Finding out the Topology of a WSN Network

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The Problem

- Large WSN
- Finding bad quality links
- Find missing nodes
- Find optimal sink
- Find CDS

Solution

- Collect neighbourhood contexts
- Data collection to sink
  - LQI
  - RSSI
  - ETX
  - received packets
  - lost packets
- Data analysis and representation

Solution

Contiki, Cooja and Z1 nodes

RIME stack

collect

broadcast

NetworkX

LQI and RSSI

- Link Quality Indicator
  - strength of the received signal and errors received
  - reliability
- Received signal strength indicator
  - strength of the received signal in dBm

ETX - Expected transmissions

- Probabilistic measure for expected transmissions on a link
- 1 = Perfect
- Infinity = non-functional link

Collection tree protocol - CTP

Uses ETX to decide routing
ETXroot = 0
ETXnode = ETXparent + ETXparentlink

Simulation in Cooja

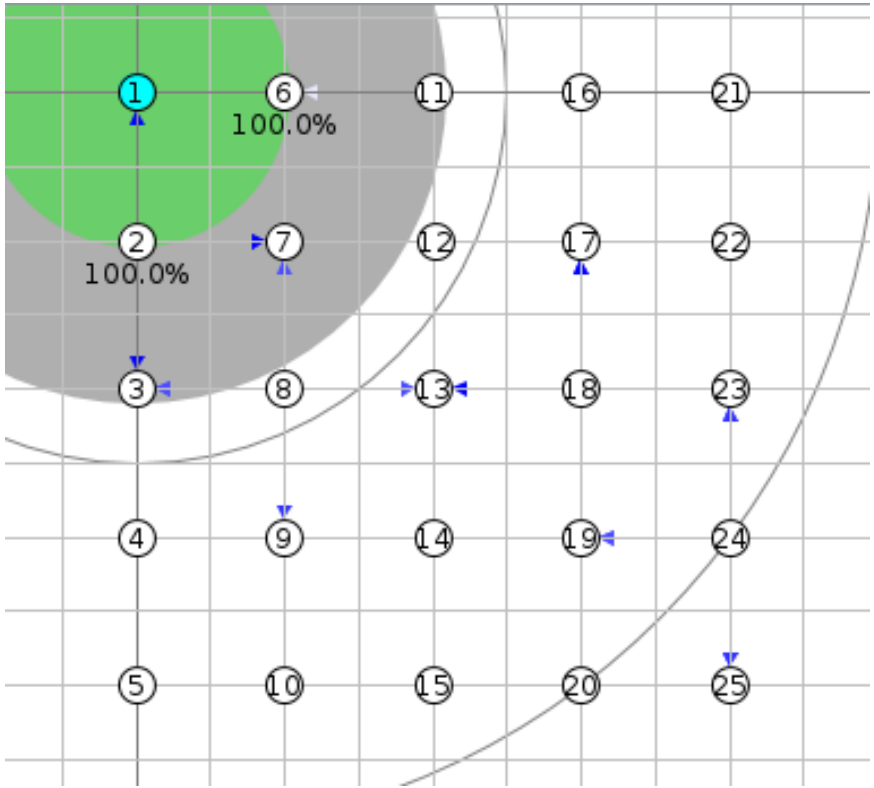
- Emulate TI MSP430 nodes
- Serial2pty (virtual serial interface) at sink

NetworkX

Python package for creating graphs.

- Collect output information data from sink.
  - Serial output saved to log files.
- Model our network
  - by analyzing this information.
  - plot the MST of our nodes.

Grid



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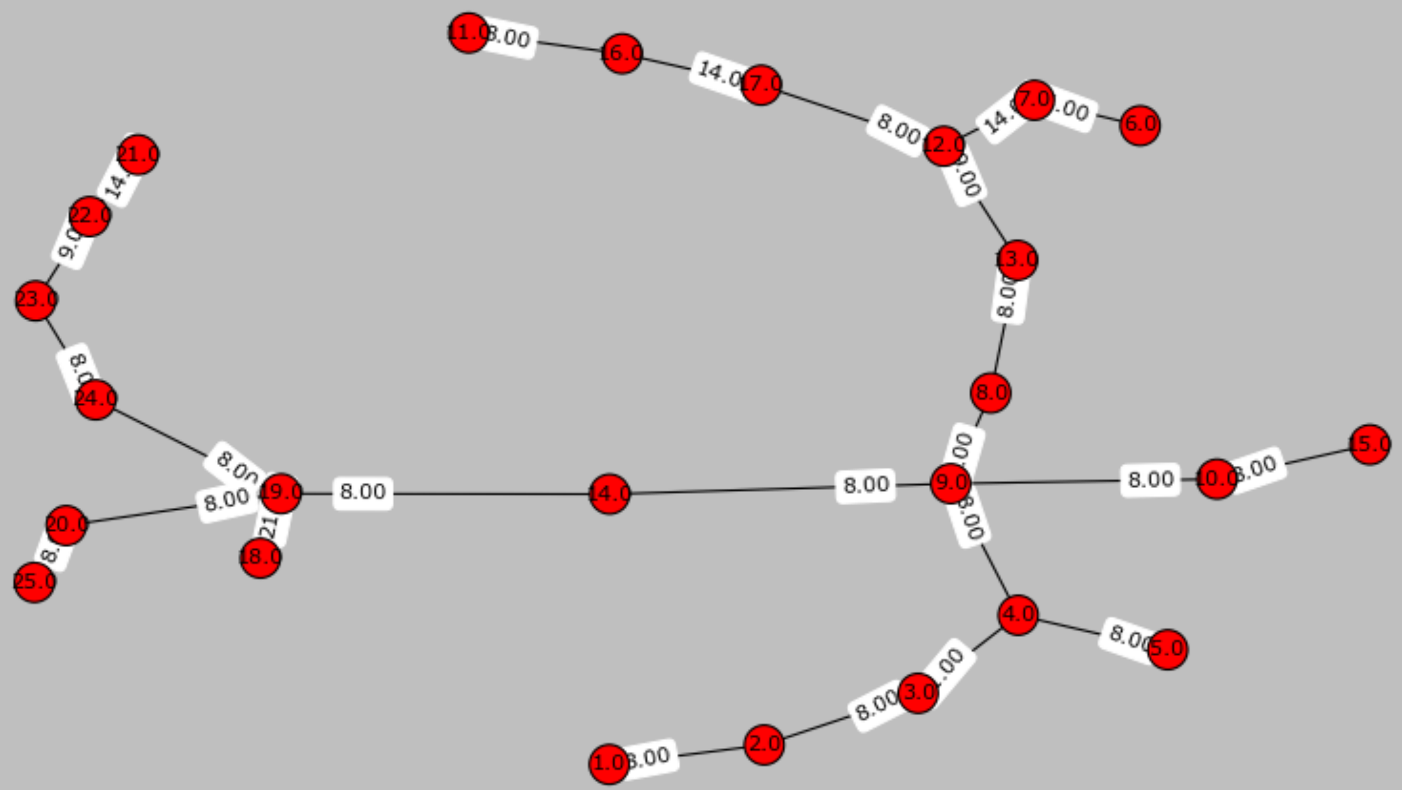
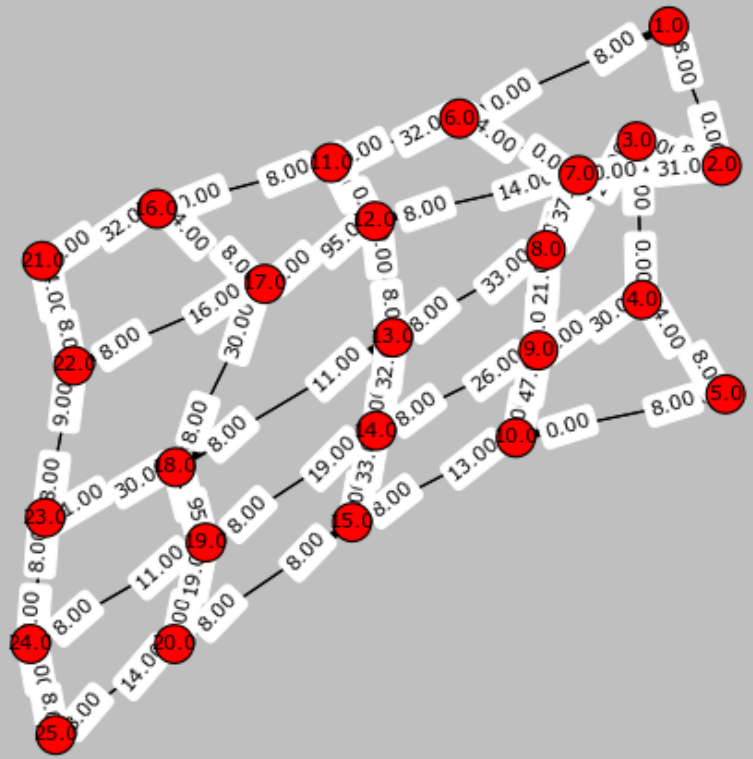
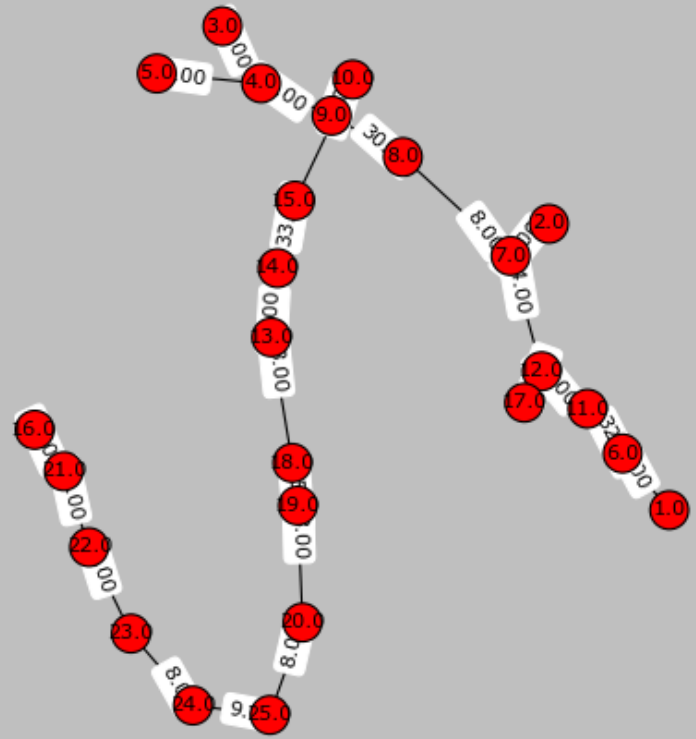
ETX MST



ETX Graph



ETX MST



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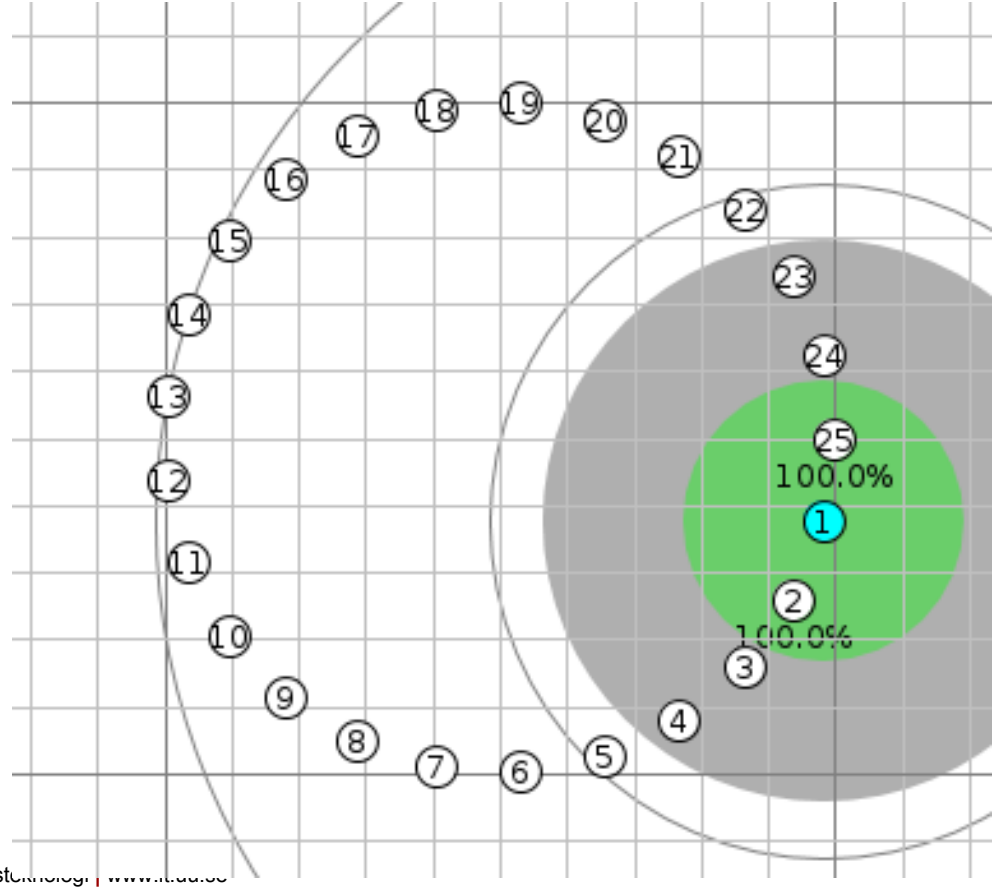
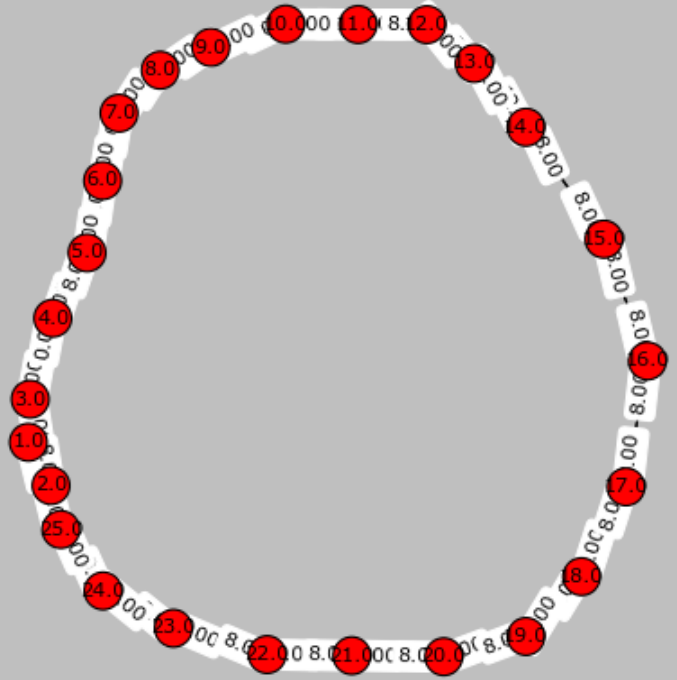
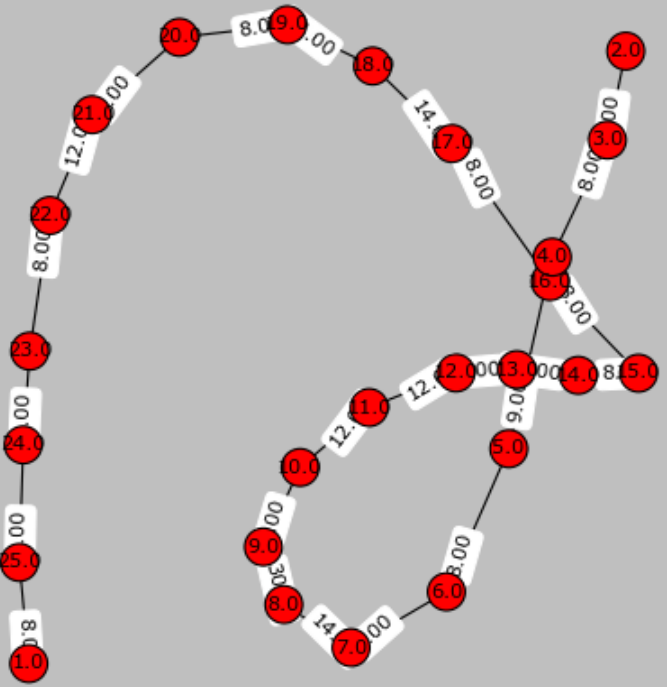
Ring



ETX Graph



ETX MST



Demo

1. Start the nodes
2. Wait for broadcast
3. Collect the data
4. Evaluate the data output

Minimum Spanning Tree - MST

Finding the best path
Dijkstra's algorithm

- ETX
  - Basic algorithm
- Normalized RSSI and LQI
  - All edge weights are between 0 and 1.
  - The best edge has weight 1
  - The worst edge has a weight 0
  - Product instead of sum

Optimal Sink Selection

- Dijkstra's Algorithm
  - Run on all nodes
  - Best MST in regards to the sum of all edge weights within the MST is the base for the sink selection.

Connected Dominating Set - CDS

- creating a backbone in the WSN
- creating minimum CDS
- creating kmCDS

Improvements

- Clustering
  - Data collection traffic,divided into optimal subnetworks. More sink nodes.
- Dynamically adapting WSN
- Protothreads

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Questions?