

Ad Hoc Routing

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Ad Hoc Networking

- No base station or infrastructural support
- Nodes cannot just transmit directly
 - But, every node can act as a router
 - Assuming willing cooperation (for now)
- Further, cannot arrange things *a priori*
 - Nodes may join and leave at any time
- And, it wouldn't be any fun if the nodes aren't mobile---maybe even constantly

Routing in *Ad Hoc* Networks

- Unknown (changing) set of nodes
 - Need some discovery mechanism
- Routes are fragile
 - Need some refresh mechanism
- Bandwidth is generally scarce
 - Minimize routing overhead
- Asymmetric links may be important
 - Depends on the MAC layer in use

Routing Protocols

■ Link State

- Each node builds a map of the entire network
- Computes best routes individually
- Consistent maps guarantee coherent routes

■ Distance Vector

- Nodes only track next hops to destinations
- Only computes locally best next hop
- Can lead to routing loops

Forwarding Mechanisms

- Hop-by-hop
 - Routing decision is re-examined at each node
 - Only destination is included in packet
- Source routed
 - Source computes full route to destination
 - Explicitly carried in the packet
 - Some protocols “salvage” broken routes

Major Routing Protocols

- Destination-Sequenced Distance Vector (DSDV)
 - Hop-by-hop / *A priori*
- Dynamic Source Routing (DSR)
 - Source routed / On demand
- Temporally-Ordered Routing Algorithm (TORA)
 - Hop-by-hop / On demand
- *Ad hoc* On-Demand Distance Vector (AODV)
 - Hop-by-hop / On demand

Dynamic Source Routing

- Routes are established on demand
 - Cached until revoked
- Individual packets are source routed
 - On-path routers need no knowledge
- Two-phase protocol
 - Route discovery
 - Route maintenance
- Many, many performance optimizations

Route Discovery

- Every node has a single, unique ID
- Controlled flooding
 - ROUTE_REQUEST message sent by sender
 - Upon receipt, ignorant node appends its identifier and floods request on
 - Nodes with known route can respond
 - Destination must respond
- (Directed) response
 - ROUTE_REPLY may or may not be flooded
 - Can be cached by on-path nodes

Route Maintenance

- Node responsible for reliable delivery
 - Hopefully implemented at MAC layer
 - ROUTE ERROR generated on failure
 - No retry mechanism
- Nodes may “salvage” packet
 - Forward along alternate route
- Flood ROUTE ERROR messages
 - Appended to subsequent ROUTE REQUESTs

DSR Performance

- Simulation issues
 - What was the radio distance?
 - What was the bit rate?
 - How big were the packets?
- Other metrics of interest
 - Queue sizes at the nodes?
 - Uniformity of packet distribution?
 - Average latency / path length?

Performance, More Generally

- Do well at low rates of mobility
 - Both give close to optimal routes
- DSR can work well at high mobility
 - Suffers in high-density networks
 - DSDV does better, but poor at high mobility
- Combine the two: AODV
 - Hop-by-hop on-demand
 - But, may give suboptimal routes