Thesis

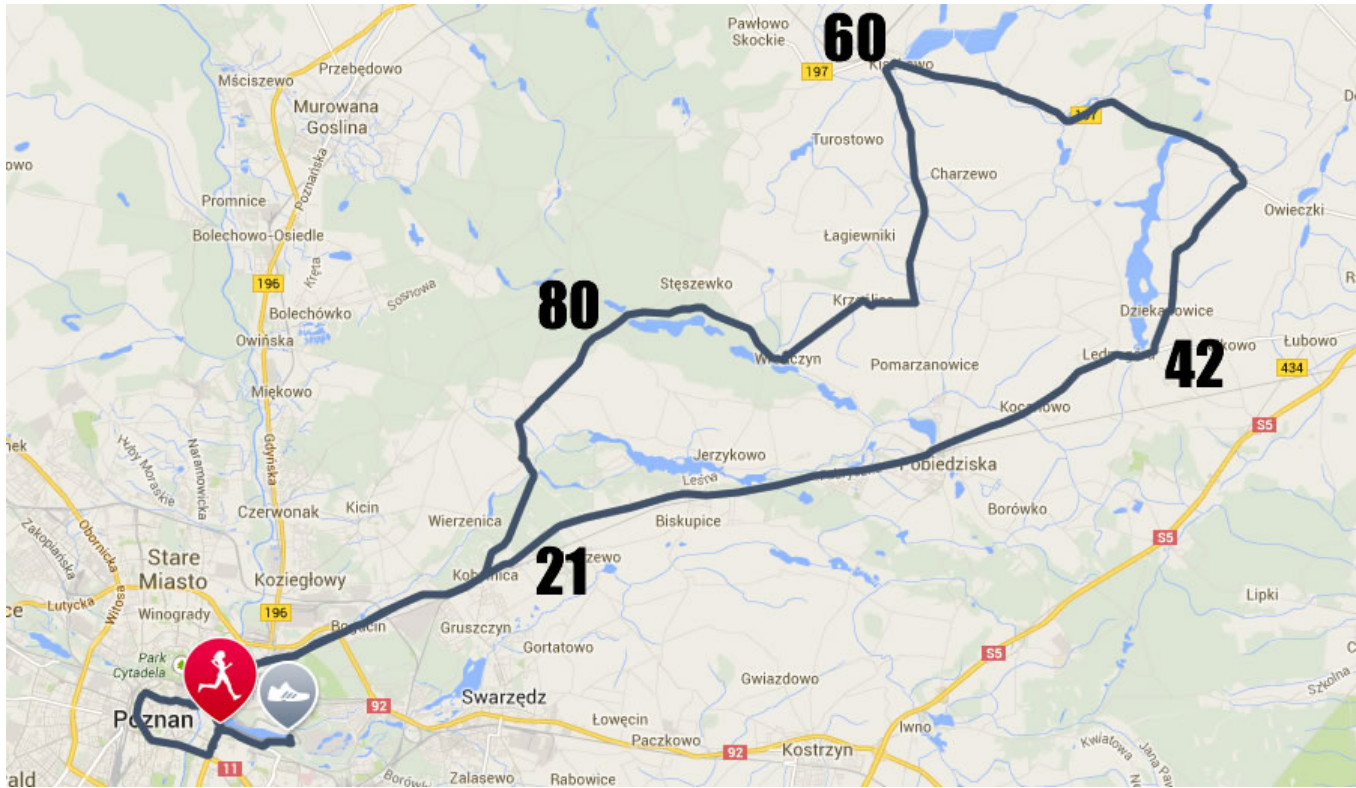Amadeusz L. Juskowiak, Tomasz Kuczma, Mateusz Rybarski, Maciej Żurad

Topic

Design and implementation of communication protocols for self-organizing, multi-hop ad-hoc network using XbeePRO-868 platform

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Thesis advisor: dr inż. Michał Kalewski

Motivation - Timing

Motivation - Sensor networks

Motivation

Xbee-PRO 900:

- supports point-to-point, point-to-multipoint and proprietary mesh
- long-range module (~40km)
- 900 MHz - legal problem (EU directive 87/372/EWG - UMTS900)

Xbee-PRO 868:

- supports point-to-point, point-to-multipoint
- long-range module (~40km)
- 868MHz - legal in EU

Goal

The goal of this thesis is to design and implement communication protocols that implements self-organizing, multihop, long distance ad-hoc networks using XbeePRO-868 devices.

Project should take into account possible topology changes, should be resistant for temporary failures of communication links and permanent failures of some of devices.

Additional assumptions

- Transmitting small pieces of data
- One piece of data = one transmitted packet
- Nodes don't change their positions
- Packet can be delivered more than once

Tasks to do

- Design of communication protocols with proofs of correctness,
- Implementation of protocols in C++ programming language,
- Setup of example hardware platform
- Efficiency and reliability tests

Hardware Xbee-PRO 868

Hardware Xbee-PRO 868

Hardware Xbee-PRO 868

Performance & features:

- Frequency - 868 MHz ISM
- Outdoor range - up to 25 miles (40 km) with dipole antenna
- Transmit power - 1 mW (0 dBm) to 315 mW (+25 dBm)
- Interference immunity - Multiple transmissions, acknowledgements
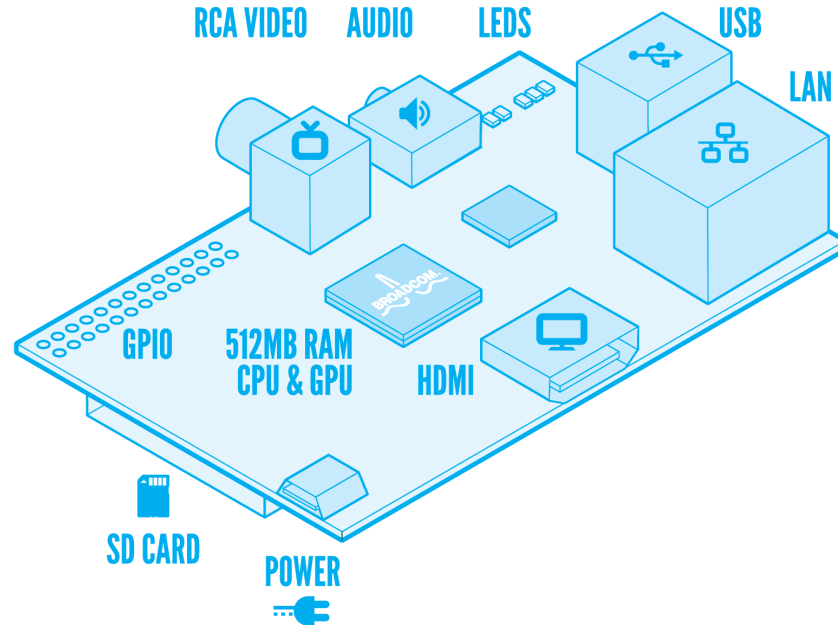- Data throughput - 2.4 kbps

Hardware Xbee-PRO 868

Networking & Security:

- Encryption - 128-bit AES
- Reliable Packet - Delivery Retries/Acknowledgments
- Addressing Options - Network ID, 64-bit address
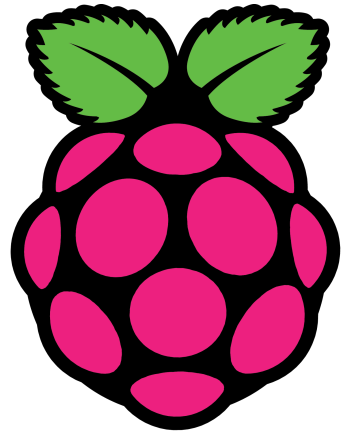- Channels - Single channel

Hardware RaspberryPI

RASPBERRY PI MODEL B

RCA VIDEO   AUDIO   LEDS   USB

LAN

GPIO   512MB RAM
CPU & GPU   HDMI

SD CARD

POWER

Hardware RaspberryPI

Performance & features:

- CPU - 700 MHz ARM1176JZF-S core (ARM11 family)
- Memory - 512 MB SDRAM (shared withGPU)
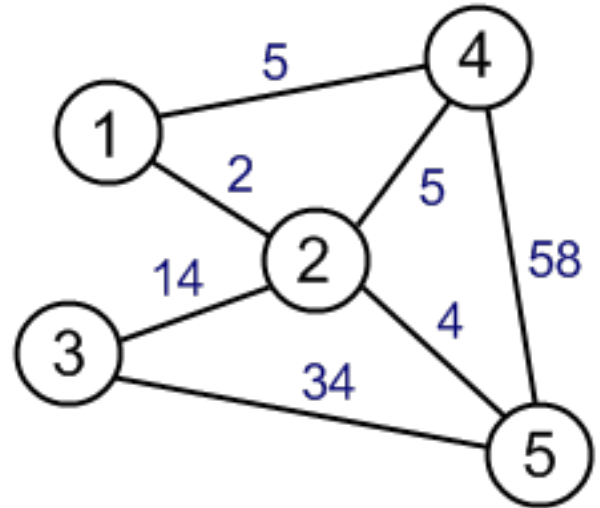- Operating system - Raspbian (Debian GNU/Linux)

RaspberryPi

Algorithm

- Network representation
- Network topology and state
- Shortest path problem
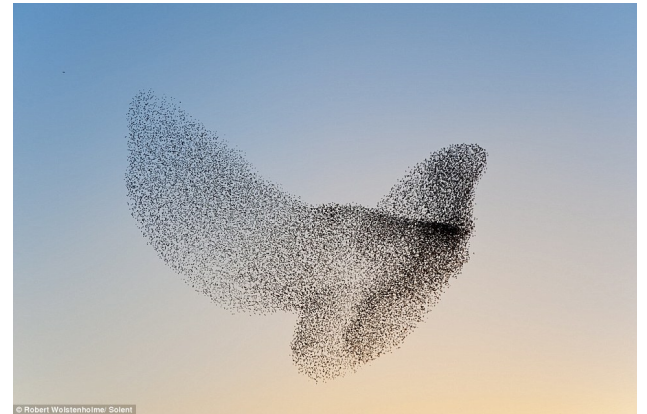- Failure detection

Algorithm - network representation

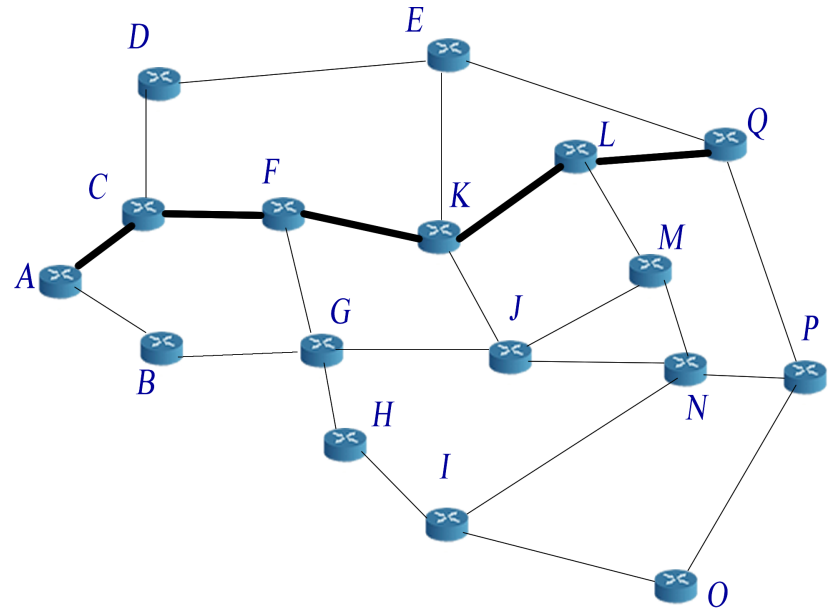- Weighted (un)directed graph
- Adjacency list

Algorithm - topology and state

- New node discovery
- Updating state of edges
- Edge dropping
- Heartbeat

Algorithm - shortest path problem

Dijkstra's algorithm with priority queue

Algorithm - failure detection

- Xbee ACK
- Software ACK
- Timeouts
- Heartbeat

Thanks for your attention!