Component Based Models for Performance Analysis and Design of Ad-Hoc Routing Protocols

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Objective and Approach:
- A formal method for design and analysis of ad-hoc routing protocols.
- Specification of the main components of a routing protocol.
- Specification of the performance metrics for each component.
- The main components are:
  - Neighborhood Discovery Component (NDC)
  - Selector of Topology Information to Disseminate
  - Route Selection
- Design methodology for each component

Implemented Fixed Point model:

Selector of Topology Information (MPR) to Disseminate (STIDC):
- Every node selects a subset of its neighbors as its MPR nodes.
- Only links from selected MPR to the MPR sector are advertised.
- MPR nodes are selected to cover all second order neighbors of a node.
- MPR nodes will also be used for information broadcasting in network

Proposed Design Methodology:
- The design objective is to design a network with predictable and robust performance.
- NDC parameters should be selected to control timeliness of link detection.
- Low detection time for good links
- Short lifetime for bad links

Let $\lambda_{ij}$ denote the rate of the bidirectional ON-OFF process observed at host “h” for every neighbor “j” in N1(h).

$$\min \sum_{j \in N^1(h)} \lambda_{ij} \text{ such that shortest paths from “h” to 2-hop neighbors are preserved.}$$

- We show that the problem is NP-Hard. Greedy Approximation Algorithm is used.

Neighborhood Discovery:
- Periodic HELLO messages to detect bidirectional links.
- Modeled as a finite state Markov Chain.
- Control parameters are U and D.
- Input is transmission success probability
- Performance metrics are computed: (1) Link detection probability, (2) Delay in detection of a link, (3) Life time of a link

Example Network

We set U=2 and D=2 to control delay of the NDC algorithm

Communication overhead of our algorithm vs MPR Heuristic

Finite State Machine for the NDC

Good link detection delay

Bad link life time