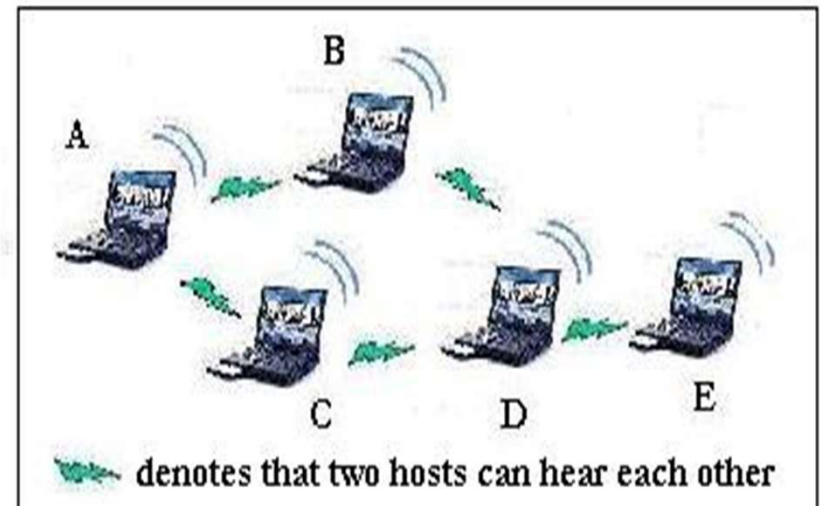
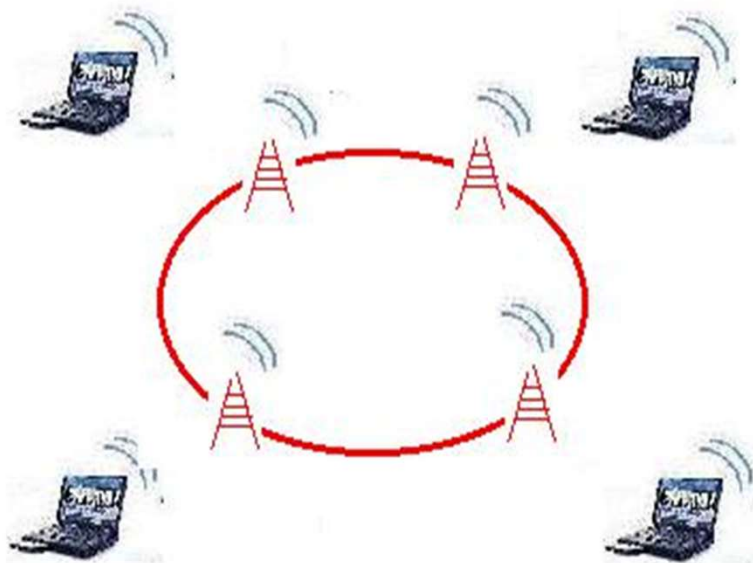


The title is centered and surrounded by six light purple circles. Three circles are positioned above the text, and three are below it. The top row consists of an empty circle on the left, and two filled circles on the right. The bottom row consists of two filled circles on the left, and an empty circle on the right.

Wireless Routing Protocols

What is a MANET

- Mobile nodes, wireless links
- Infrastructure-less: by the nodes, ...
- Multi-hop routing: ..., and for the nodes
- Minimal administration: no hassles



What's unique about a MANET ?

- Moving nodes → ever changing topology
- Wireless links
 - → various and volatile link quality
- Pervasive (cheap) devices
 - → Power constraints
- Security
 - Confidentiality, other attacks

Challenges in MANET Routing

- Need dynamic routing
 - Frequent topological changes possible.
 - Very different from dynamic routing in the Internet.
 - Potential of network partitions.
- Routing overhead must be kept minimal
 - Wireless → low bandwidth
 - Mobile → low power
 - Minimize # of routing control messages
 - Minimize routing state at each node

Other Challenges



- Auto configuration issues
 - Address assignment
 - Service discovery
- Security issues
 - Ease of denial-of-service attack
 - Misbehaving nodes difficult to identify
 - Nodes can be easily compromised
- New Applications/services
 - Location based: Distribute some information to all nodes in a geographic area (geocast).
 - Content based: Query all sensors that sensed something particular in the past hour.

Routing Protocols



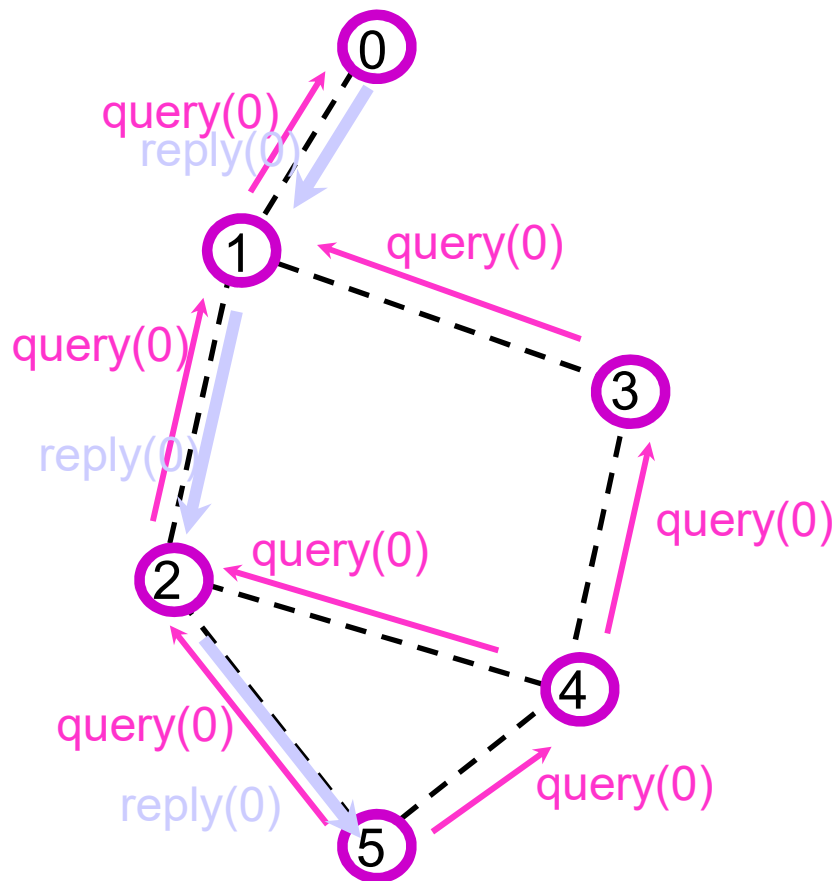
- Reactive (On-demand) protocols
 - Discover routes when needed
 - Source-initiated route discovery
- Proactive protocols
 - Traditional distributed shortest-path protocols
 - Based on periodic updates. High routing overhead
- Tradeoff
 - State maintenance traffic vs. route discovery traffic
 - Route via maintained route vs. delay for route discovery

Reactive Routing

- **Key Goal:** Reduction in routing overhead
 - Useful when number of traffic sessions is much lower than the number of nodes.
- No routing structure created *a priori*. Let the structure emerge in response to a need
- Two key methods for route discovery
 - source routing
 - backward learning (similar to intra-AS routing)
- **Introduces delay**

Reactive (on-demand) routing:

- Routing only when needed



Advantages:

- eliminate periodic updates
- adaptive to network dynamics

Disadvantages:

- high flood-search overhead with
 - mobility, distributed traffic
- high route acquisition latency

Reactive Routing - Source initiated

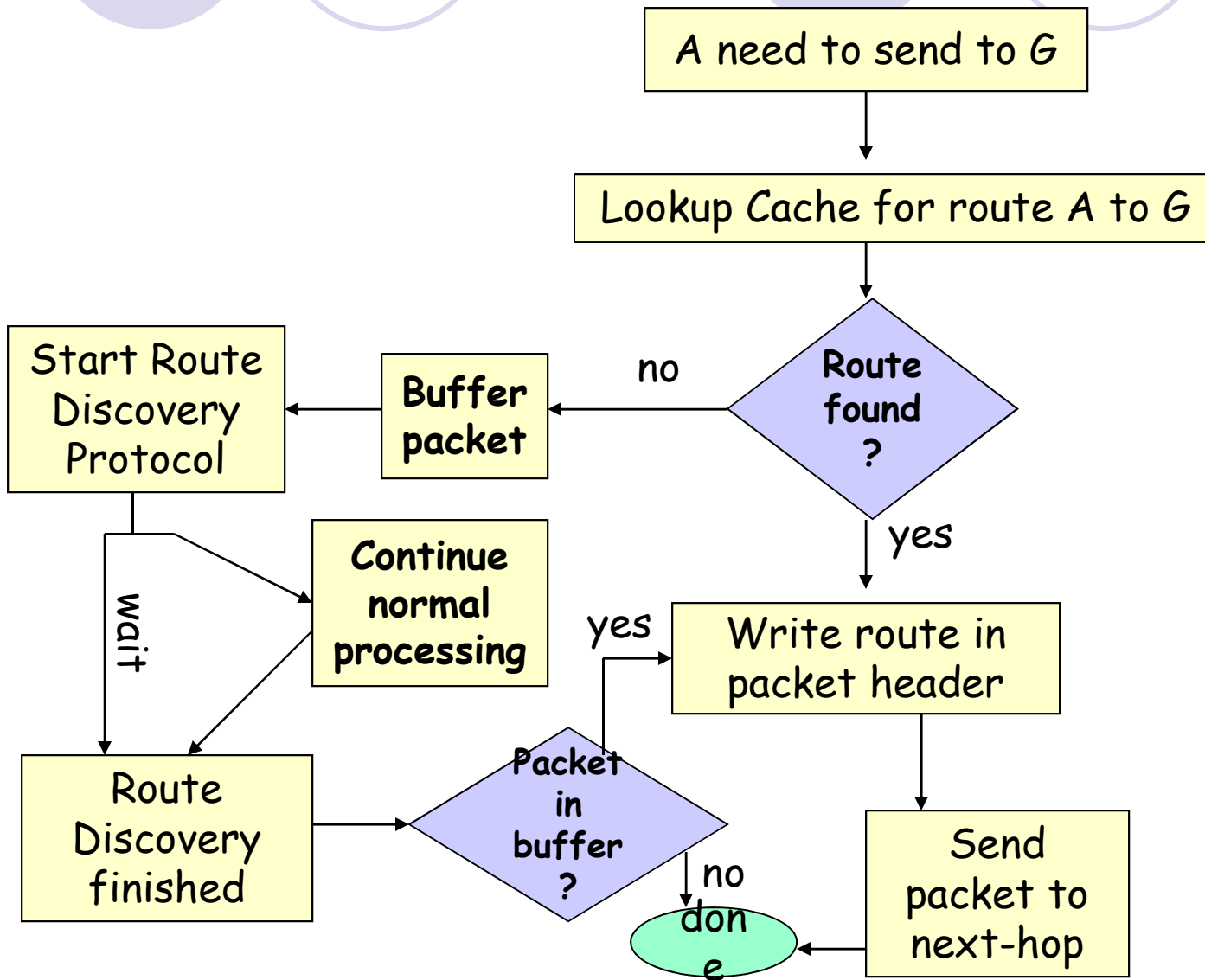
- Source floods the network with a *route request* packet when a route is required to a destination
 - Flood is propagated outwards from the source
 - Pure flooding = every node transmits the request only once
- Destination *replies* to request
 - Reply uses reversed path of route request
 - sets up the forward path
- Two key protocols: DSR and AODV

Dynamic Source Routing (DSR)

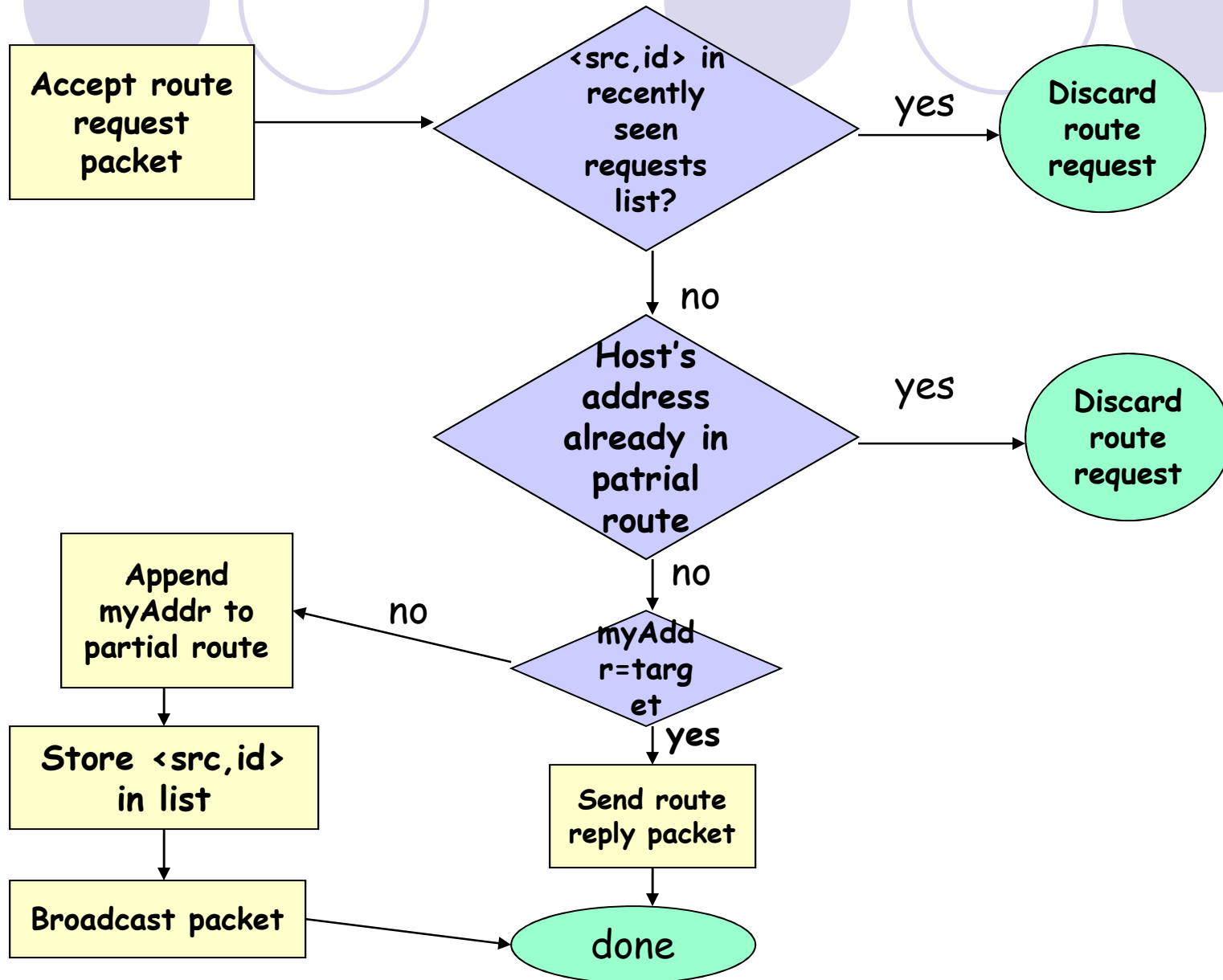


- Cooperative nodes
- Relatively small network diameter (5-10 hops)
- Detectable packet error
- Unidirectional or bidirectional link

Route Discovery: at source A



Route Discovery: At an intermediate node



DSR - Route Discovery

- *Route Reply* message containing path information is sent back to the source either by
 - the destination, or
 - intermediate nodes that have a route to the destination
 - Reverse the order of the route record, and include it in *Route Reply*.
 - Unicast, source routing
- Each node maintains a *Route Cache* which records routes it has learned and overheard over time

Route Maintenance

- Route maintenance performed only while route is in use
- Error detection:
 - Monitors the validity of existing routes by *passively* listening to data packets transmitted at neighboring nodes
 - Lower level acknowledgements
- When problem detected, send *Route Error* packet to original sender to perform new route discovery
 - Host detects the error and the host it was attempting;
 - *Route Error* is sent back to the sender the packet - original src

A Summary of DSR

- 👍 Entirely on-demand, potentially zero control message overhead
- 👍 Trivially loop-free with source routing
- 👍 Conceptually supports unidirectional links as well as bidirectional links
- 👎 High packet delays/jitters associated with on-demand routing
- 👎 Space overhead in packets and route caches
- 👎 Promiscuous mode operations consume excessive amount of power