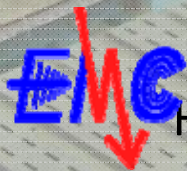




# Development of a wireless sensor network for engine rooms of vessels



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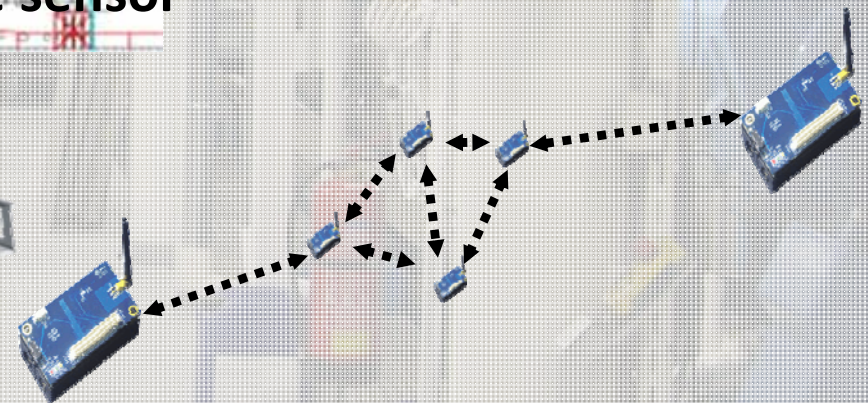
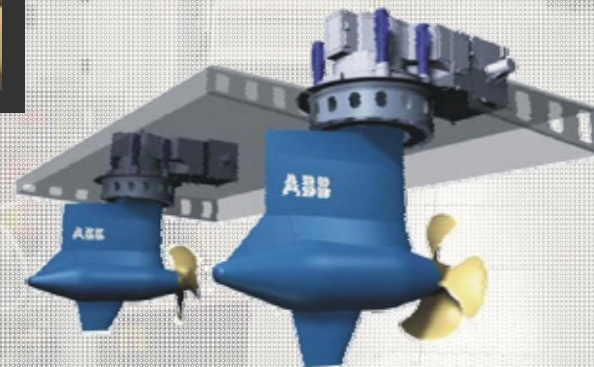
- I. Introduction
  - II. Development environment
  - III. Interferences inside the engine room
  - IV. Requirements for routing algorithm in the engine room
  - V. Multi-hop routing algorithms
  - VI. Developed routing protocol
  - VII. Field test at the engine room
  - VIII. Conclusion
-

## Sensors:

- Flow
- Temperature
- Pressure
- ~~Switch settings~~
- ...
- Up to 15.000 sensors
- Lot of cables
- Difficult accessible sensor positions

main engine:  
16.800 KW

**The aim is a  
wireless sensor network**



- **Hardware**

- **IRIS Mote**

- **Atmega128L**
      - Memory : 512 kByte
    - **AT86RF230**
      - Based on: IEEE 802.15.4-2003
      - max. data rate: 250 kBit/s
      - Operating distance: 50m (indoor)
      - Max. network size: 65 000+



- **Sensor board**

- **Temperature**
    - **Pressure**
    - **Humidity**



- **Software**

- **TinyOS 2.x**

- **Hardware independent**
    - **Energy efficient**

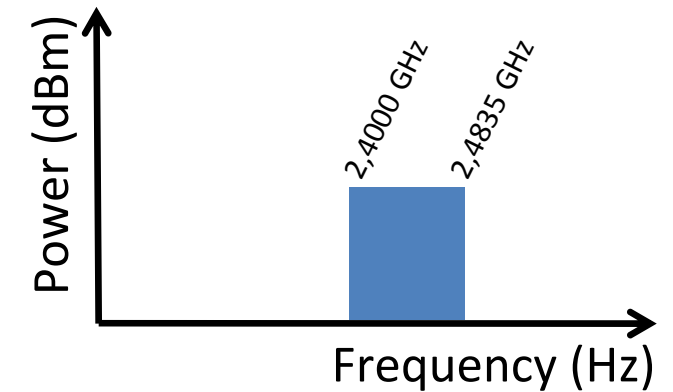


- **nesC**

- **Component based**
    - **Event based execution model**

# Interferences inside the engine room

## Spectrums



- 2,4 GHZ-ISM-band
- worst case (max. hold)

Measurement equipment:

- Rohde & Schwarz FSL 9kHz...18 GHz
- Schwarzbeck ESLP 9145

# Multihop Routing Protocols

Requirements for routing algorithm in the engine room

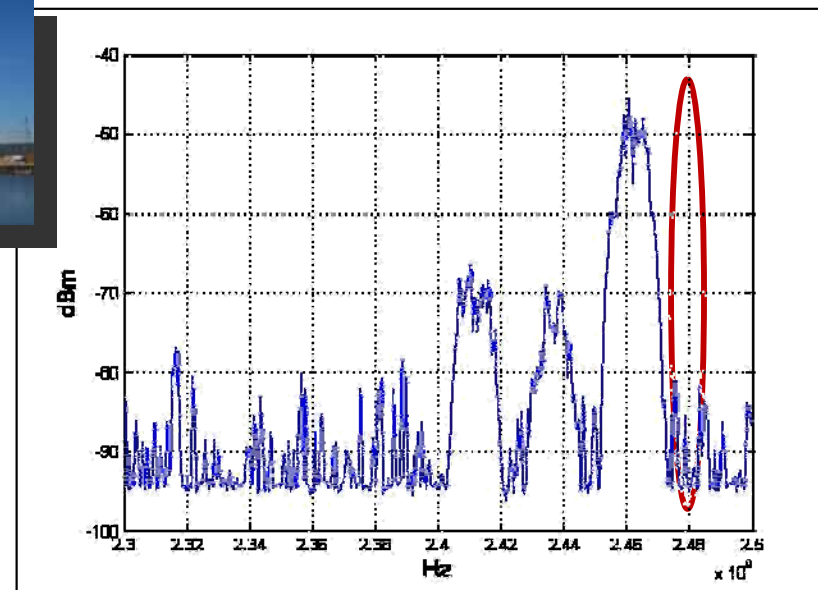
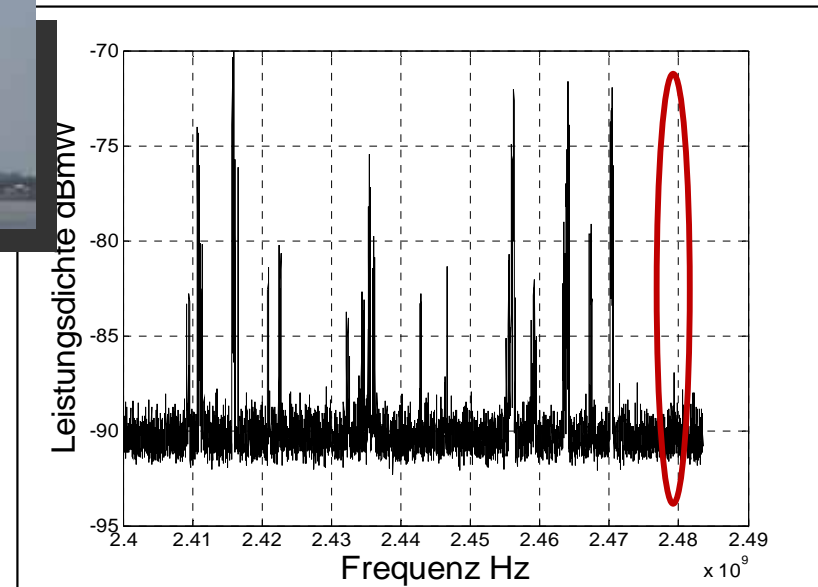
- **Frequency planning**
- **Type order of wireless sensor node is possible**
- **No line of sight likely**
- **Long distances**
- **Proactive**

# Interferences inside the engine room

## Spectrums

Which transmission channel should be used?

- max. hold, measurement period: 5 min.
- interferences occur temporarily
- source of interferences not easily detectable
- amplitude depends on location

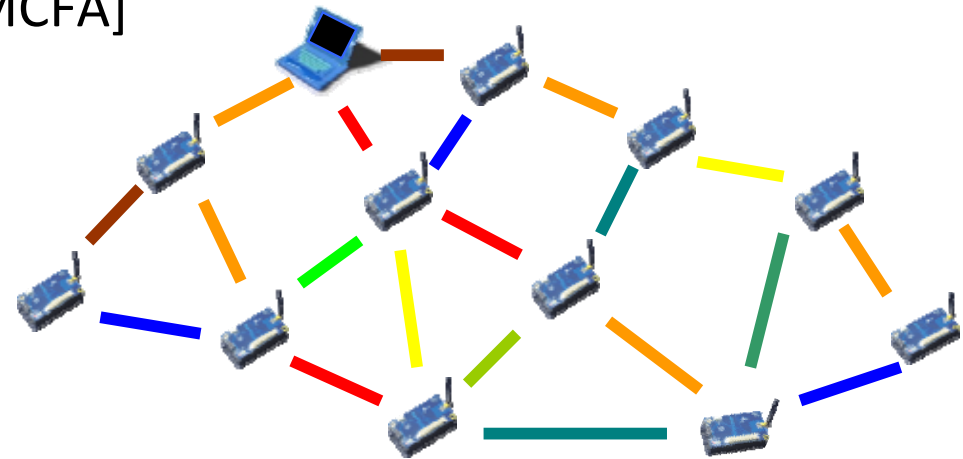


Channel 25 is least disturbed, therefore chosen as the transmission channel!

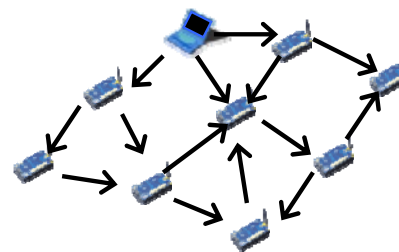
# Multihop Routing Protocols

## Routing algorithms

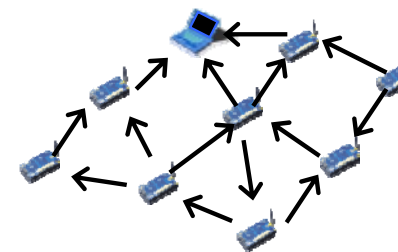
- Minimum Cost Forwarding Algo. [MCFA]
  - Table based
  - Proactive
  - Path with minimum cost



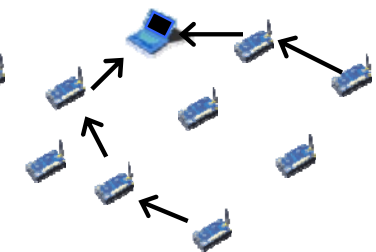
- Direct Diffusion [DD]
  - Table based
  - Reactive
  - Data centric



Propagation interest



Set up gradient

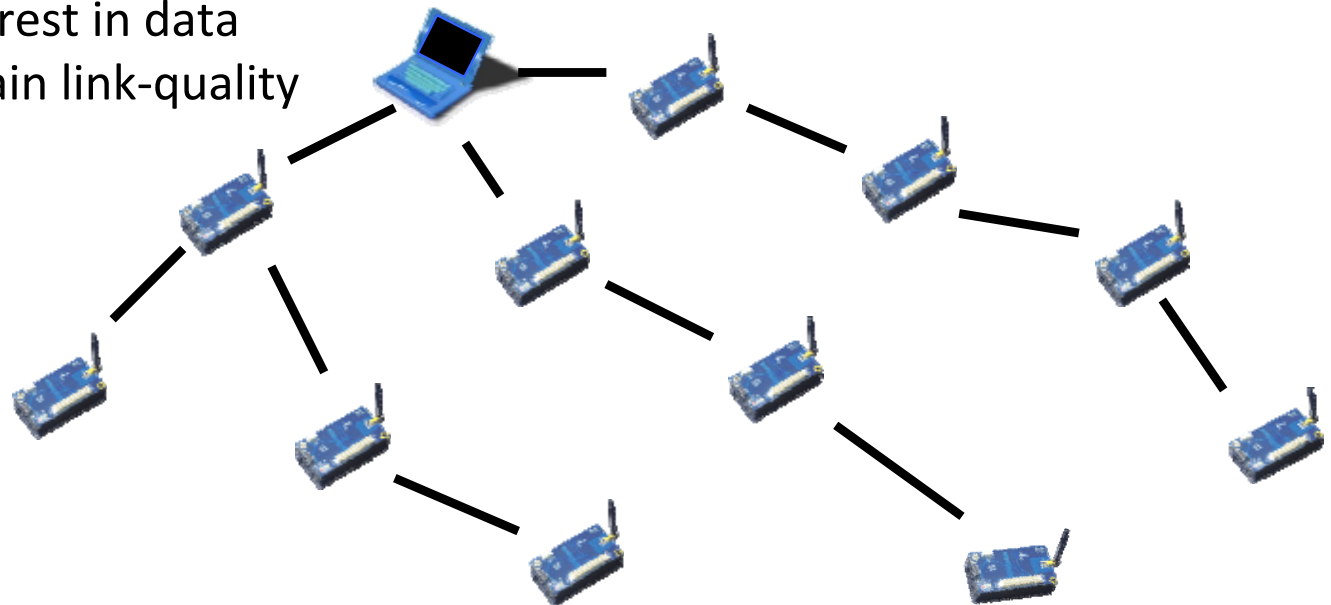


Send data

# Multihop Routing Protocols

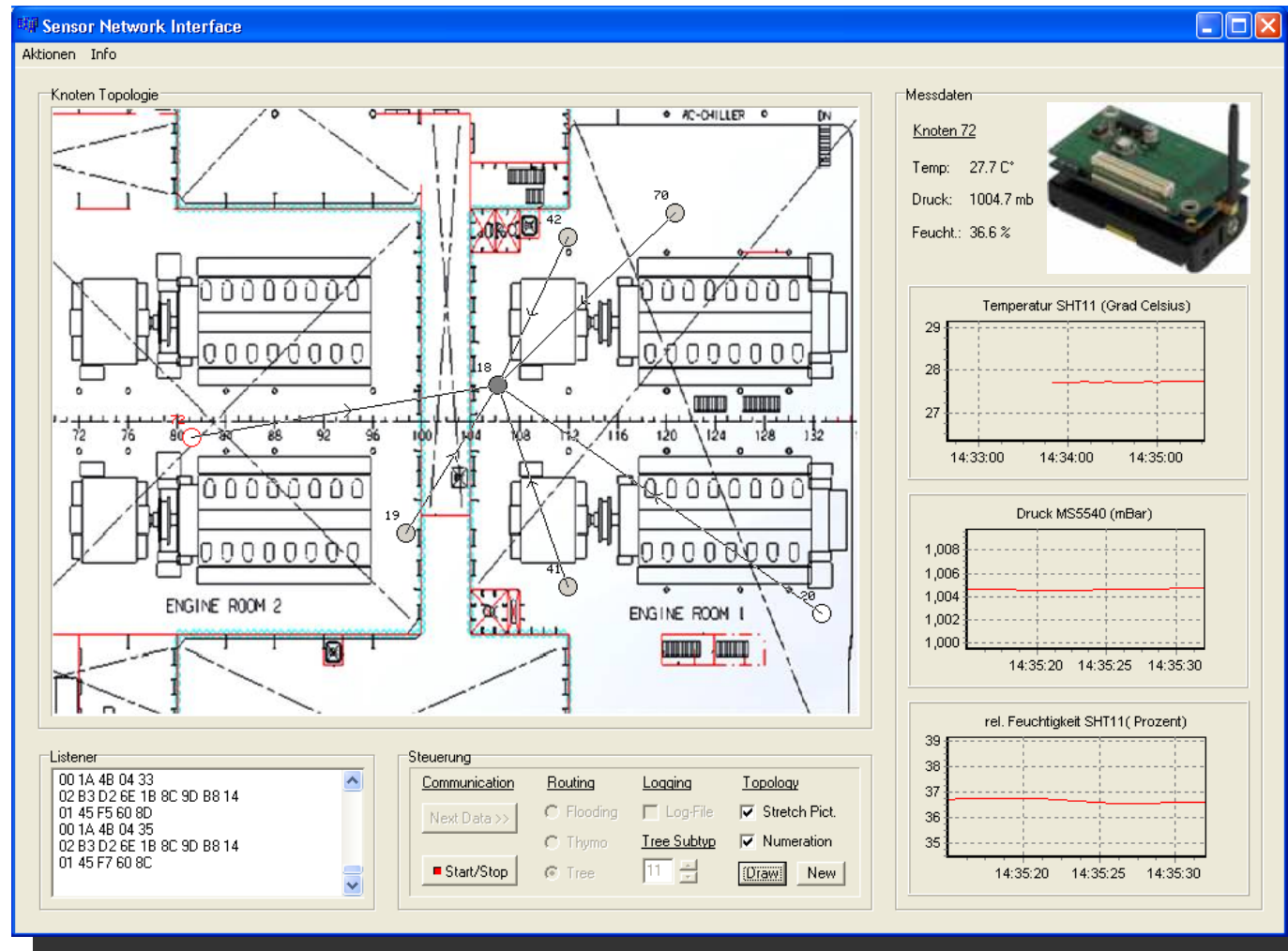
## Developed routing Algorithm

- Initialize routing tree for data of interest
  - Use flooding for tree creation
  - Choose shortest path in respect to RSSI
- Transmit data of interest from nodes to sink via tree.
- Periodical tree reconstruction
  - Renew and modify interest in data
  - Update paths to maintain link-quality



# Application at the engine room

## Field test



Test duration: 24h

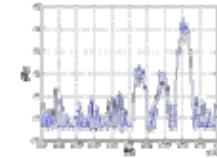
Data range: 1 data packet per second

# Conclusion

Hardware and Software



Interferences



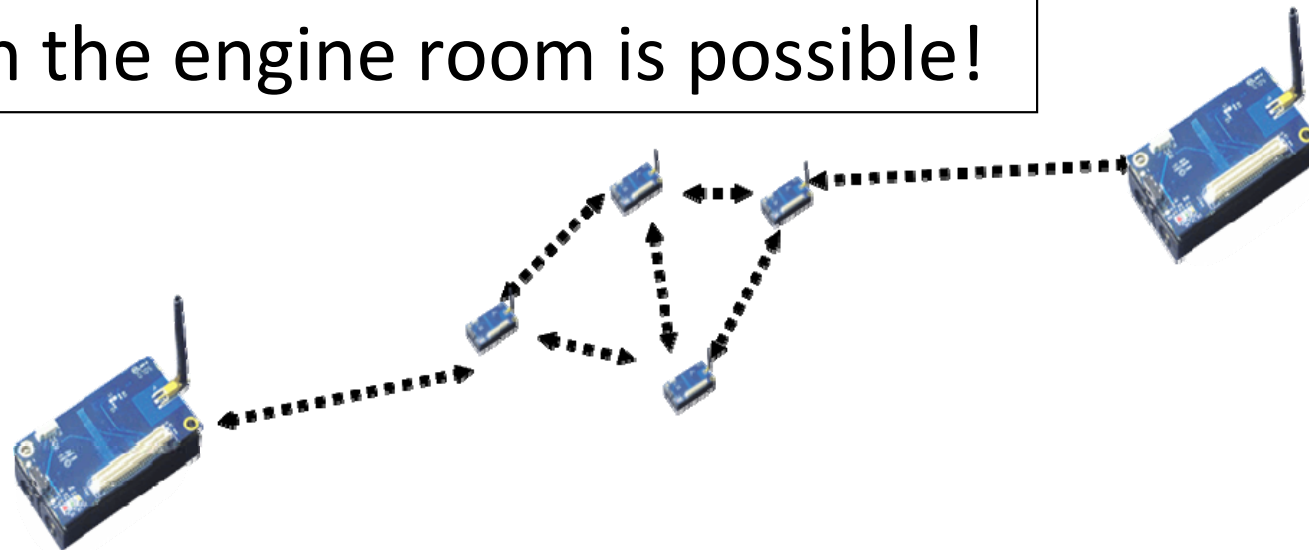
Routing Algorithms



Application at engine room



A WSN within the engine room is possible!





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**Thank you for your attention!**

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