1.5 Ad hoc wireless Internet

- Ad hoc wireless internet extends the services of the internet to the end users over an ad hoc wireless network. It shows in figure 1.6.
- Some of the applications of ad hoc wireless internet are :
- Wireless mesh network.
- Provisioning of temporary internet services to major conference venues.
- Sports venues.
- Temporary military settlements.
- Battlefields
- Broadband internet services in rural regions.
- The major issues to be considered for a successful ad hoc wireless internet are the following :
- Gateway
- They are the entry points to the wired internet.
- Generally owned & operated by a service provider.
- They perform following tasks ,
- Keeping track of end users.
- Bandwidth management.
- Load balancing.
- Traffic shaping.
- Packet filtering.
- Width fairness &
- Address, service & location discovery.
- Address mobility
- This problem is worse here as the nodes operate over multiple wireless hops.
- Solution such as Mobile IP can provide temporary alternative.

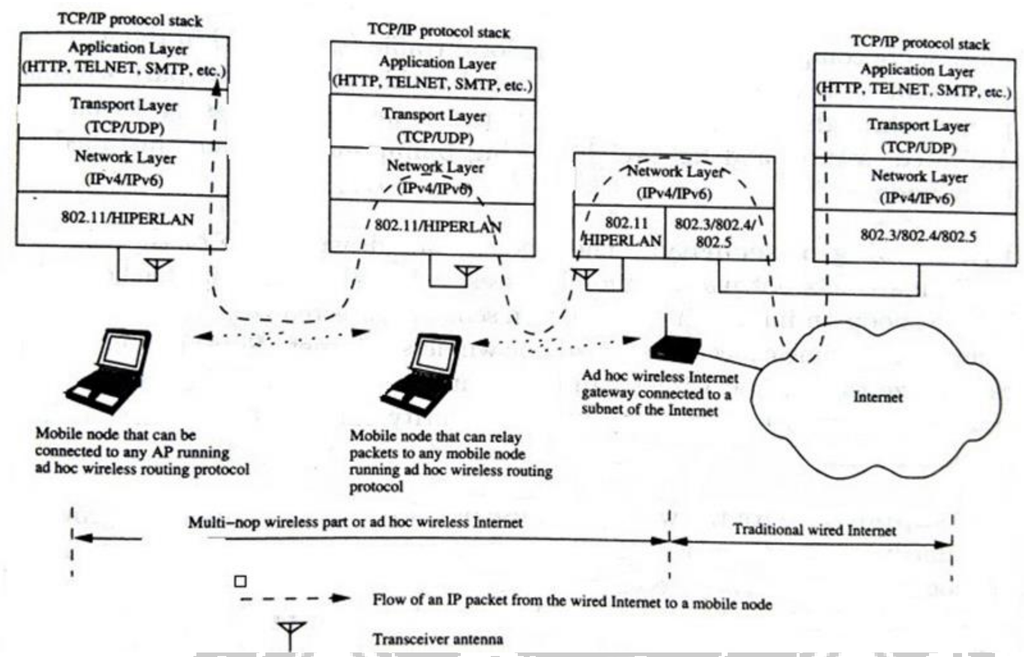


Figure (a) Ad Hoc Wireless Internet

Source : Ad Hoc Wireless Networks Architectures and Protocol by C. Siva Ram Murthy and B. S. Manoj

Routing

- It is a major problem in ad hoc wireless internet, due to dynamic topological changes, the presence of gateways, multi-hop relaying, & the hybrid character of the network.
- Possible solution is to use separate routing protocol for the wireless part of ad hoc wireless internet.
- Transport layer protocol
- Several factors are to be considered here, the major one being the state maintenance overhead at the gateway nodes.
- Load balancing
- They are essential to distribute the load so as to avoid the situation where the gateway nodes become bottleneck nodes.
- Pricing / Billing

- Since internet bandwidth is expensive, it becomes very important to introduce pricing/billing strategies for the ad hoc wireless internet.

- Provisioning of security
  - Security is a prime concern since the end users can utilize the ad hoc wireless internet infrastructure to make e-commerce transaction.
- QoS support
  - With the widespread use of Voice Over IP (VOIP) & growing multimedia applications over the internet, provisioning of QoS support in the ad hoc wireless internet becomes a very important issue.
- Service, address & location discovery
  - Service discovery refers to the activity of discovering or identifying the party which provides service or resource.
  - Address discovery refers to the services such as those provided by Address Resolution Protocol (ARP) or Domain Name Service (DNS) operating within the wireless domain.
  - Location discovery refers to different activities such as detecting the location of a particular mobile node in the network or detecting the geographical location of nodes.

1.6 Routing Protocols for Ad Hoc Wireless Networks

- Routing is the exchange of information from one station of networks to other and Protocol is the set of standard or rules to exchange data between two devices.
- An ad hoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in a mobile ad hoc network.
- An ad hoc wireless network consists of a set of mobile nodes (hosts) that are connected by wireless links. The network topology (the physical

connectivity of the communication network) in such a network may keep changing randomly.

- Routing protocols that find a path to be followed by data packets from a source node to a destination node used in traditional wired networks cannot be directly applied in ad hoc wireless networks due to their highly dynamic topology absence of established infrastructure for centralized administration (e.g., base stations or access points), bandwidth-constrained wireless links, and resource (energy)-constrained nodes.

1.7 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 of nodes
- Bandwidth Constraints
- Error-Prone channel state
- Hidden Terminal Problem
- Exposed Terminal Problems
- Resource Constraints

1.7.1 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.

1.7.2 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.

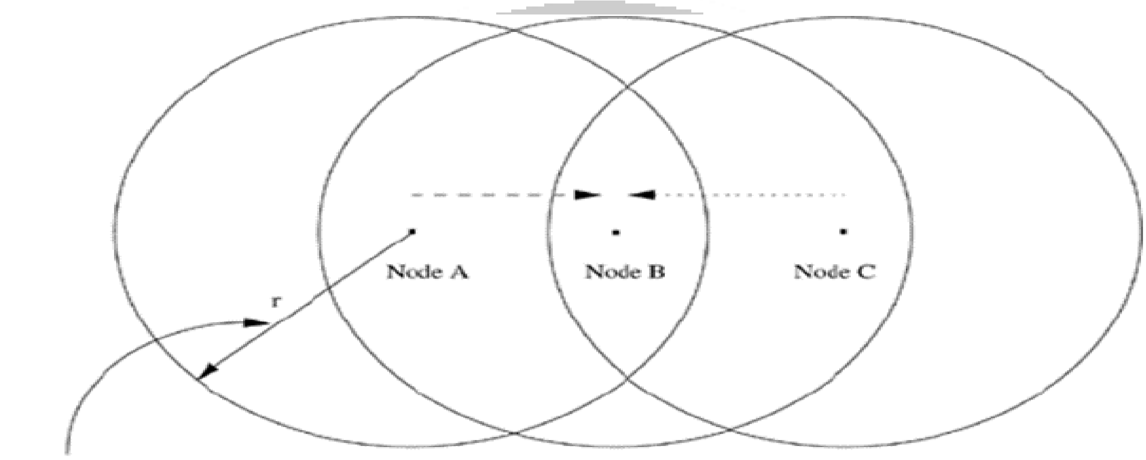
- The limited bandwidth availability also imposes a constraint on routing protocols in maintaining the topological information.

1.7.3 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.

1.7.4 Hidden Terminal Problem

- 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.



Source : Ad Hoc Wireless Networks Architectures and Protocol by C. Siva Ram Murthy and B. S. Manoj

- For example, consider figure (a). 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.
- Solution for this problem (figure 1.8), include medium access collision avoidance (MACA)

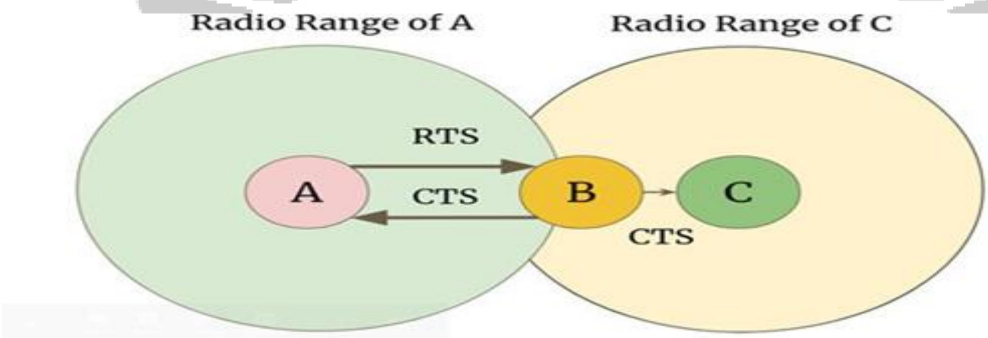


Figure 1.8 Solution for Hidden Terminal Problem

- 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.

1.7.5 Exposed Terminal Problem

- 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.
- For example, consider the figure 1.9, 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.

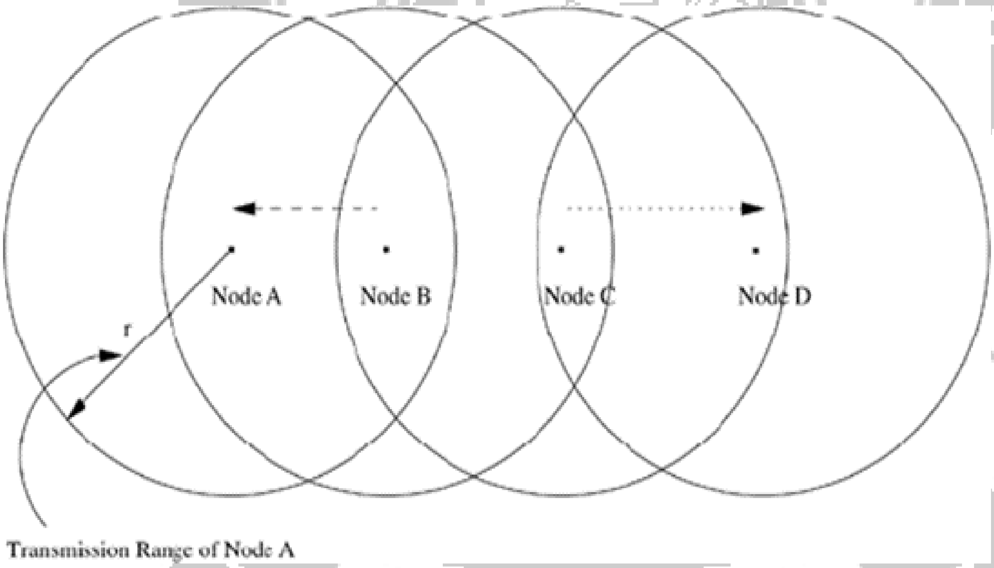


Figure 1. 9 Exposed Terminal Problem

Source : Ad Hoc Wireless Networks Architectures and Protocol by C. Siva Ram Murthy and B. S. Manoj

- Solution for this problem, illustrated in figure 1.10. In this case, node A did not successfully receive the CTS originated by node R and hence assumes that there is no on-going transmission in the neighborhood. Since node A is hidden from node T, any attempt to originate its own RTS would result in collision of the on-going transmission between nodes T and R.

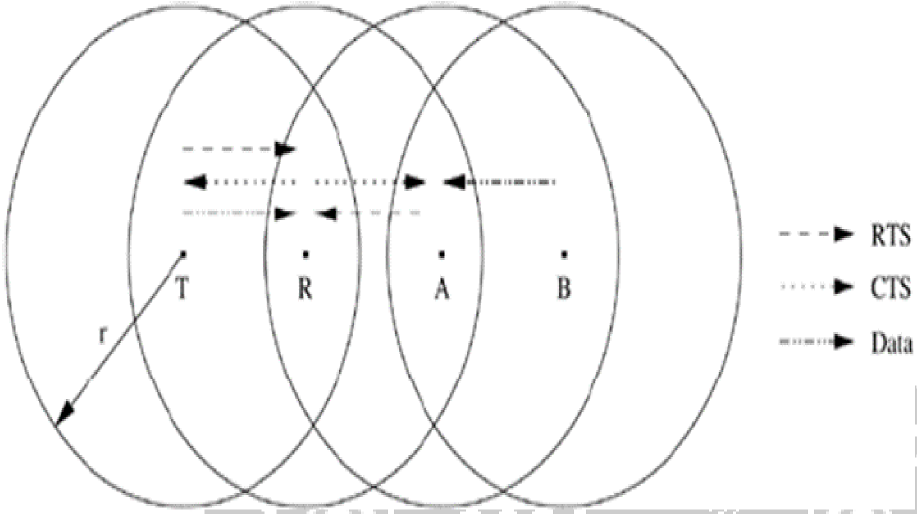


Figure 1. 10 Solution for Exposed Terminal Problem

Source : Ad Hoc Wireless Networks Architectures and Protocol by C. Siva Ram Murthy and B. S. Manoj

1.7.6 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.

1.8 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.