Multichannel Cross-Layer Routing for Sensor Networks

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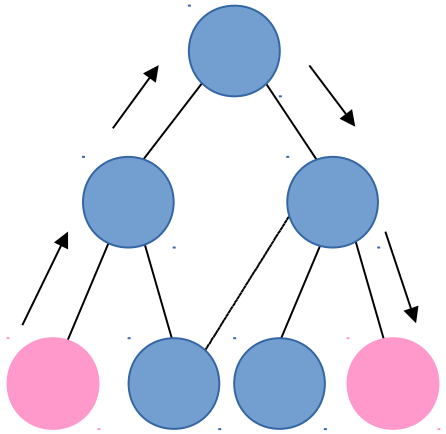
Motivation

- Sensor networks where only one node is connected to the Internet
- Application energy constraint
- Environment interference in communication

Outline

- Background
- MCRP – Multichannel Routing Protocol
- Two-hop colouring algorithm
- Preliminary results

Routing: RPL



- RPL forms routing graph from root node (LPBR)
- Routes selected using:
  - Objective Functions (ETX Expected Transmissions)
  - How many transmissions to expect (less number is used as the route)
- Uses limited memory: sending upwards – it sends to the parent if the destination in unknown

MCRP: Multichannel Routing Protocol

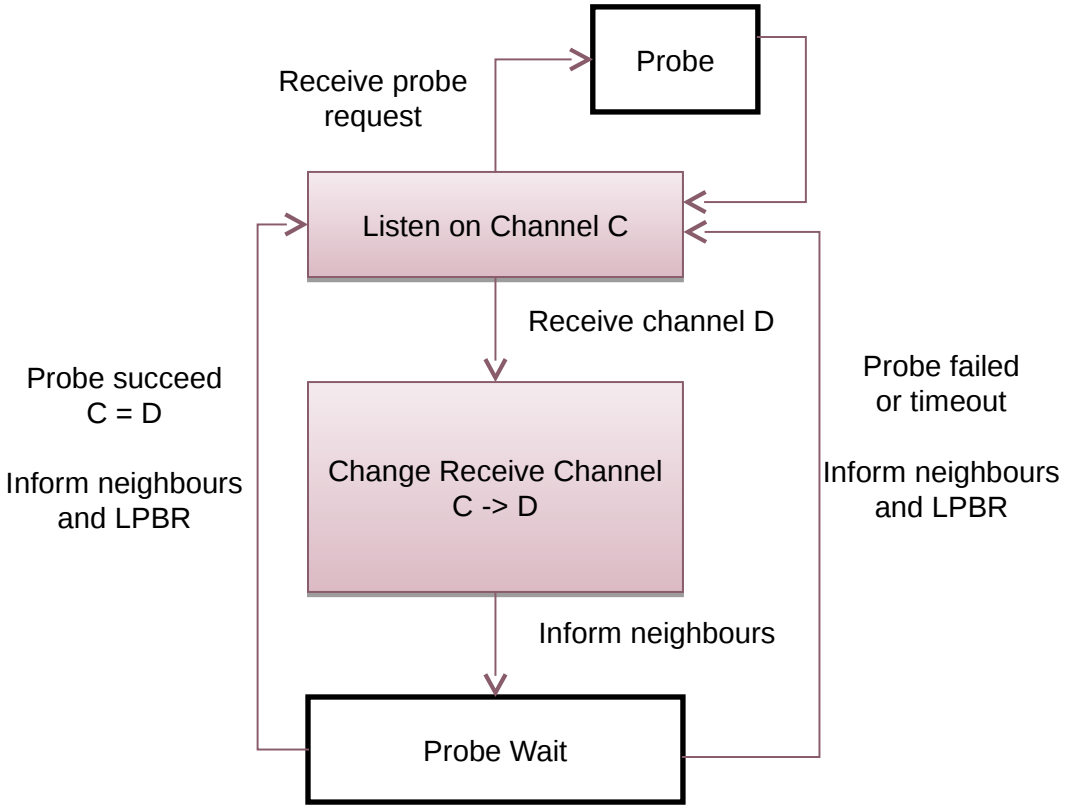
- Focuses on network and application layer
- 2 parts of the system:
  - Central algorithm with LPBR (channel selection)
  - Channel change communication
- Channel selection strategy
- Channel switching
- Channel quality checking

Channel Selection Strategy

- Two-hop colouring
- LPBR selects a random channel from the full range available (11-26)
- Checks channels of neighbours and neighbours of neighbours
- Use new channel, otherwise current channel is kept

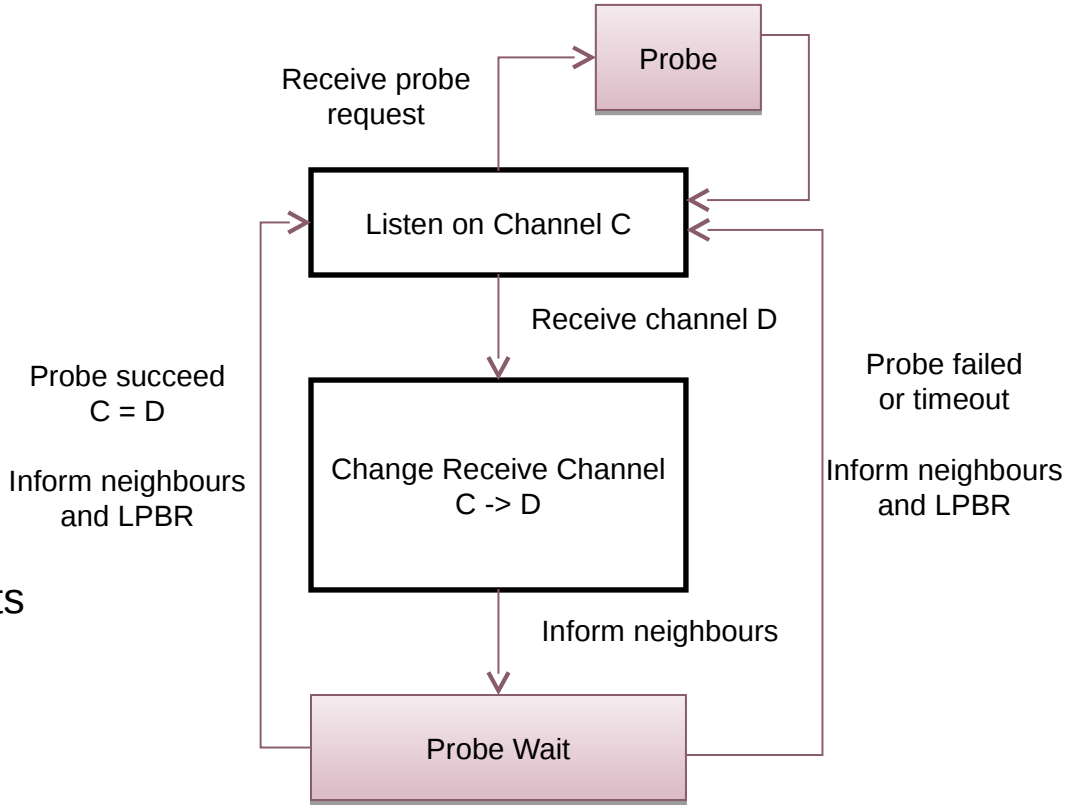
Channel Switching

- Node N receives a change channel message
- N stores its current channel C
- N communicates to all its neighbours the new channel D
- Neighbours update the neighbour tables to send to N on channel D
- N begins the channel quality checking process with each neighbour
- If fails, N revert back to C



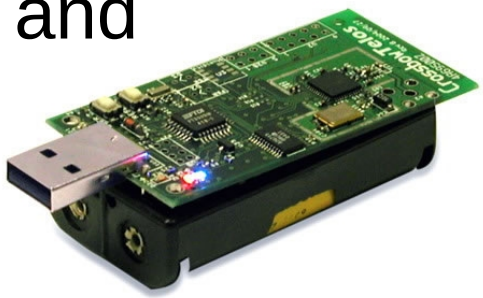
Channel Quality Checking

- Probing – overview of the channel condition
- It is done between node and tree neighbours
- Node N listens on channel D
- N sends Probe message to each neighbour in turn
- Neighbour responds by sending probing packets to N on D
- If the process times out or packet received below a threshold, N reverts back to C
- All neighbours and LPBR are informed
- Can also use passive measurement of application traffic

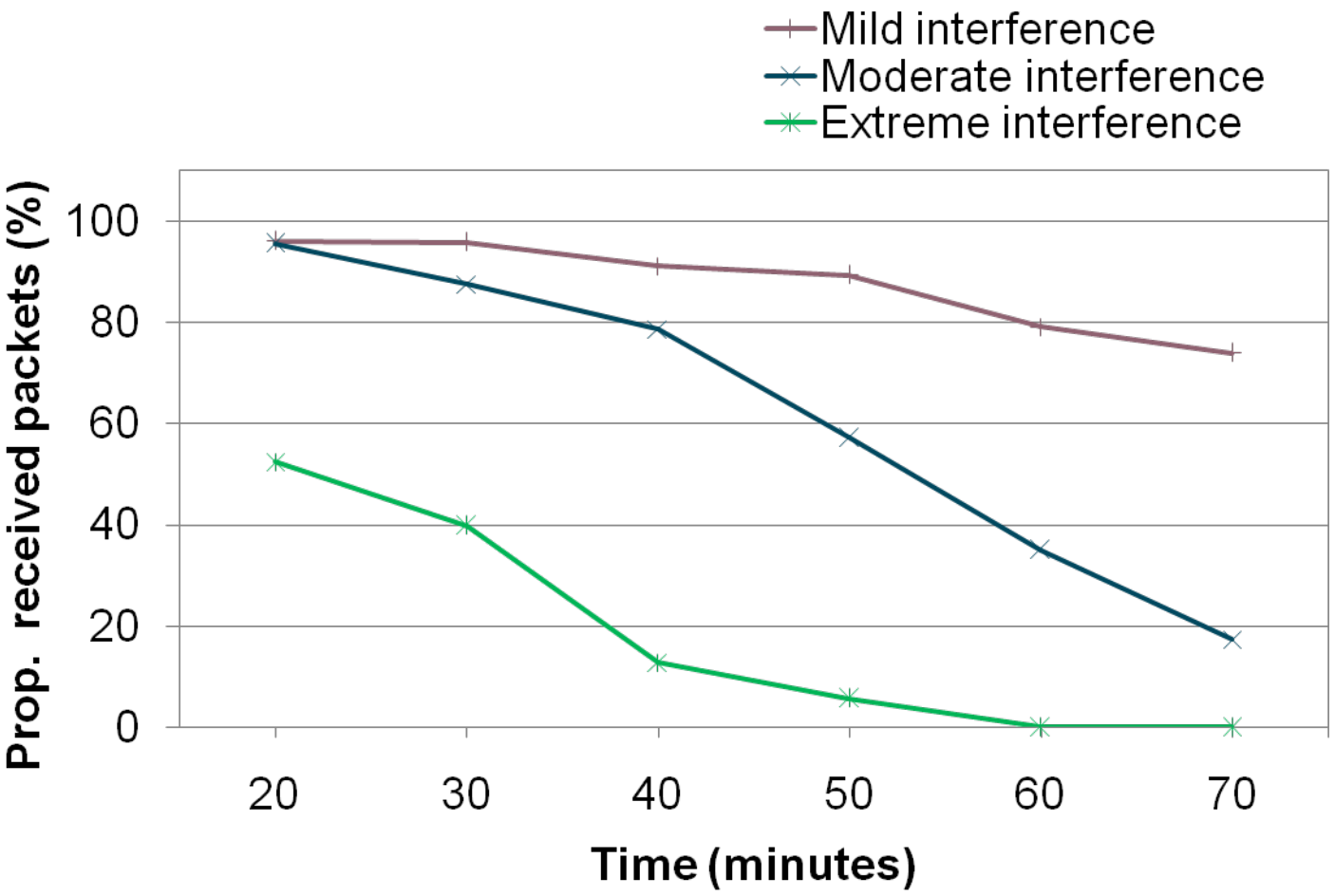


Implementation in Contiki

- An open source operating system for wireless sensor networks
- Designed for microcontrollers with small amounts of memory
- Provides IP communication in both IPv4 and IPv6
- Includes a network simulator - Cooja
- Runs on a range of different hardware platforms
- MCRP implemented on the application and network layer of the OS

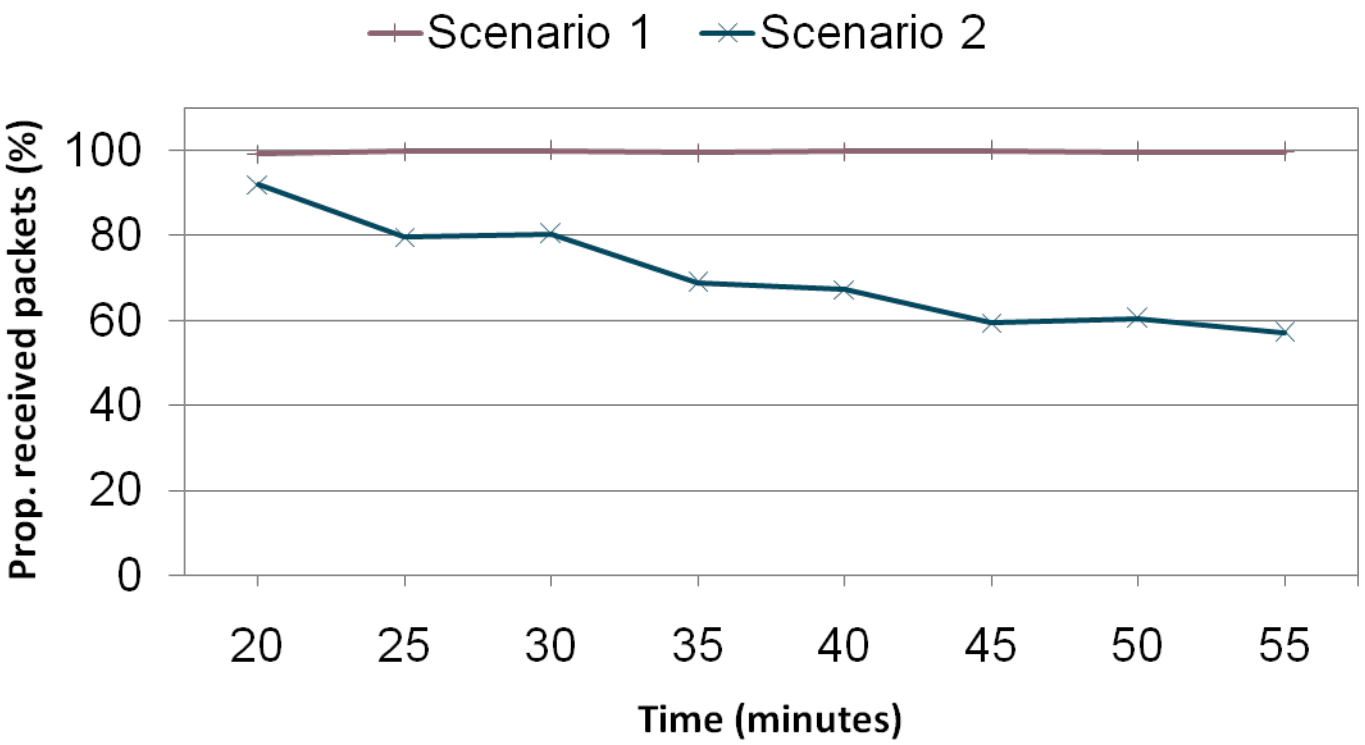


Preliminary Results: Single Channel



Preliminary Results: Multichannel

- Scenario 1: extreme and no interference rate on 8 channels each
- Scenario 2: extreme, moderate, mild and no interference on 4 channels each



Conclusion

- MCRP, a centralised cross-layer protocol that avoids affected channel by moving to another channel
  - Channel Selection Algorithm
  - Channel Switching Protocol
  - Channel Quality Checking
- Increases spectrum usage significantly
- Low overhead

Interference Model

- Controlled interference node that generates semi-periodic bursty interference to resemble a simplified WiFi or Bluetooth transmitter
- Interference has 2 states; clear and interference states

¾ * clear_time to 5/4 * clear_time

9/16 to 15/16

Low Overhead