International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169
Volume: 2 Issue: 8
2553 – 2555

Co-operative Communication with Opportunistic Relays

Dr Himani Goyal*1
*1 Dean ECE, MLRIT1,
Dundigal1, Hyderabad-431,
Telangana*1, India*1.
goyalhimani@gmail.com

Thota Kishore*2,
Dept of ECE*2,
MLRIT*2, Dundigal*2
Hyderabad-43*2, Telangana*2, India*2
kishorenaidu93@gmail.com

K.Aravind*3,
Dept of ECE *3,
MLRIT*3, Dundigal*3
Hyderabad-43*3, Telangana*3, India*3
aravindmudhiraj@gmail.com

K.Swetha*4,
Dept of ECE*4,
MLRIT*4, Dundigal*4
Hyderabad-43*4, Telangana*4, India*4
kukatlaswetha7@gmail.com

Abstract**--**In multihope mobile Adhoc Networks, developing efficient and scalable routing protocols is one of the challenging tasks due to the inherent nature of infrastructurelessness and high dynamics. We propose a simple Shortest Distance path relay selection criteria employing Decode and Forward (DF) Cooperative Protocol. We consider a single source and a single destination network with N candidate relays which distribute uniformly within the coverage area. The cooperation between the source and a relay provides improved robustness to wireless fading. Assuming a Flat Rayleigh fading channel with Log-distance path loss model the proposed relay selection criteria is compare with Reactive Best Expectation relay selection criteria and Proactive Opportunistic relay selection criteria. We will further analyze energy consumption, throughput and compare the proposed system results with the other techniques available in literature. The simulation results will show that the proposed Shortest Distance path relay selection consumes less energy and has shortest delay compared to the Reactive Best Expectation and Proactive Opportunistic relay selection methods.

Software Tools required: MATLAB 7.8.0(R2009a) by Math work.

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I. Motivation

MIMO:

Degree-of-freedom gain & diversity gains Higher data rates Increases throughput

- MIMO technique provides transmitter diversity or receiver diversity which requires more than one antenna at the transmitter or at the receiver.
- However, many wireless mobile devices are limited by size or hardware complexity to one antenna.

Cooperative

Achieve spatial diversity with even one antenna per-node (e.g.: MISO, SIMO, MIMO)

- Cooperative communication uses single antenna but provides the cooperative diversity over spatial diversity.

II. Main idea

- Recruit nearby idle nodes to assist transmitting and receiving data
- Use relays (or multi-hop) to provide spatial diversity in a fading environment

Cost effective for MANET

From the above observations, for MANETs Cooperative Communication is selected .

- Introduction:
  Cooperative Communication Schemes
    - Amplify and Forward (AF)
    - Decode and Forward (DF)
- Estimate and Forward In this we use

Decode and forward,

$$y_{RD} = \sqrt{p_R} h_{RD} \hat{x} + n_{RD}$$

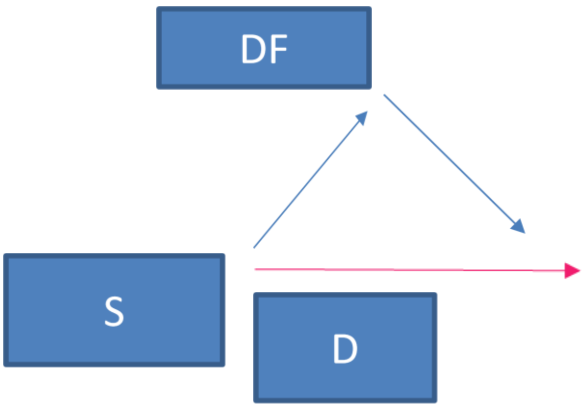

Fig.1 General DF relay

III. Objective:

The main objective of this research is to propose a Shortest Distance Path Relay Selection Criteria that will outperform the available Reactive Best Expectation and Proactive Opportunistic relay selection methods.

The relay must be selected (assuming Flat Rayleigh Fading Channel with log-distance path loss model) in such a way that :

1. Consumes Low Energy
2. Takes less Delay
3. High Signal to Noise ratio

IV. Relay selection:

The relay selection based on before or after source transmission can be classified into two types:

(i) Reactive Relay Selection (Best expectation method)

(ii) Proactive Relay Selection (Opportunistic relay selection)

In reactive type, relay is selected after source transmission and in proactive type, relay is selected before source transmission.

- Reactive Best Expectation Relay Selection Criteria

  N Candidate relays uniformly distributed in the coverage radius

  R'= {r1, r2,….rN}

  Relays selected for co operation

  R= {r1, r2,….rK}

Best Expectation Criterion minimizes the total transmission time (grows exponentially with Number of relays)

$$T = T_L + E\{T_C\} = \frac{N}{\min\limits_{R_i \in R_{Sel}} C_{SR_i} W} + E\left\{\frac{N}{C_{SR_{Sel}D} W}\right\}$$

$$C_{SR_i} = \log_2\left(1 + \frac{P_1 |h_{SR_i}|^2}{\sigma^2}\right)$$

$$R_{Sel}^* = \arg\min_{R_{Sel} \subset R'}\left(\frac{1}{\min\limits_{R_i \in R_{Sel}} C_{SR_i}} + E\left\{\frac{1}{C_{SR_{Sel}D}}\right\}\right)$$

$$C_{S\bar{R}_k} = \min_{R_i \in R_{Sel}} C_{SR_i}$$

$$C_{S\bar{R}_k} = \min_{R_i \in R_{Sel}} C_{SR_i}$$

$$R_{Sel}^* = \arg\min_{R_{Sel} \subset R'}\left(\frac{1}{C_{S\bar{R}_k(R_{Sel})}} + E\left\{\frac{1}{C_{SR_{Sel}D}}\right\}\right)$$

$$C_{SR_{Sel}D} = \log_2\left(1 + \frac{P_1}{\sigma^2}\left(\sum_{R_i \in R_{Sel}} |h_{R_iD}|^2\right)\right)$$

Proactive Opportunistic Relay Selection Criteria

(DF Relay is selected before source transmission

Received signal at D

$$y_{R_iD} = h_{SR_i} h_{R_iD} x_{R_i} + n$$

Mutual information

$$I = \frac{1}{2}\log_2\left(1 + |h_{SR_i} h_{R_iD}|^2 \frac{P}{N_o}\right)$$

Relay with max. Mutual information is selected

$$R_{Sel}^* = \arg\max_{R_i \in R_{Sel}} W_{R_i}$$

- Research gap

- Cooperative relay selection in distributed networks requires space time coding, global CSI which are quite difficult.
- The simple distributed single Proactive Opportunistic relay selection doesn't require global CSI at each relay and require less cooperation overhead.
- In Reactive Best Expectation Relay Selection method the source has no instantaneous CSI of the channels between relays and destination and adaptively selects the relays to optimize the total transmission time.
- Here we propose a Shortest Distance Path Relay Selection Criteria that minimizes the total transmit time.

- Shortest Distance Path Relay Selection Criteria

  SER guaranteed radio coverage is defined with geographic area within which any receiving node can meet the SER below Target SER

$$R^C(S, R_i) = \left\{X \in R^2 \,|\, P_{SER}(S, R_i) \le \rho\right\}$$

$$P_{SER} \approx \frac{1}{b^2 \bar{\gamma}_{SD}}\left(\frac{A^2}{\bar{\gamma}_{SR_i}} + \frac{B}{\bar{\gamma}_{R_iD}}\right)$$

$$\bar{\gamma}_{SD} = P_1\sigma_{SD}^2 / N_o, \bar{\gamma}_{SR_i} = P_1\sigma_{SR_i}^2 / N_o, \bar{\gamma}_{R_iD} = P_2\sigma_{R_iD}^2 / N_o \text{ and } b = 3/2(M-1),$$

$$A = (M-1)/2M + \left(1 - 1/\sqrt{M}\right)^2/\pi, B = 3(M-1)/8M + \left(1 - 1/\sqrt{M}\right)^2/\pi$$

The tolerable relay is the node which has the minimum distance to the node 'k' .

The node in the coverage range of the Source and with minimum distance from the assumed LOS is selected and considered for the short distance communication path. The above process is repeated form the selected relay for multihop until destination is reached.

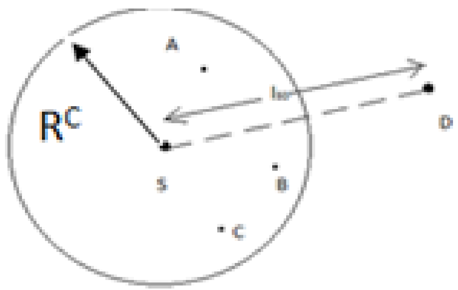

Fig.2 Radio coverage of Source

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ISSN: 2321-8169
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