Neighbor Discovery in IEEE 802.11

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What is Topology Discovery?

- Topology is the ordered list of all wireless backbone nodes on a train backbone IEEE 802.11 network.
- Topology discovery (TD) is discovering information about all wireless nodes in the network and their one hop neighbor nodes.

What is Neighbor Discovery?

- A neighbor node is defined as a node that is exactly one hop away from the node of interest.
- Neighbor discovery (ND) is discovering right and left one hop neighbors of the node of interest.
- The work presented here focuses on ND.

IEEE 802.11 - Wireless LAN

- IEEE 802.11 is a set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area network (WLAN) (2.4, 3.6, 5 and 60 GHz).
- 802.11b and 802.11g (2.4 GHz) control their interference and susceptibility to interference by using direct-sequence spread spectrum (DSSS) and orthogonal frequency-division multiplexing (OFDM) signaling methods, respectively.
- 802.11 MAC layer uses Carrier Sensing Multiple Access/Collision Avoidance (CSMA/CA) feature to combat Hidden Terminal problem.
- 802.11 uses sensing and receiving thresholds to perform carrier sensing test.

Network Simulator-2 (NS-2)

- NS-2 is a discrete event simulator targeted at networking research and the most commonly used network simulator.
- NS-2 provides support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks.
- NS-2 is developed by UC Berkeley and maintained by USC.
- Two languages used to work with NS-2: C++ and OTcl.

Neighbor Discovery Mechanism

- Each antenna in the topology periodically broadcasts hello frames with probability p_{HELLO}.
- A node keeps independent counts of received hello frames that pass 802.11 carrier sensing test.
- Neighbor discovery is established once the node counts a prescribed number of messages (hello frame count threshold - M_H) from another node.

Simulation

- Simulation is done using NS-2 version 2.35.
- Simulated topology has a total number of 6 wireless nodes aligned along the same horizontal axis.
- All wireless nodes employ directional antennas with 45 degrees main-lobe width.
- Edge nodes (0 and 4) have only one neighbor each. Center nodes (1, 2, and 3) have two neighbors at each side.
- In Slotted Aloha, time is divided into time slots. A user with data will transmit at the beginning of the next time slot.
- Time slots are randomly assigned to users in a first-come-first-serve basis.

Simulated Topology

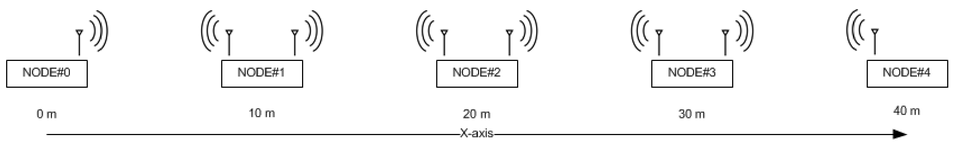

Figure 1 – General representation of the simulated topology.

NS-2 Simulation Parameters

Parameter	Value
MAC layer model	IEEE 802.11 and Slotted-Aloha
PHY layer model	WirelessPhy
Channel model	Rayleigh multipath fading channel
Frequency	2.472 GHz (Channel 13)
Data rate	3 Mbps
Carrier sensing threshold	-75 dBm (3.652e-11 W)
Receiving threshold	-65 dBm (3.652e-10 W)
Capture threshold	0 dBm
Hello period	100 msec
Neighbor discovery timeout	48 sec
Hello counter threshold (M_H) range	1-51
Probability of sending Hello frames (p_{HELLO})	30%
Number of Monte Carlo simulations (per point)	100

ND Results: Effect of M_H

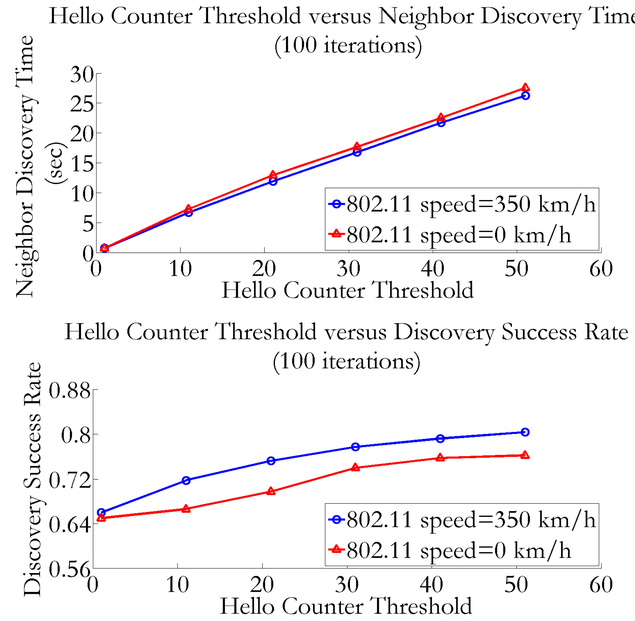

Figure 2 – NS-2 simulation results for the effect of hello counter threshold for high speed and stationary scenarios.

ND Results: Effect of MAC Type

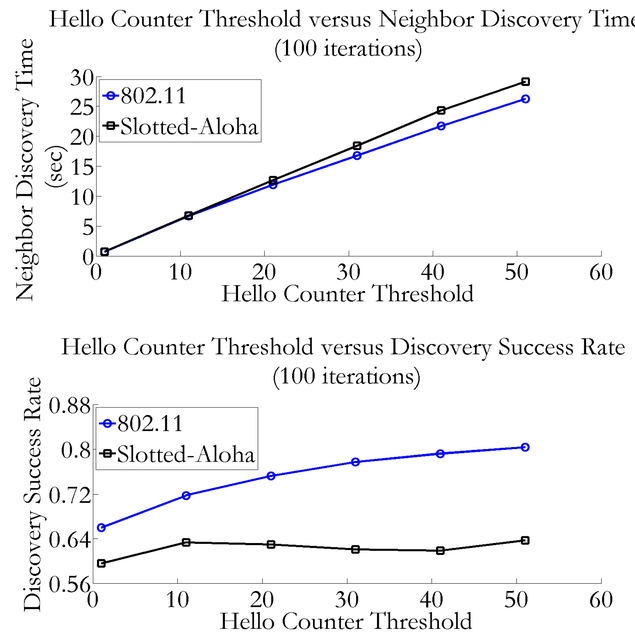

Figure 3 – NS-2 simulation results for the effect of hello counter threshold for 802.11 and slotted-Aloha networks (speed=350km/h).

Conclusions

- Based on the above results obtained from NS-2 simulations:
  - High speed scenario results in better performance in multipath fading environment than stationary, since it gives chance to the bad channels as well as good channels.
  - IEEE 802.11 results in better performance in high speed scenario than Slotted-Aloha for the high speed scenario.
  - Increasing hello counter threshold increases the time ND process takes for the entire topology.
  - Increasing hello counter threshold enhances the ND success rate since the reliability is increased by higher number of frames received from the same node.