

# PERFORMANCE EVALUATION OF ENERGY EFFICIENT ROUTING PROTOCOLS FOR MOBILE AD HOC NETWORKS

Nischala Uppala

Master's Thesis Presentation

Advisor: Dr. Chansu Yu



## Outline

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- Wireless Networks
- Routing protocols for MANETs
- Energy Efficient Routing Protocols for MANETs
- Implementation
- Simulation
- Results & Discussion
- Conclusion

## Wireless Networks



## Wireless Networks

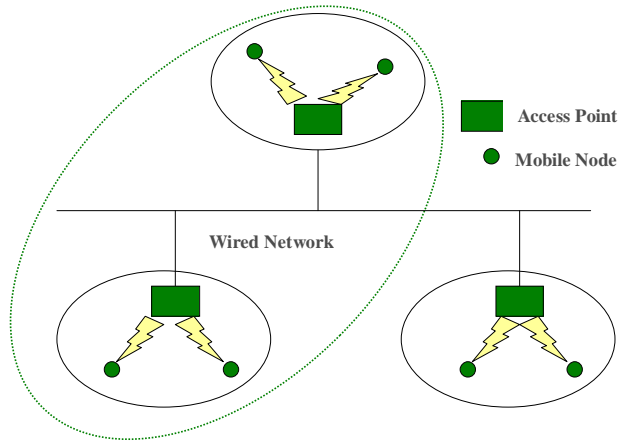
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Wireless networks are divided into two types

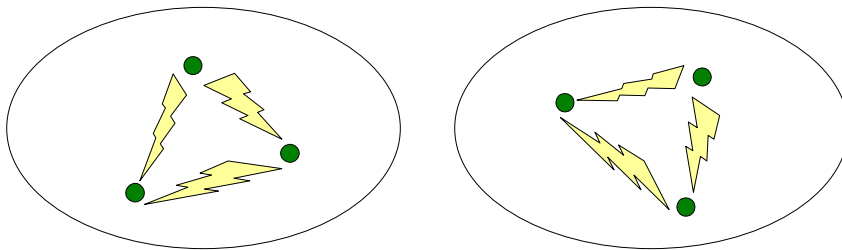
- Infrastructured Networks
- Ad Hoc Networks



## Infrastructured Networks

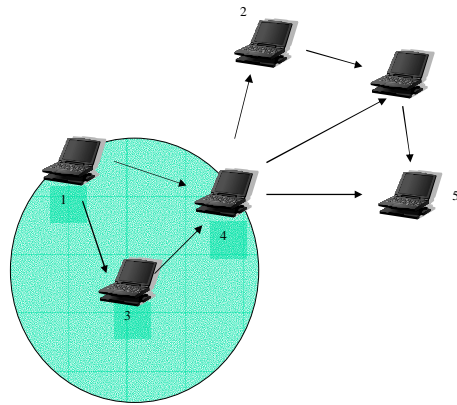


## Ad Hoc Networks





## Motivation



## Routing Protocols for MANETs



## Routing Protocols for MANETs

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Routing protocols are divided into two types

- Table-driven (proactive) routing protocols
- On-demand (reactive) routing protocols



## Proactive protocols

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- Routes are obtained from the table
- Periodic updates for the routes
- Low latency in delivering the data packets
- Examples are DSDV, OLSR, FSR, etc.



## Reactive Protocols

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- Routes are discovered on demand
- Routes are updated using route maintenance mechanisms
- High latency in delivering the data packets
- Examples are DSR, AODV, and TORA etc.



## Dynamic Source Routing Protocol (DSR)

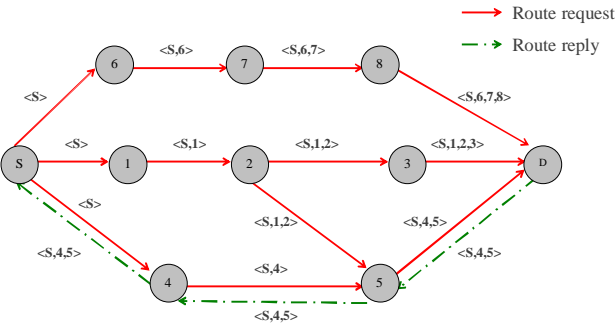
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The mechanisms used in DSR are


- Route Discovery – mechanism for discovering routes
  - Route Request (RREQ)
  - Route Reply (RREP)
  - Route Cache
- Route Maintenance – mechanism for maintaining routes
  - Route Error (RERR)



# DSR (Contd.)-Route Discovery Procedure

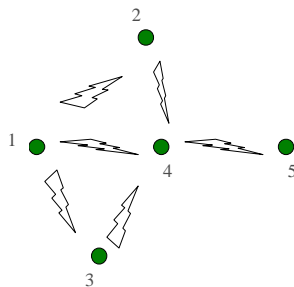


## Energy Efficient Routing Protocols for MANETs



## Importance of Energy Efficient Routing Protocols


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## Power Aware Metrics

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- Minimize energy consumed per packet
- Maximize time to network partition
- Minimize variance in node power levels
- Minimize cost per packet
- Minimize maximum node cost



## Classification of Energy Efficient Routing Protocols

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- Transmission power control technique –transmission power of the node is adjusted just enough to reach the destination node
- Load-balancing technique – balance in the energy consumption is achieved by using paths containing less frequently used nodes instead of shorter paths

Implementation



## Protocols implemented in this thesis

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- MMBCR
- LEAR
- RDRP

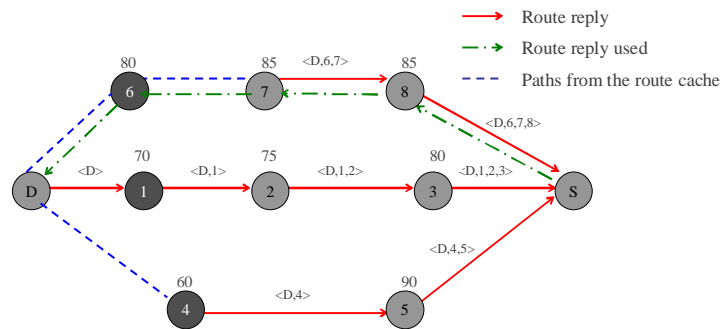


## MMBCR

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- MMBCR differs from DSR in processing the route replies
- The source node does not use the RREP received first
- It waits for some time before processing the reply
- After waiting for ' $T_w$ ' seconds, it chooses among all the received replies depending on the energy levels of the nodes in the path
- The energy levels of the nodes are compared to a *fixed* threshold value

## MMBCR (Contd.)

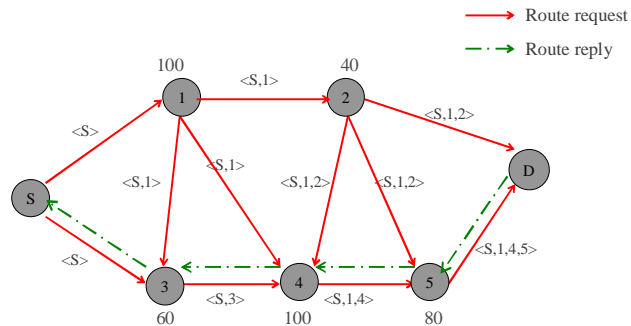


## RDRP

- Differs from DSR in the route discovery procedure
- Each node waits for a certain amount of time ' $T_d$ ' before it processes a route request packet
- The value of ' $T_d$ ' is inversely proportional to the energy level of the node
- Thus, the destination receives the route request through the richest nodes first



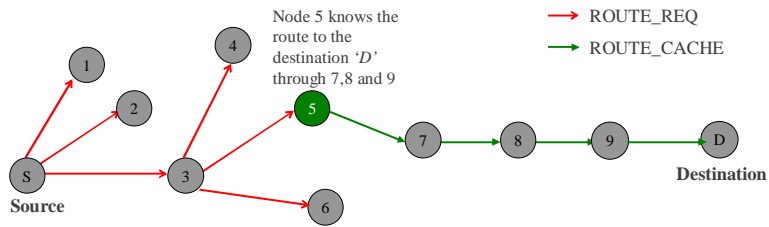
## RDRP (Contd.)



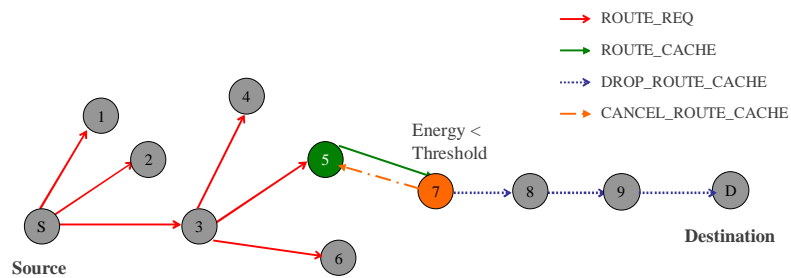
## LEAR

- Uses a complex route discovery procedure
- The new control messages used are ROUTE\_CACHE, DROP\_ROUTE\_REQ, DROP\_ROUTE\_CACHE, CACNEL\_ROUTE\_CACHE
- Takes each node's willingness to forward packets into consideration
- Overcomes the disadvantages of using the fixed threshold values

## LEAR (Contd.)-Route Discovery Mechanism



## LEAR (Contd.)- Route Discovery Mechanism



## Simulation



### Simulation Environment

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- Terrain dimensions: 1500m X 300m
- Simulation duration: 900 seconds
- Number of nodes: 50
- Pause times: 0s, 40s, 80s, 120s, 200s, 300s, 600s, and 900s
- Maximum node speed: 1 meter/sec, 20 meters/sec
- Minimum node speed: 0 meter/sec
- Movement model: Random way point
- Seed numbers: 10



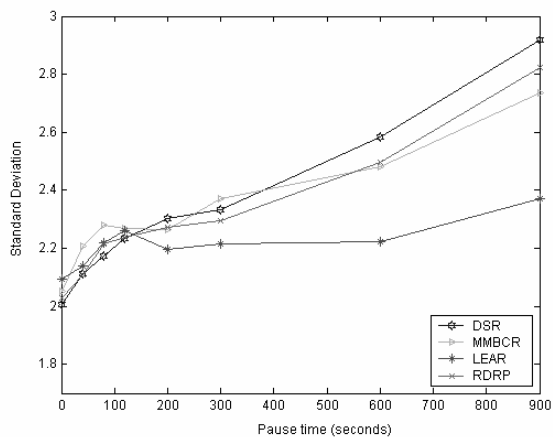
## Performance metrics used in this thesis

- Standard Deviation of the energy consumption of all the nodes in the network (SD)
- Peak-to-Mean Ratio of the energy consumption (PMR)
- Average latency in delivering the data packets
- Packet Delivery Ratio (PDR)

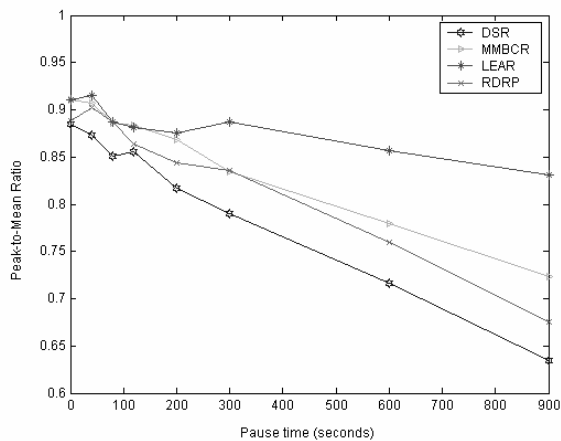
## Results & Discussion



## Standard Deviation at node speed of 20 meters/sec

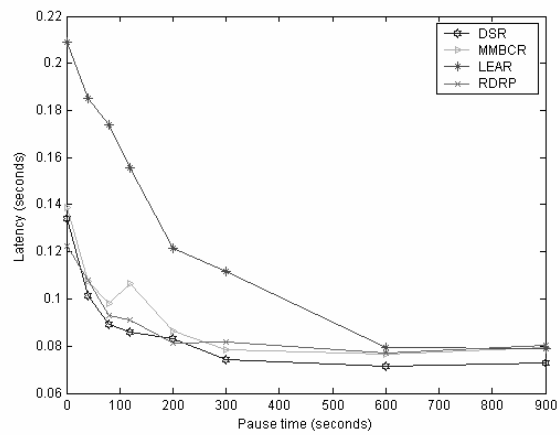


## Peak-to-Mean Ratio at node speed of 20 meters/sec

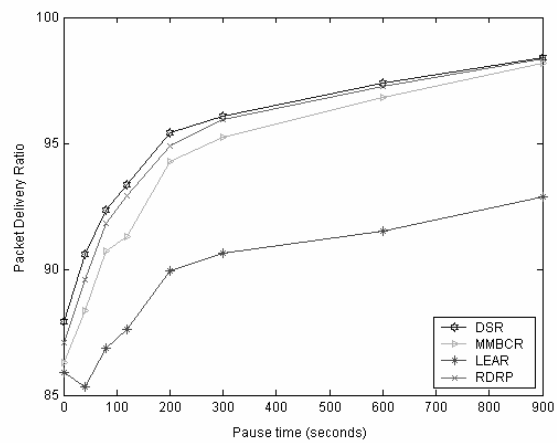




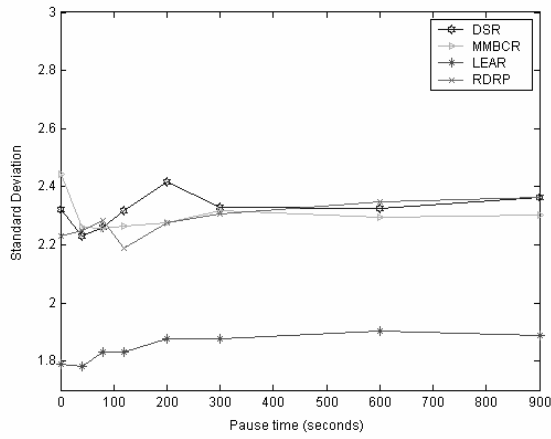
## Latency at node speed of 20 meters/sec



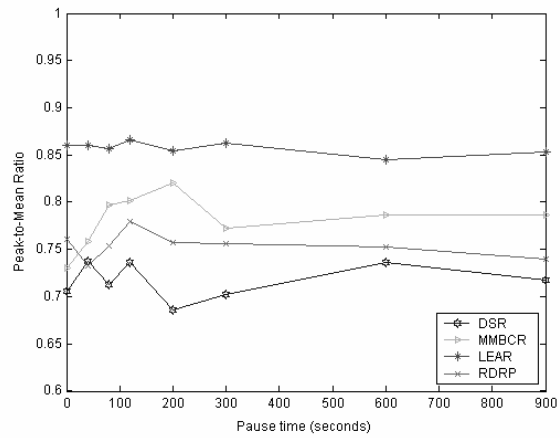
## Packet Delivery Ratio at node speed of 20 meters/sec



## Standard Deviation at node speed of 1 meter/sec

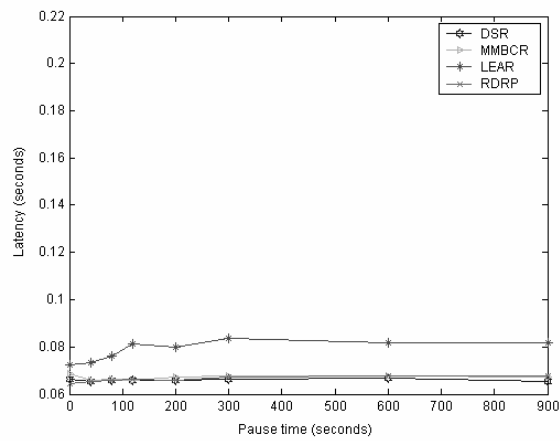


## Peak-to-Mean Ratio at node speed of 1 meter/sec

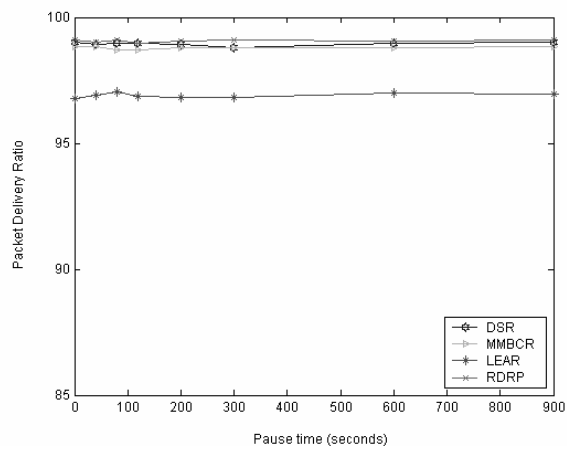




## Latency at node speed of 1 meter/sec



## Packet Delivery Ratio at node speed of 1 meter/sec



## Conclusions



## Conclusions

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- Trade-off between the energy conservation of a network protocol and the general performance in terms of PDR and latency
- useful in selecting a routing protocol depending on the application
- Ex: sensor networks



## Conclusions (Contd.)

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- LEAR shows improvement in the SD of up to 25% compared to DSR, while the protocols MMBCR and RDRP show the improvement in SD by 6%-10% compared to DSR
- LEAR shows improvement in the PMR up to 32% compared to DSR, while the other two protocols show improvement in PMR of 8%-15% compared to DSR

Thank you