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T-79.7001 Postgraduate Course in Theoretical Computer Science
T-79.5401 Special Course in Mobility Management: Ad hoc networks
(2 - 10 cr) P V

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Credits

- **Material based on**
  - **S. Doshi, S. Bhandare, T. Brown: “An On-Demand Minimum Energy Routing Protocol for a Wireless Ad Hoc Network”, in Mobile Computing and Communications Review, July 2002, Vol. 6, No. 3**
  - **Link:**
    - **http://ece-www.colorado.edu/~timxb/timxb/pubs/02MCCR.pdf**

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Motivation for energy-awareness

$$P_r = P_t G_t G_r \left(\frac{\lambda}{4\pi d}\right)^2$$

where

P_r *receive power*

P_t *transmission power*

G_t *transmission gain*

G_r *receive gain*

λ *wavelength*

d *distance between transmitter/receiver*

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Motivation for energy-awareness

$$P_r = P_t G_t G_r \left(\frac{\lambda}{4\pi}\right)^2 \frac{1}{d^{\gamma}}$$

where

γ propagation coefficient between 2 (open space) and 5 (strong fading)

Energy consumption:

- **Basic energy usage to send a packet:**
  - **Page 3: Equations (1) – (3)**
- **Impact of radio channel (i.e., the variable distance)**
  - **Page 3: Equation (4)**
- **Impact of power control**
  - **Page 3: Equations (5) – (8), Figure 1**

Multihop data delivery

- **Impact of multihop data delivery**
  - **Page 4: Equations (9) – (11), Figure 2**

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Energy-aware routing protocol: Requirements

- **New metrics (instead of hop count)**
  - **Energy consumption**
- **Transmit power control**
- **Minimum energy route discovery**
  - **Page 5: Figure 3**
- **Tracking energy costs**
  - **Page 5: Figure 4**
- **Scalability**
  - **Page 7: Figure 5**

Implementation

- **Impact on SW, FW, and HW components**
  - **Page 7, Table 1**

Simulation results

- **NS2-simulator in use**
- **Random Waypoint – mobility model (0.1 – 10 m/s)**
- **Number of nodes: 10**
- **Area: 1000x300 m2**
- **Max radio transmission range 250 m**
- **Traffic CBR, 1 packet/s, 512 bytes**

Simulation results

- **Three models:**
  - **DSR with link cache, without power control**
  - **DSR with link cache & power control, plus power aware route selection**
    - **No energy aware route discovery and maintenance**
  - **DSR with energy aware link cache**
    - **Minimum energy routing**
- **Concept of ”God” (i.e., absolute accurate knowledge)**
- **Results:**
  - **Page 9, Figures (6) – (8) as function with speed of mobility**
  - **Page 9, Figure (9) as function of number of nodes**

Conclusions

- **Transmission power control saves energy significantly in ad hoc networks**
  - **Also, it increases network throughput**
- **Energy awareness in routing saves energy**
  - **Saving is better when nodes are moving slowly**
  - **Fast moving mobiles have smaller benefit from energy awareness routing**
- **More hops usually saves energy, but**
  - **increases delays**
  - **increases probability to link breakage**
  - **sometimes more hops increases total energy consumption**