•The end node of the broken link initiates a table update message with the broken link's weight assigned to infinity (∞) and with a sequence number greater than the stored sequence number for that destination.
•Each node upon receiving an update with weight ∞, quickly disseminates it to its neighbors in order to propagate the broken-link information to the whole network.
•A node always assigns an odd number to the link break update to differentiate it from the even sequence number generated by the destination.
•Figure 3.5 shows the case when node 11 moves from its current position.

Advantages

- ✓ Less delay involved in the route setup process.
- ✓ Mechanism of incremental update with sequence number tags makes the existing wired network protocols adaptable to ad hoc wireless networks.
- ✓ The updates are propagated throughout the network in order to maintain an up-to-date view of the network topology at all nodes.

Disadvantages

- ➢ The updates due to broken links lead to a heavy control overhead during high mobility.
- ➢ Even a small network with high mobility or a large network with low mobility can completely choke the available bandwidth.
- ➢ It suffers from excessive control overhead.
- ➢ In order to obtain information about a particular destination node, a node has to wait for a table update message initiated by the same destination node.
- ➢ This delay could result in state routing information at nodes.