Simulation and Performance Study of Ad Hoc Networks

ENSC 835 Project
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Outline

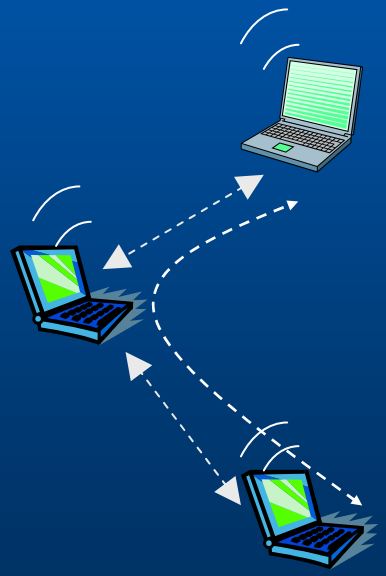
- Introduction to the project
- Ad hoc routing protocol overview
- Implementation and simulation goals
- Discussion
- Conclusion

Project Goals

- Understand ad hoc networks
- Study an ad hoc routing protocol
- Determine influencing performance factors specific to ad hoc routing
- Simulate a standard protocol evaluating performance and suggesting enhancements

Ad-hoc Networks

- Infrastructure less
- Self starting based on *proximity*
- Assumes no centralized access point
- Wireless mobile nodes
- IETF, **manet** working group
- Examples
  - Nomadic: in a conference room
  - Military applications
  - Sensor networks



Ad hoc routing: Related Work

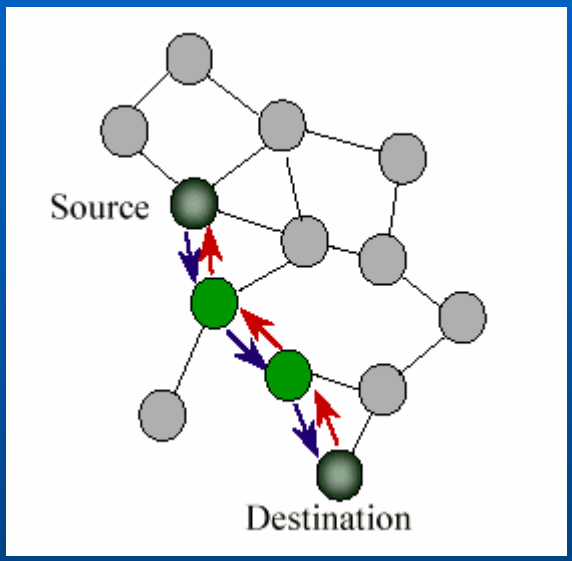
- **Proactive** approaches
  - Maintain complete routing information for the network (similar to link state algorithms)
  - Examples: DSDV *
  - Overhead: dealing with frequent link breakages
- **Reactive** approaches ***(on demand)***
  - Establish route only when needed
  - Overhead: route establishment delay is added when a source sends to destination

  →*Utilize prior route information as links are valid*
- **Hybrid** approaches

* DSDV: Destination-Sequenced Distance Vector Algorithm

Ad-hoc On-Demand Distance Vector Routing (AODV)

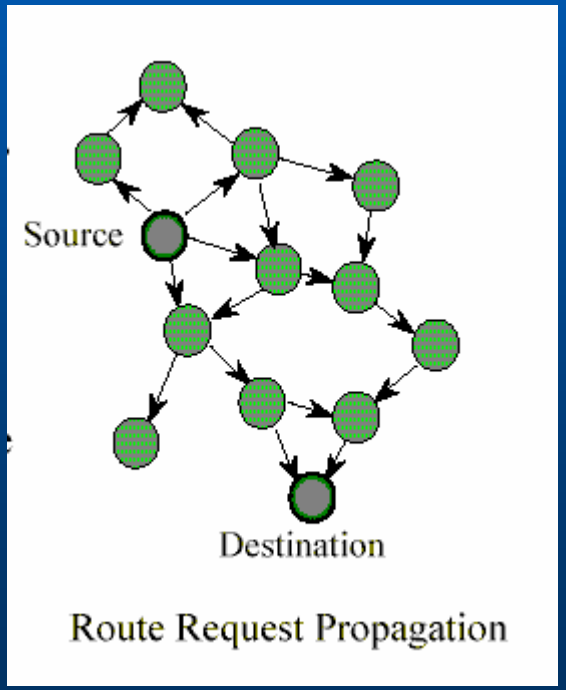
- Route establishment
  - Route discovery: request (RREQ) & reply (RREP) discovery cycles
  - Reverse route establishment
  - Forward path establishment
- Routing Tables
  - Record next hop and hop count to destination
  - Uses seq # to determine route freshness
  - Updated on RREQ & RREP
- Local connectivity management
  - The hello message and *hello_interval*



Route Discovery

- Source broadcasts *Route Request (*RREQ)
  <*J_flag, R_flag*, *Broadcast_ID, Src_Addr*, *Src_Seq#*, *Dst_Addr*, *Dst_Seq#*, *HopCnt*>
- Node can issue *Route Reply* if
  - It is the destination
  - It has a "fresh enough" route to destination
- Record Src IP Addr / Broadcast ID to prevent multiple processing

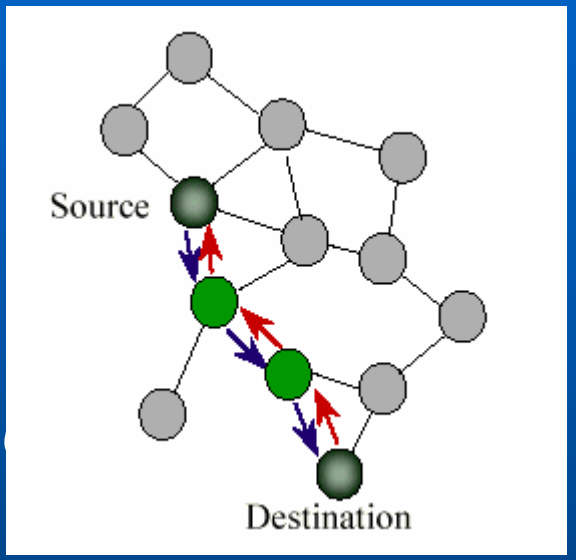
→ *Reverse path setup*



Route Request Propagation

Forward Path Setup

- Destination, or intermediate node unicasts RREP to source <*R_flag, Dst_Addr, Dst_Seq#, Prev_Hop_Addr, HopCnt, Lifetim*



- Nodes along path create *forward route* to dest
- No RREP → route will expire (active_route_timout = 3 sec.)
- If duplicate RREP
  - Higher seq# for dest is used (fresher info)
  - Or same seq# and lower hop count (shorter route)

Local Connectivity Management

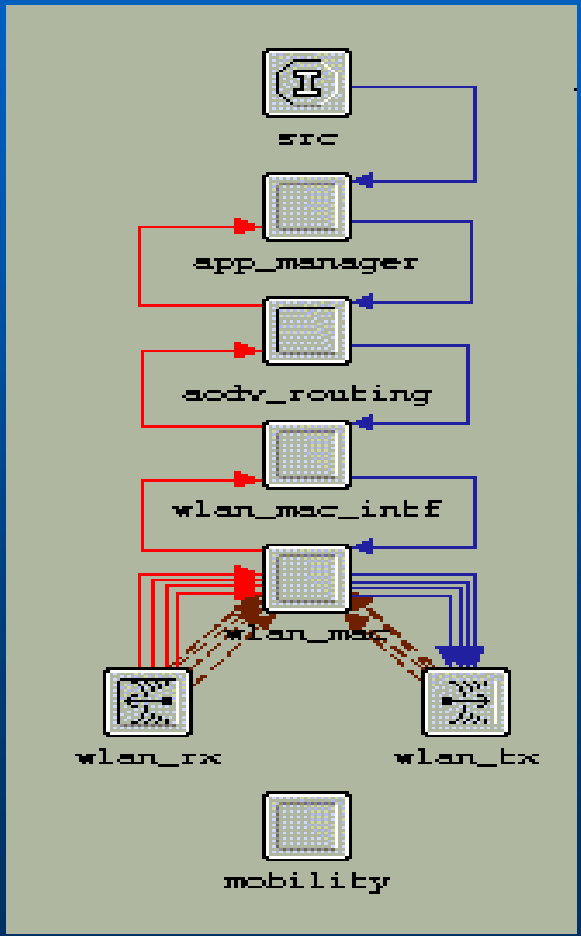
- Node must periodically (hello_interval) hear from *active* neighbors to know they are still within range
- Every time hear broadcast, update lifetime
- If no broadcast with **hello_interval**, broadcast **Hello message** (TTL = 1)
- Failure to hear from a neighbor

  allowed_hello_loss=2 indicates loss of link

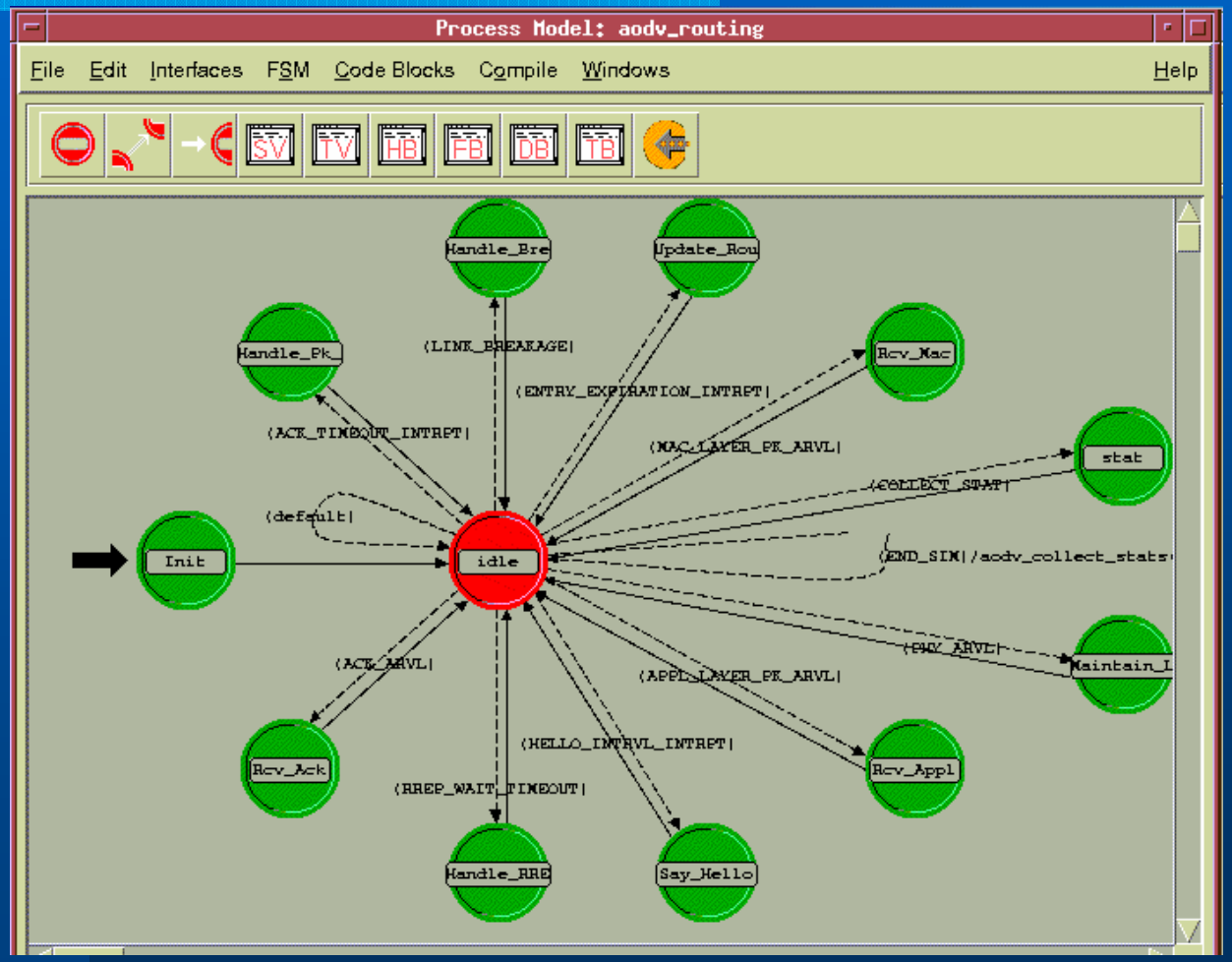
  →Notify of link failure (broadcast RERR)

  →Source to issue an new RREQ with new dest seq #

AODV OPNET Node Model



AODV Routing Process Model



Performance Evaluation

- Based on RFC 2501
  - Average end-to-end delay and data throughput & control overhead (route establishment)
  - Route Acquisition latency (control overhead of on-demand protocol)
- Dynamic topology
  - Protocol performance and connectivity in response to nodes movement
- Scalability indicator
  - Protocol performance stability in response to adding new nodes

Enhancements

- Giving multiple routes different priorities (or expiry) based on density of prior visited data packets
- By linking the hello_interval value to mobility model
  - → When nodes move less frequently, links are less probable to break that can reduce control overhead

Conclusion

- Ad hoc networks are spontaneous networks created on the fly based on proximity
- AODV – an IETF standard Ad hoc on demand routing protocol
- Dynamic topology is a main characteristic on ad hoc networks
- Scalability is a main concern
- Many interesting applications

References

[1] C. Perkins and E. Royer, "Ad-hoc On-Demand Distance Vector Routing“
In IEEE Workshop on Mobile Computing Systems and Applications, February 1999.

[2] C. Perkins, E. Royer, and S. Das, Mobile Ad Hoc Networking (MANET), "Ad-hoc On-Demand Distance Vector (AODV) Routing", IETF RFC 3561.

[3] S. Corson and J. Macker, "Routing Protocol Performance Issues and Evaluation Considerations" in IETF RFC 2501.

[4] I. Chakeres and E. Royer, "The Utility of Hello Messages for Determining Link connectivity", The Fifth International Symposium on Wireless Personal Multimedia Communications, Oct. 2002.

[5] Günes, U. Sorges, I. Bouazizi, "ARA The Ant-Colony Based Routing Algorithm for MANETs" Int. Workshop on Ad Hoc Networking (IWAHN 2002), Vancouver, British Columbia, Canada, August 18-21, 2002.

Thank You

Questions