



Development of a wireless sensor network for engine rooms of vessels



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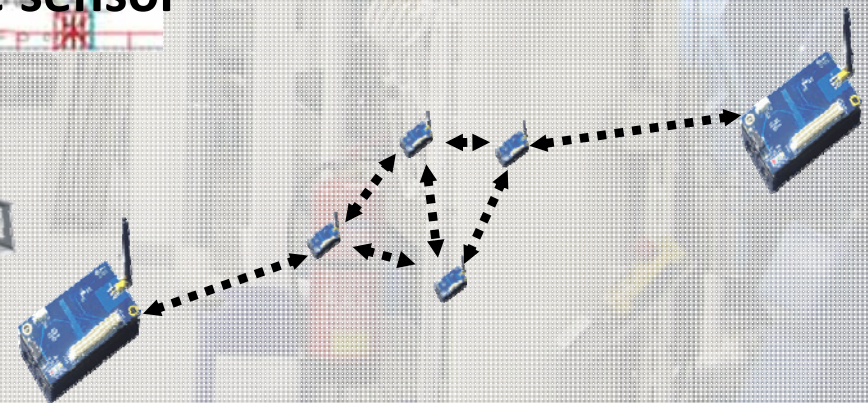
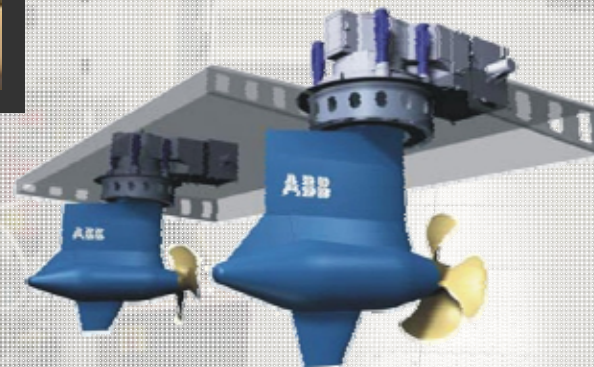
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Sensors:

- 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**



Development Environment

- **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

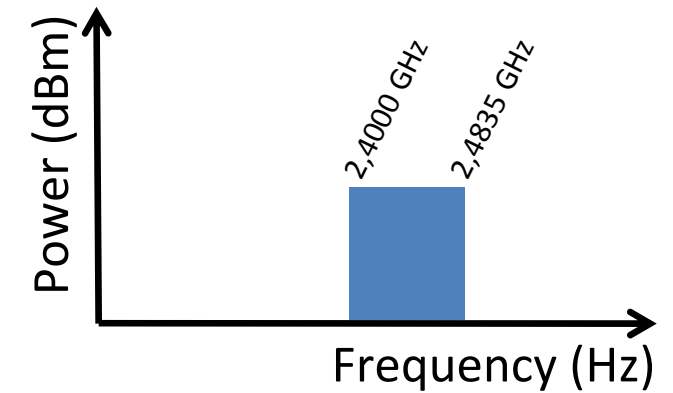


- **nesC**

- 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

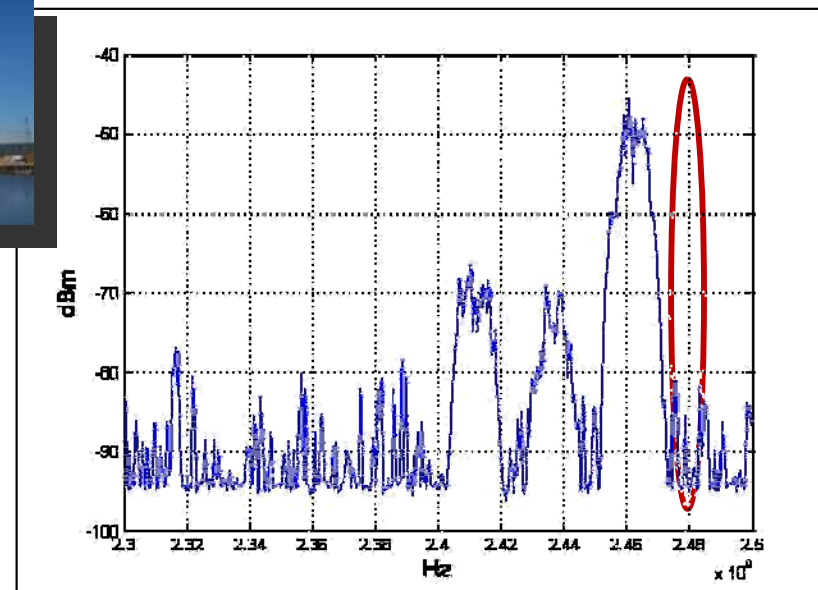
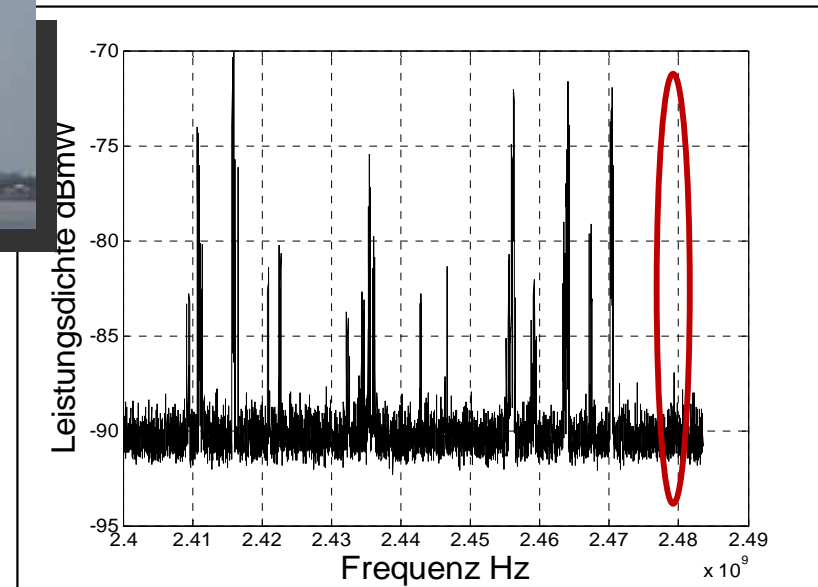
- **Frequency planning**
- **Type order of wireless sensor node is possible**
- **No line of sight likely**
- **Long distances**
- **Proactive**

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

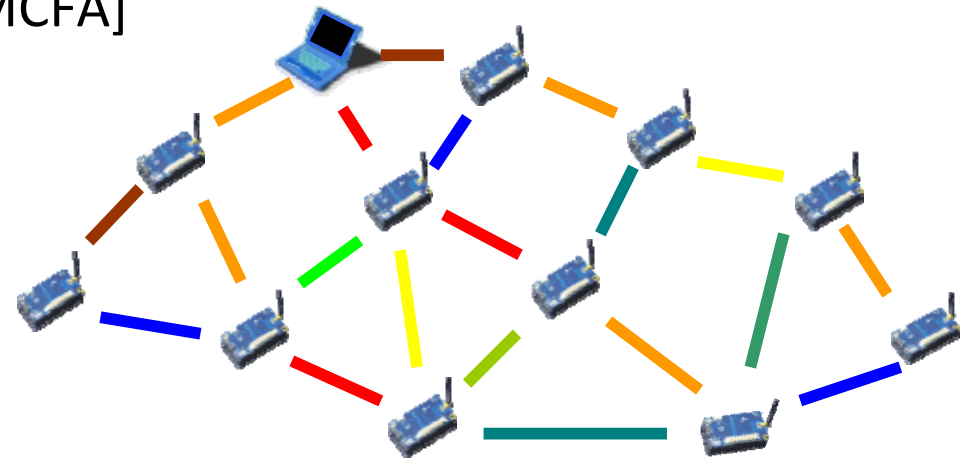


Channel 25 is least disturbed, therefore chosen as the transmission channel!

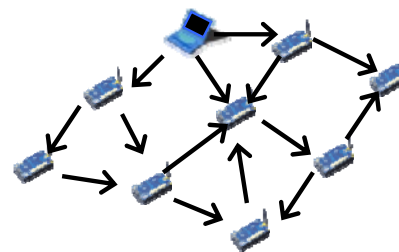
Multihop Routing Protocols

Routing algorithms

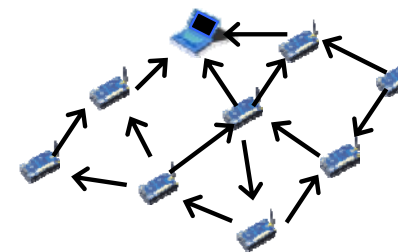
- Minimum Cost Forwarding Algo. [MCFA]
 - Table based
 - Proactive
 - Path with minimum cost



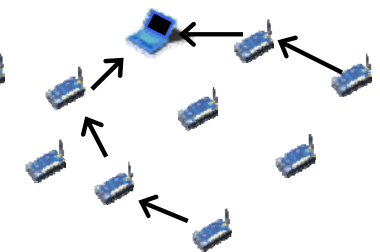
- Direct Diffusion [DD]
 - Table based
 - Reactive
 - Data centric



Propagation interest



Set up gradient

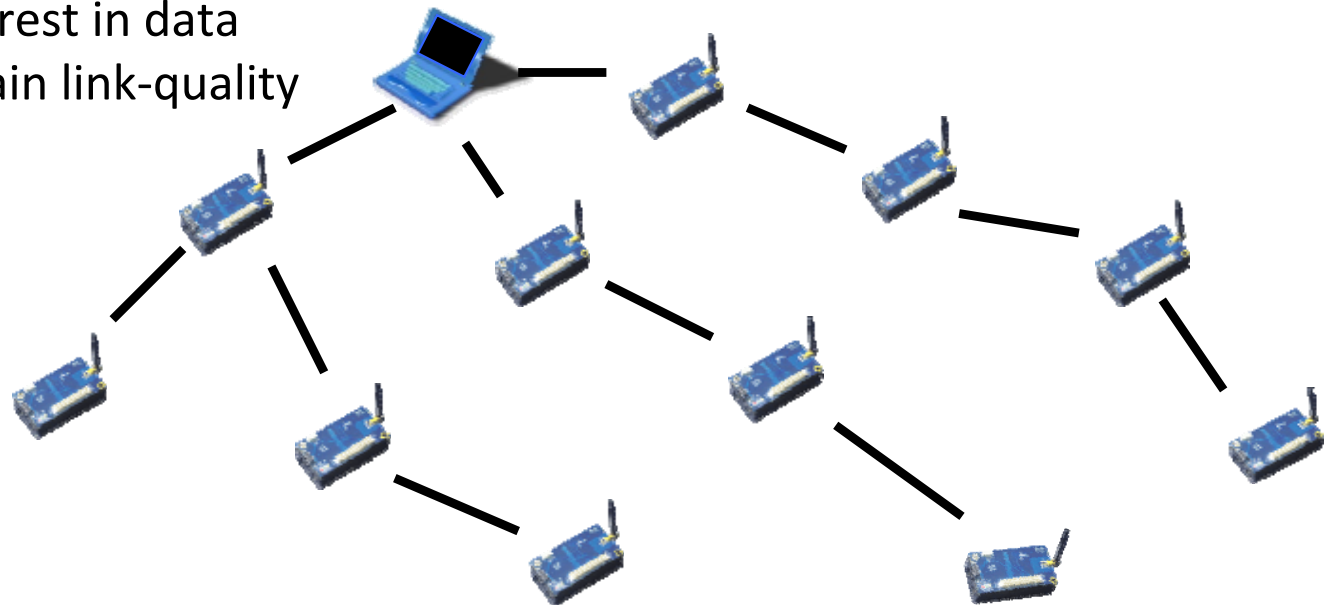


Send data

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

Sensor Network Interface

Aktionen Info

Knoten Topologie

AC-CHILLER

ENGINE ROOM 2

ENGINE ROOM 1

Messdaten

Knoten 72

Temp: 27.7 C°

Druck: 1004.7 mb

Feucht.: 36.6 %

Temperatur SHT11 (Grad Celsius)

Time	Temperature (°C)
14:33:00	27.7
14:34:00	27.7
14:35:00	27.7

Druck MS5540 (mBar)

Time	Pressure (mBar)
14:35:20	1004.7
14:35:25	1004.7
14:35:30	1004.7

rel. Feuchtigkeit SHT11 (Prozent)

Time	Relative Humidity (%)
14:35:20	36.6
14:35:25	36.6
14:35:30	36.6

Listener

```
00 1A 4B 04 33
02 B3 D2 6E 1B 8C 9D B8 14
01 45 F5 60 8D
00 1A 4B 04 35
02 B3 D2 6E 1B 8C 9D B8 14
01 45 F7 60 8C
```

Steuerung

Communication Routing Logging Topology

Next Data >> Flooding Log-File Stretch Pict.

Thymo Tree Subtyp Numeration

Start/Stop Tree 11

Test duration: 24h

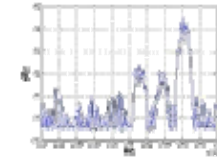
Data range: 1 data packet per second

Conclusion

Hardware and Software



Interferences



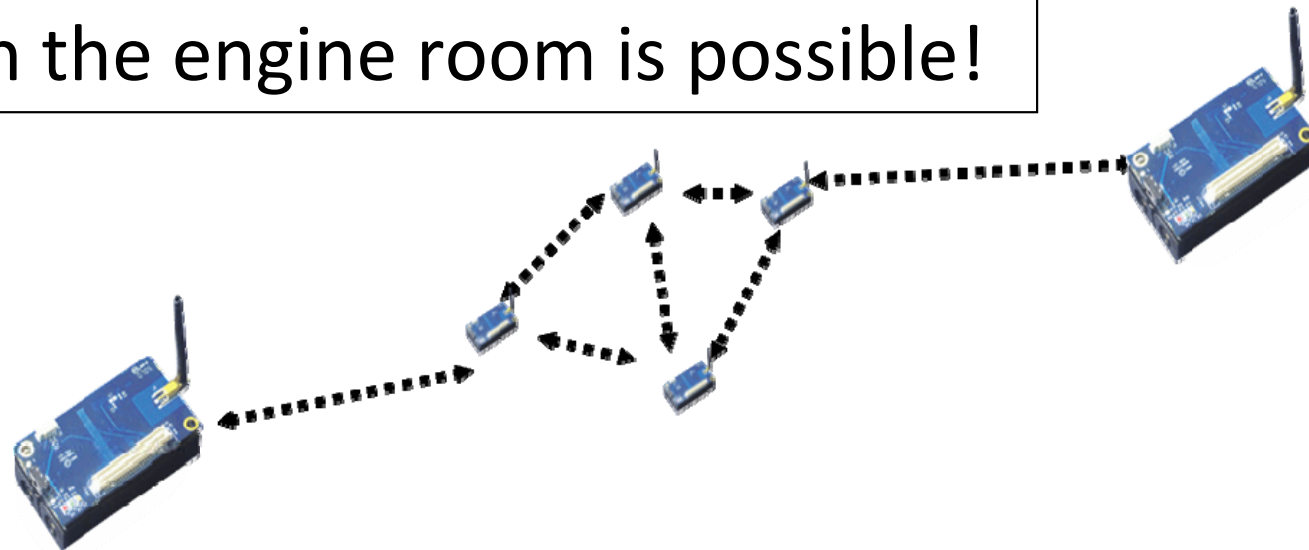
Routing Algorithms



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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