Wireless Sensor Networks

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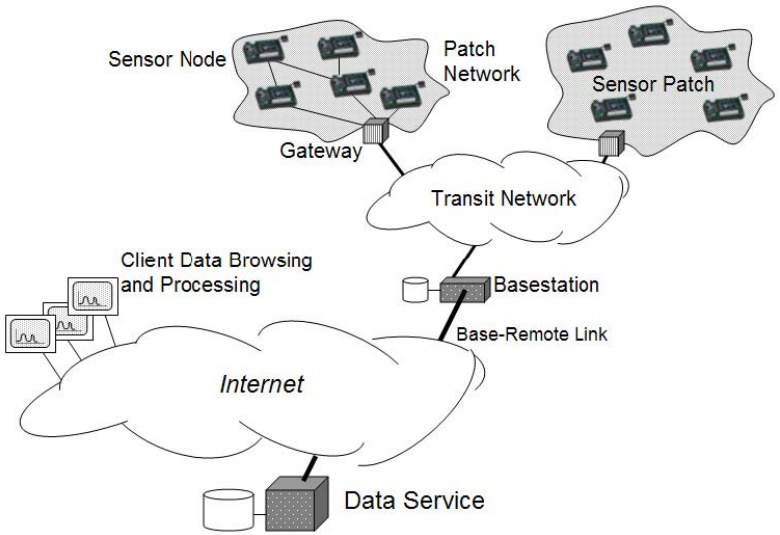
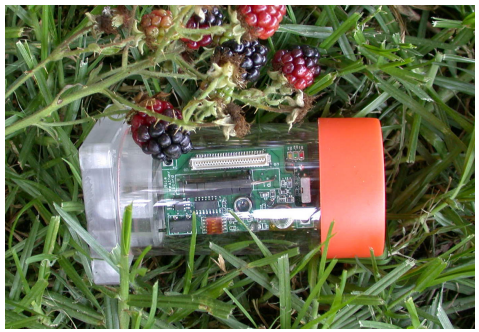
Great Duck Island Experiment, 2002





URL:

http://www.coa.edu/html/greatduckisland.htm

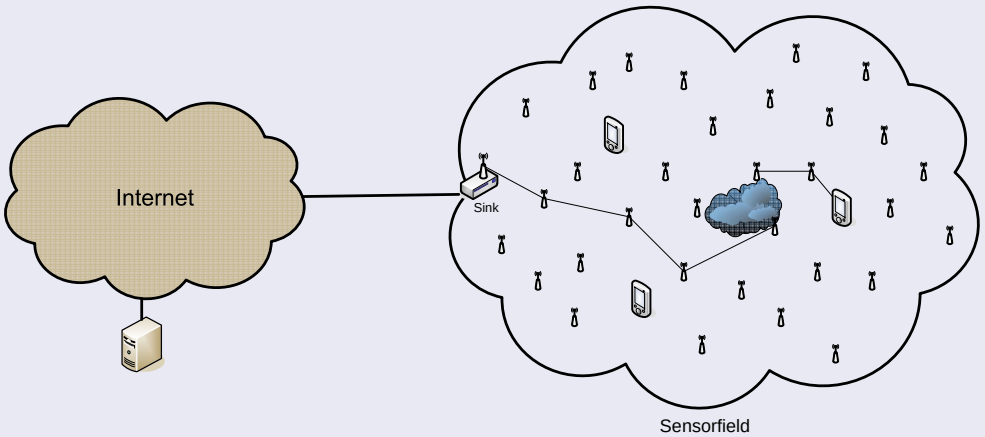
Sensor/Actuator-Network I

Definition:

" Large number of spatially distributed autonomous devices to cooperatively sense and instrument physical or environmental conditions with high accuracy and low costs.
Devices communicate wireless and are deployed either inside the considered phenome or very close to it."

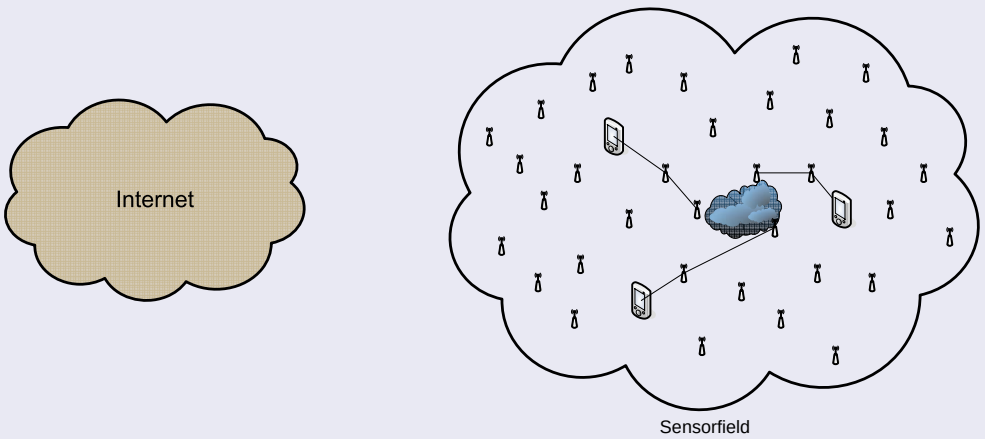
Sensor/Actuator-Network II

Semi Automated Architektur



Sensor/Actuator-Network II

Automated Architektur



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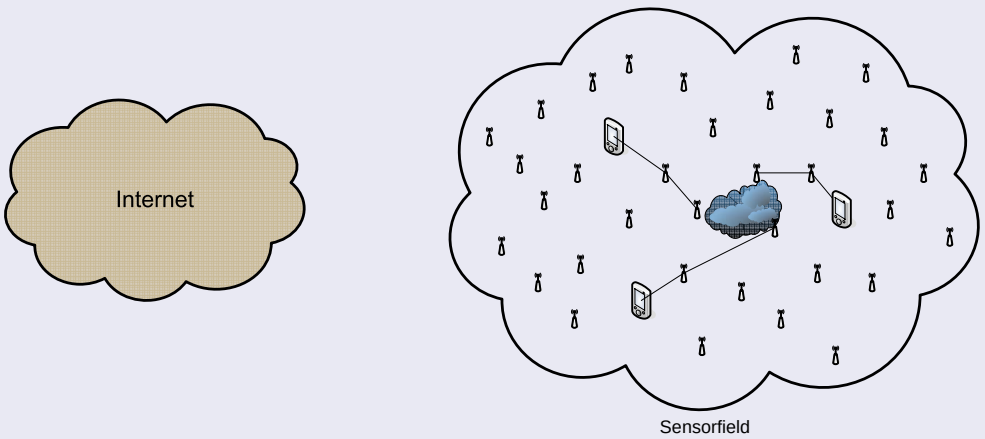
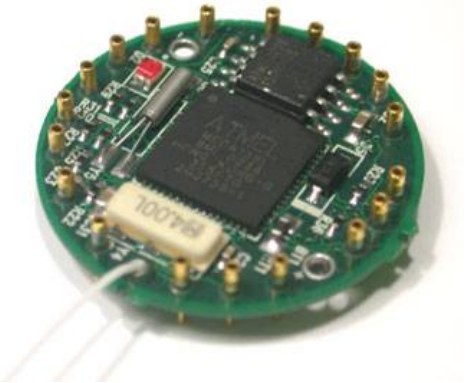


- Adressability
- Energy efficiency
- Fault Tolerance
- Kooporation
- Koordination
- Mobility / Dynamic

Sensor/Actuator-Node



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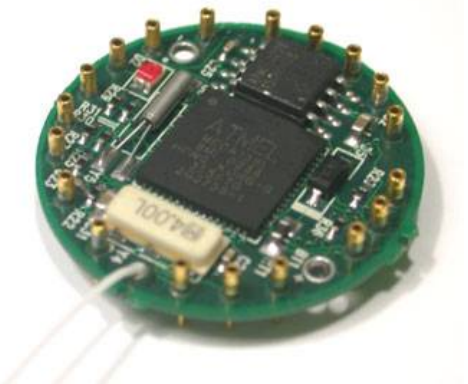
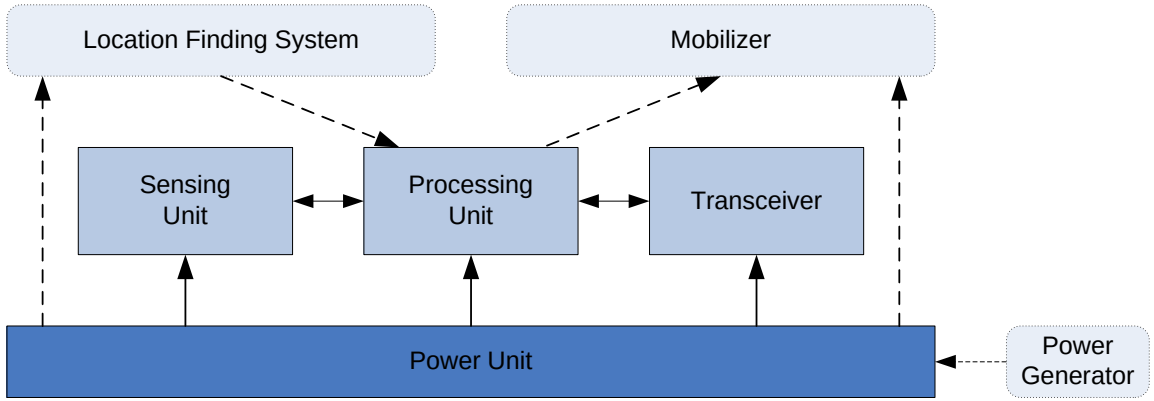
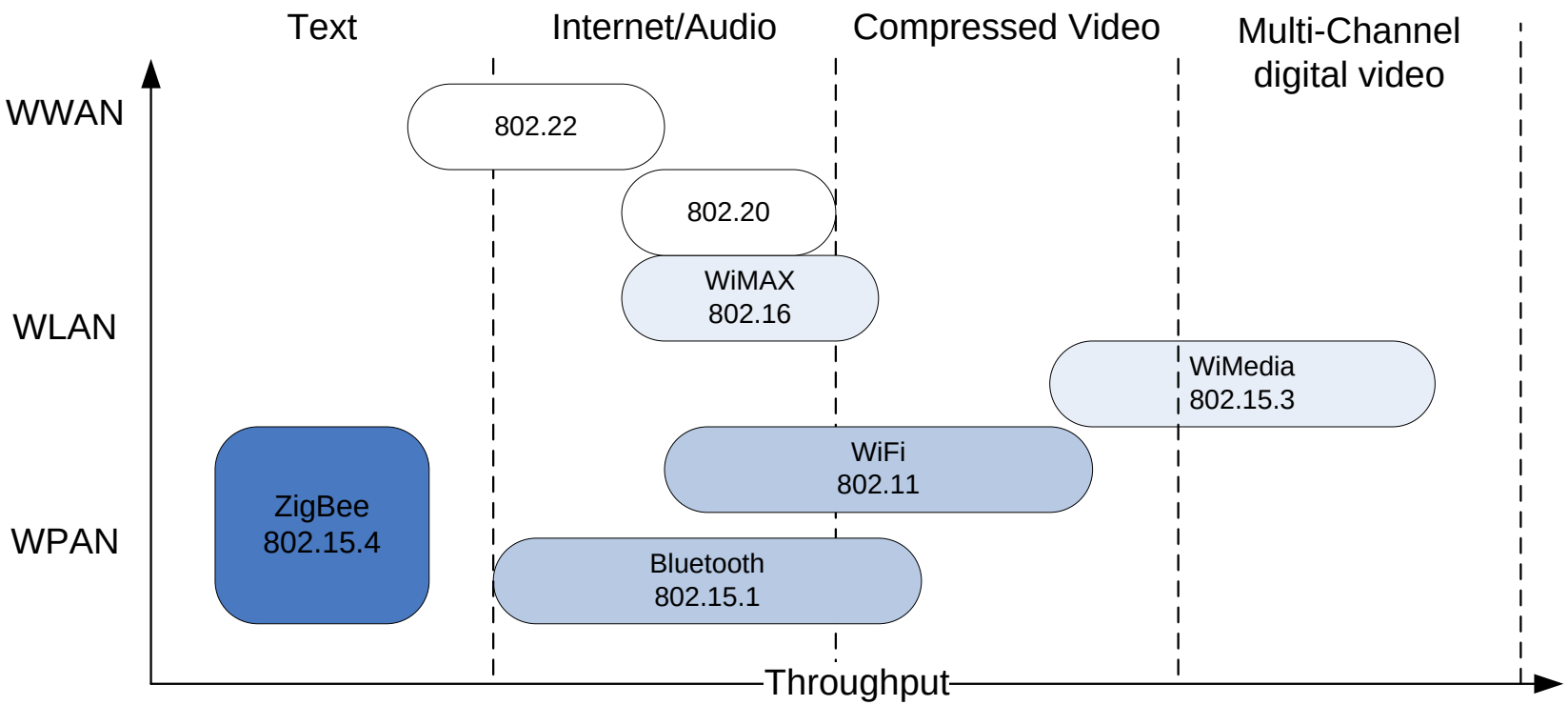




Characteristics

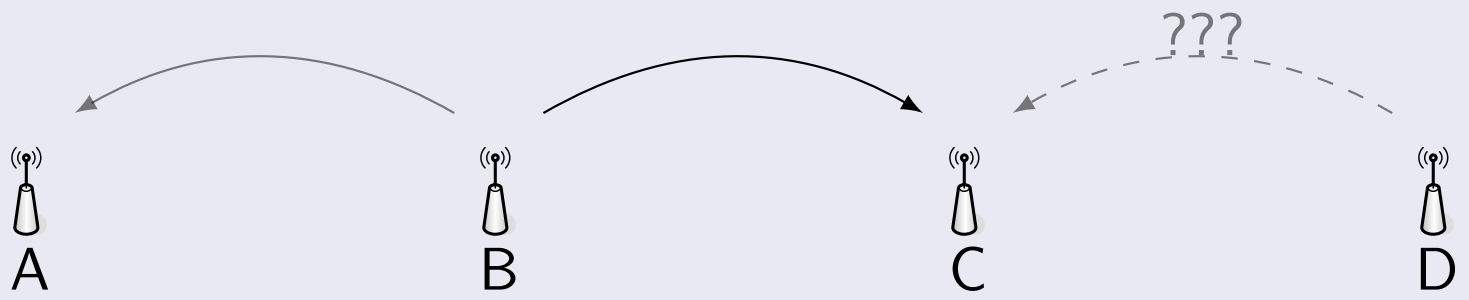
- Small but multifunctional nodes
- Low cost (*dispensable*)
- Low power
- Low bitrate
- High density
- Autonomous
- Adaptive
- Wireless communication

IEEE-Standards for wireless Communication

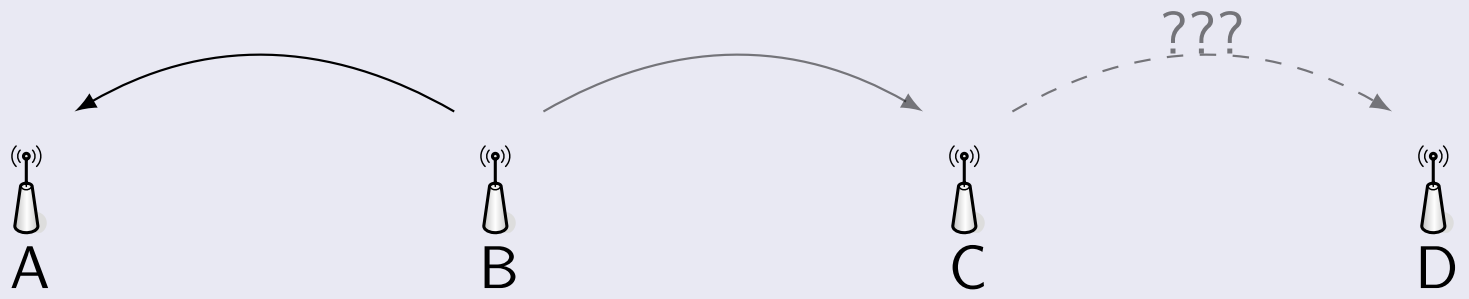


Problems of Wireless Communication

Hidden Station



Exposed Station



RTS/CTS-Schema

Implemented in **MACA** (*Medium Access with Collision Avoidance*) and adapted in 802.11 to ensure an undisturbed reception.

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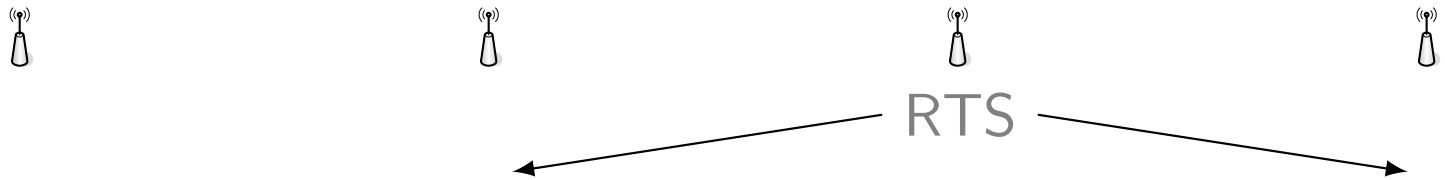

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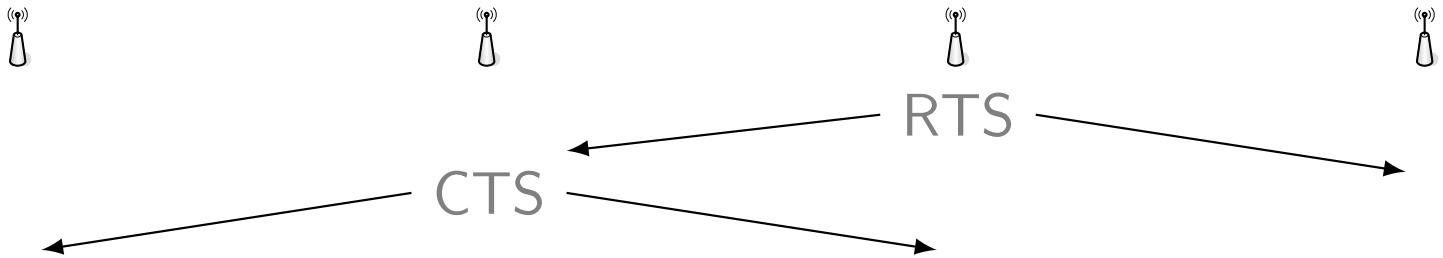

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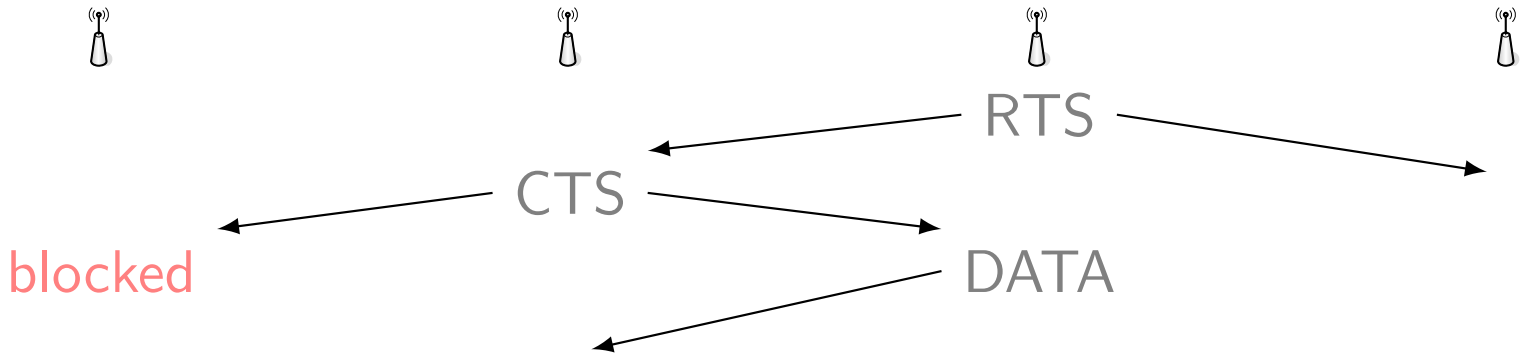

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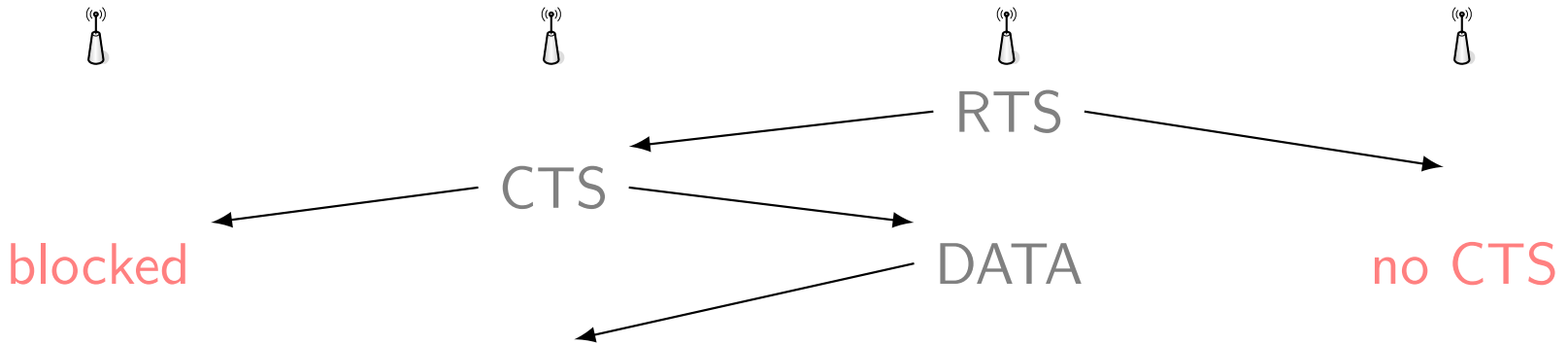

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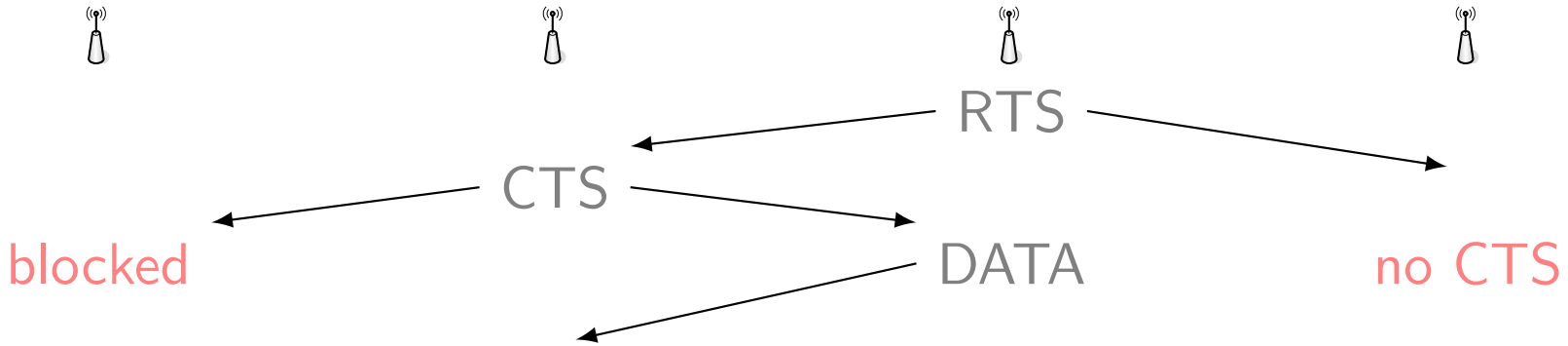
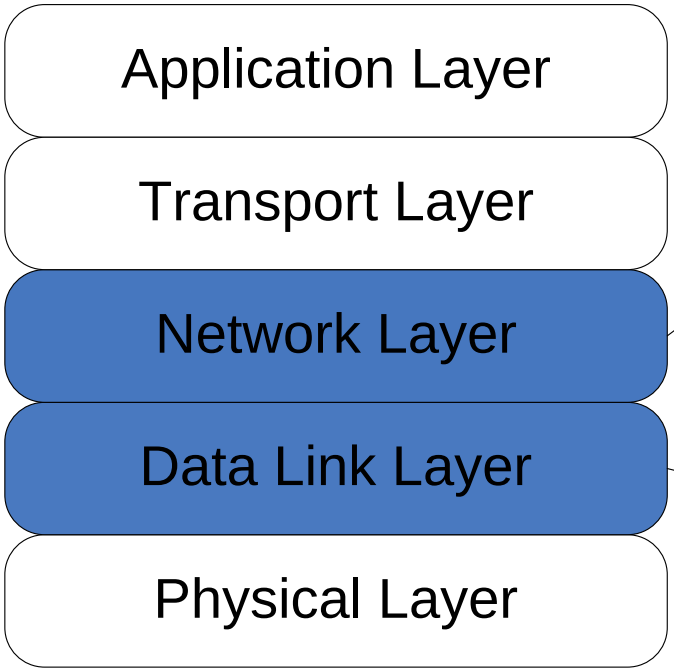


The recipient can use the checksum to verify wether the message was received correctly and send an acknowledgment (*ACK;* **MACAW**).

Waste of Energy

- **idle listening** node monitors medium although no sender is active (*cannot be omitted easily*)
- **collisions** nodes transmit at the same time and messages destroy each other
- **overemitting** node sends message while recipient is unable to listen
- **overhearing** node receives a message addressed to someone else
- **thrashing** unbalanced load increases the probability of collisions

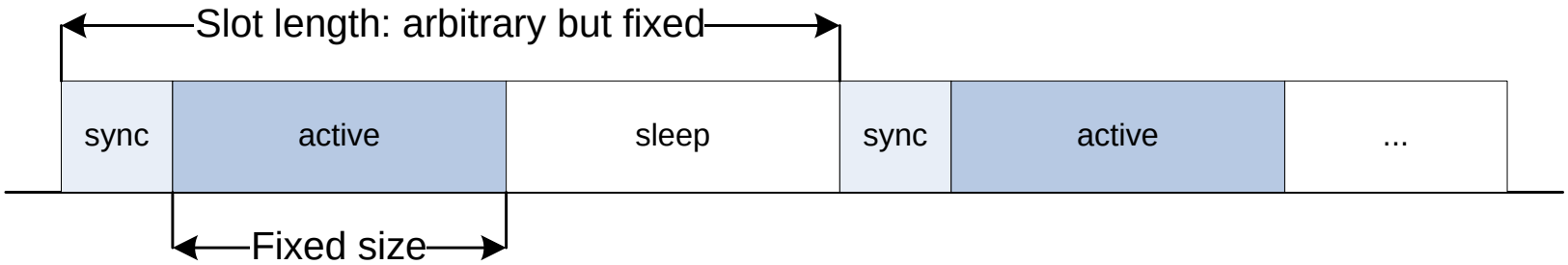
Approaches to reduce power consumption



- Aggregation
- Directed Diffusion
- LEACH
- SPIN

- Adaptive Schemes
- Activation Channel
- Scheduling (TDMA)
- Preamble

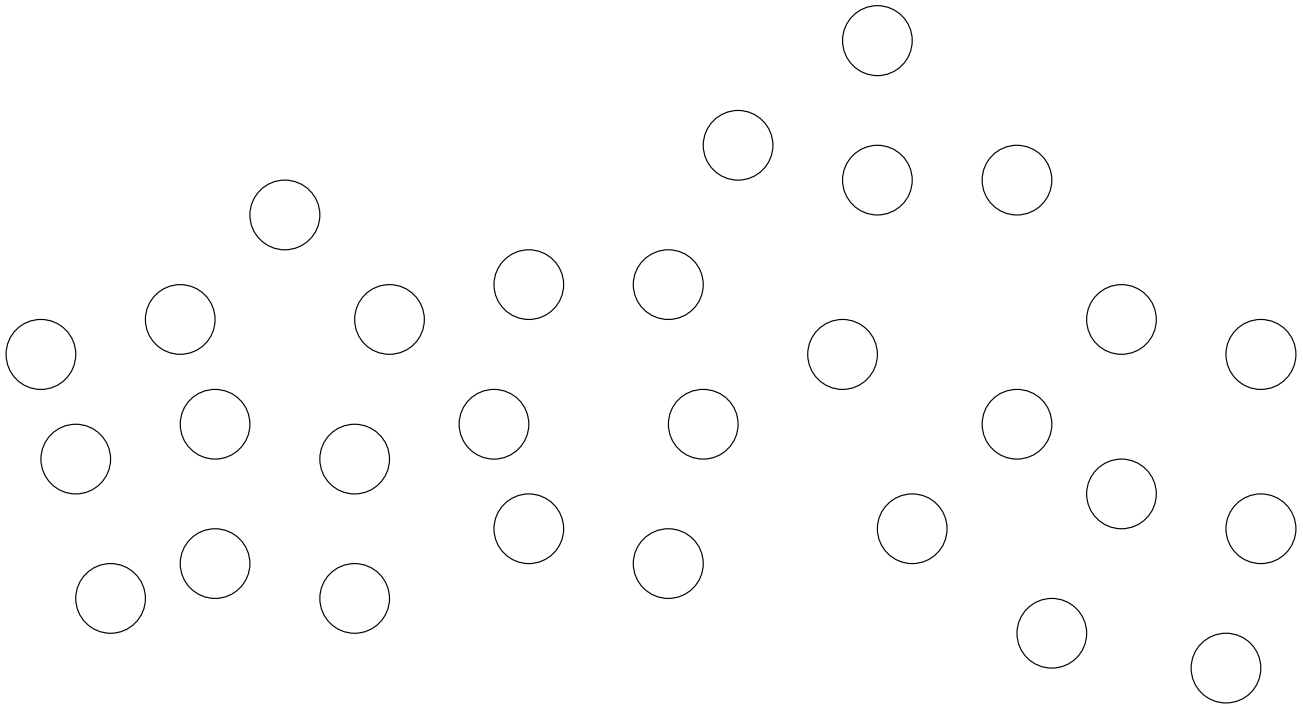
Scheduled MAC-Protocols



Nodes are organized in *virtual* clusters, which adapt a common slot format.

- **Example** S-MAC (*Sensor-MAC*)
- **Variation** T-MAC (*Time-out MAC*)

Sensor-MAC (S-MAC)



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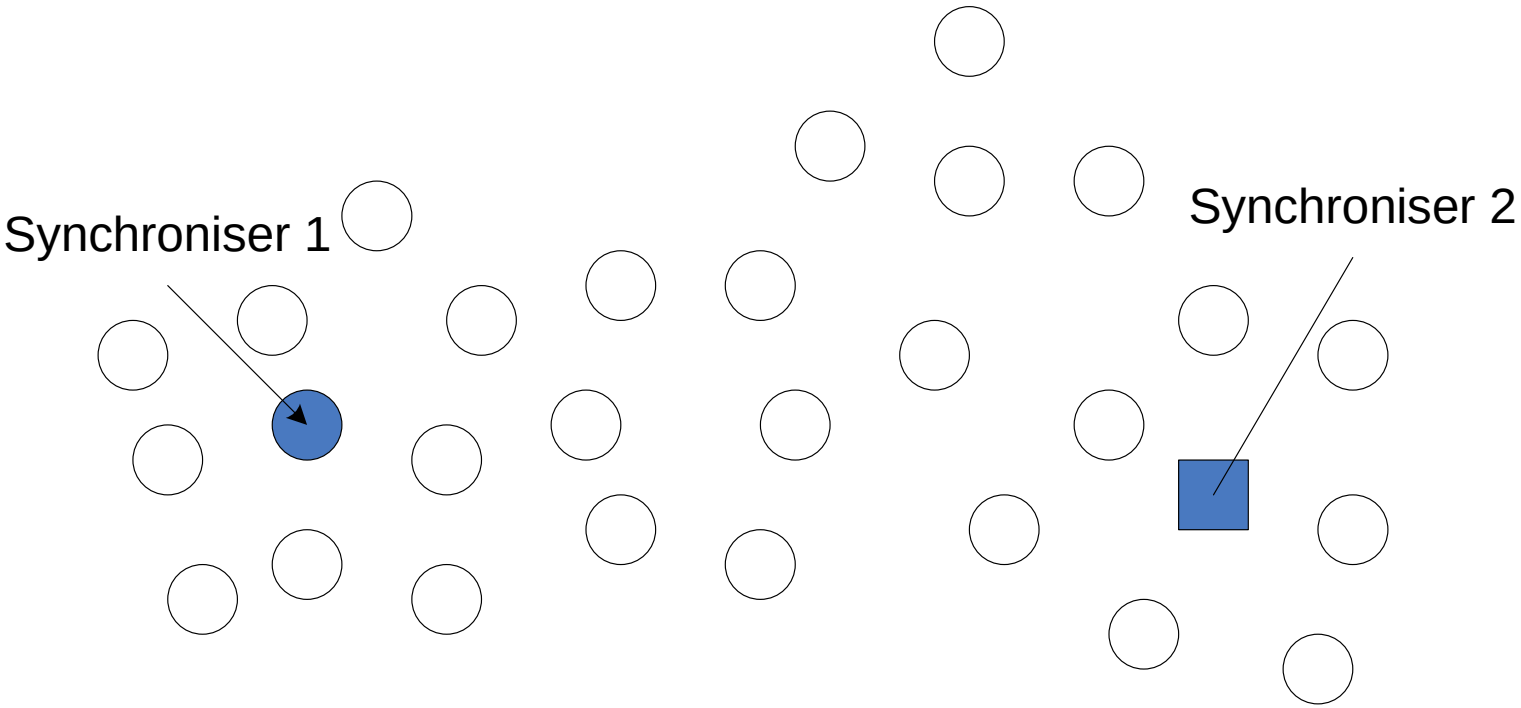

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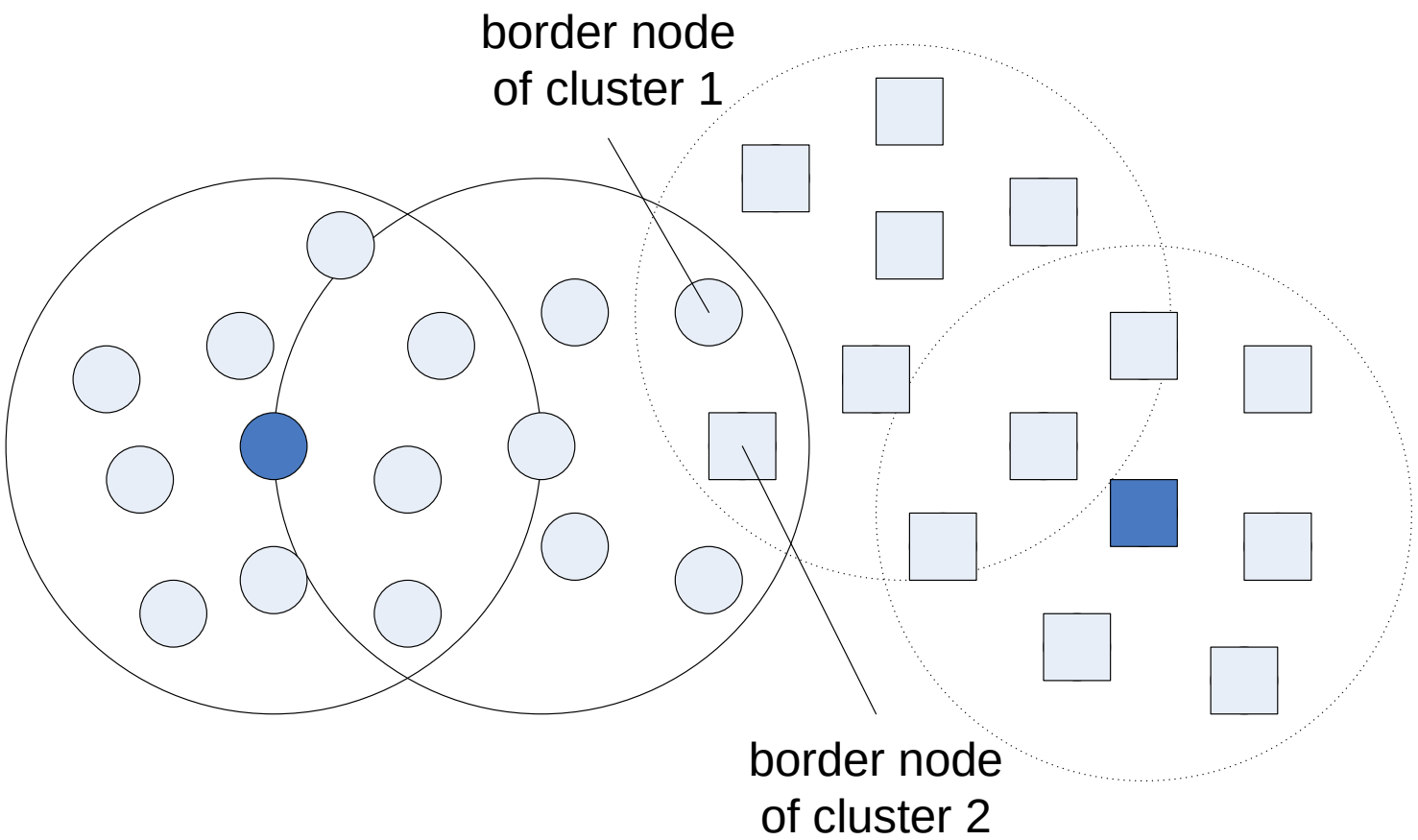
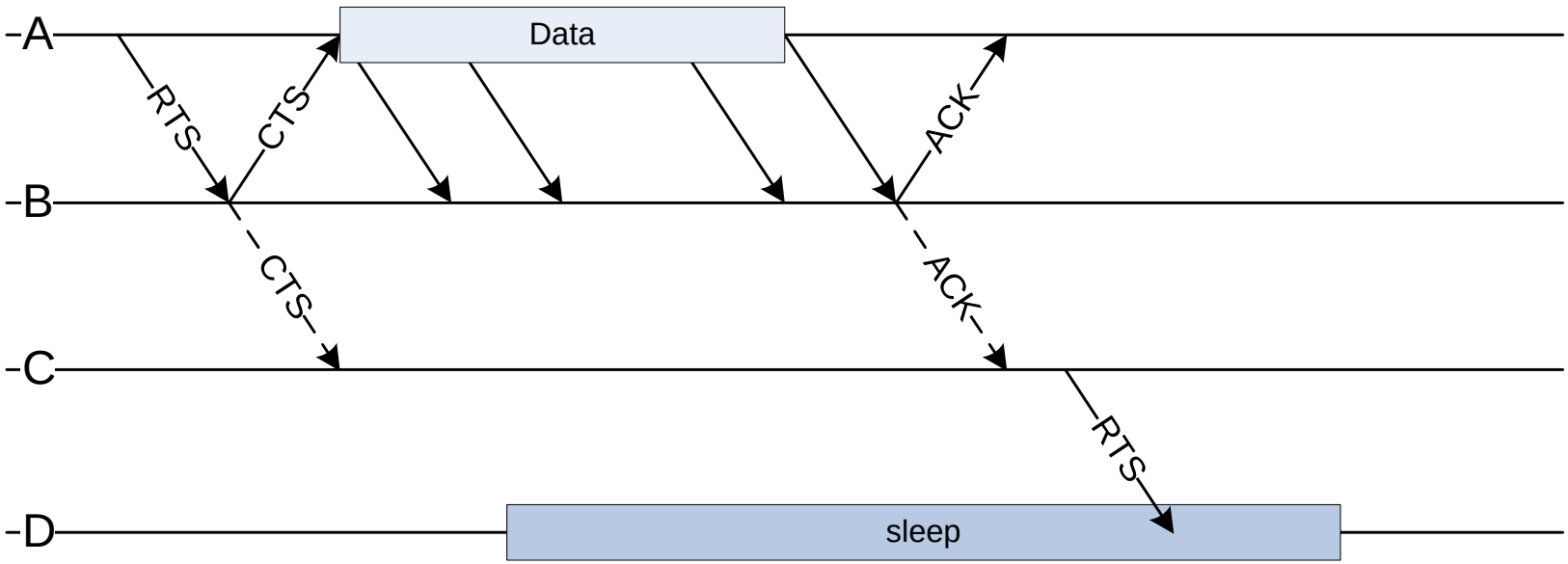


Time-out MAC (T-MAC)

Using activation events T-MAC determins the relation between active and sleep periods adaptively.



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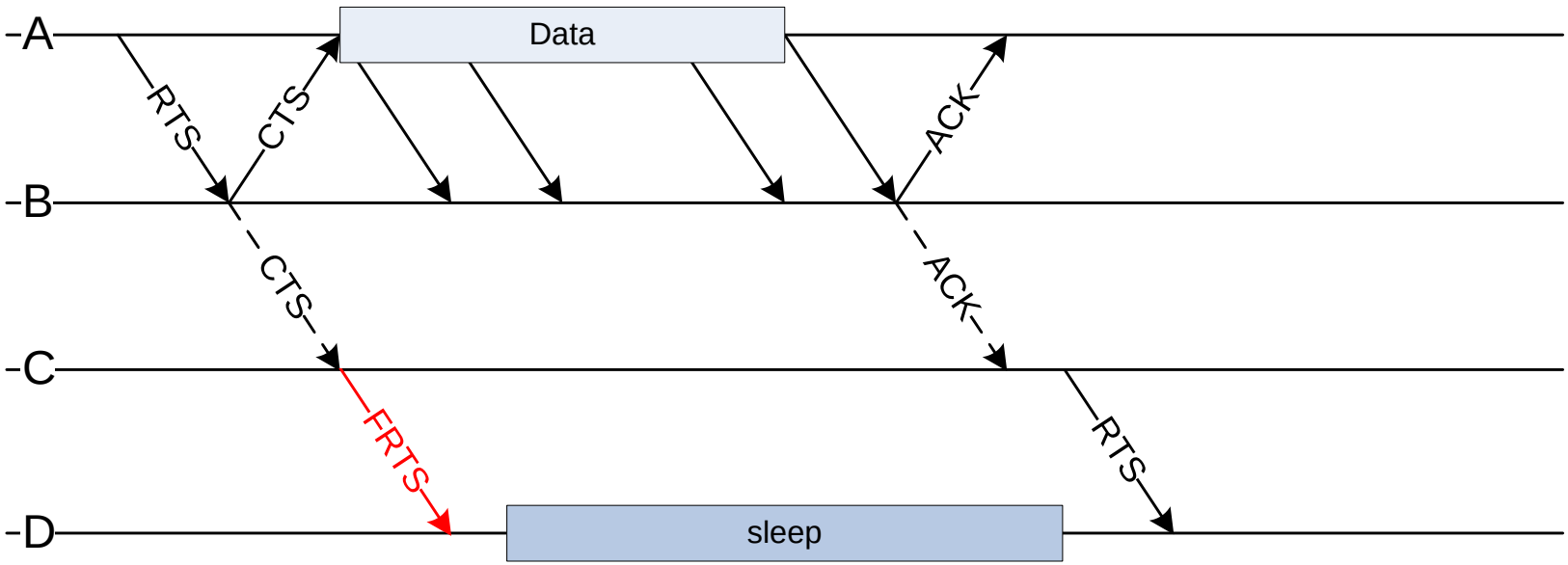
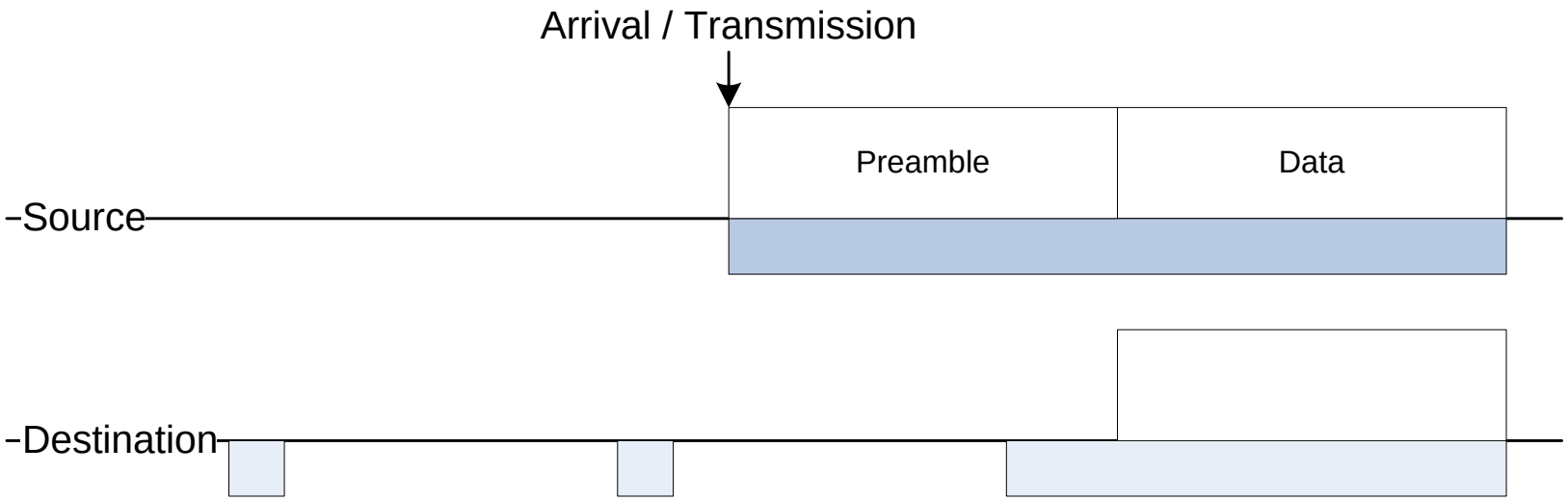


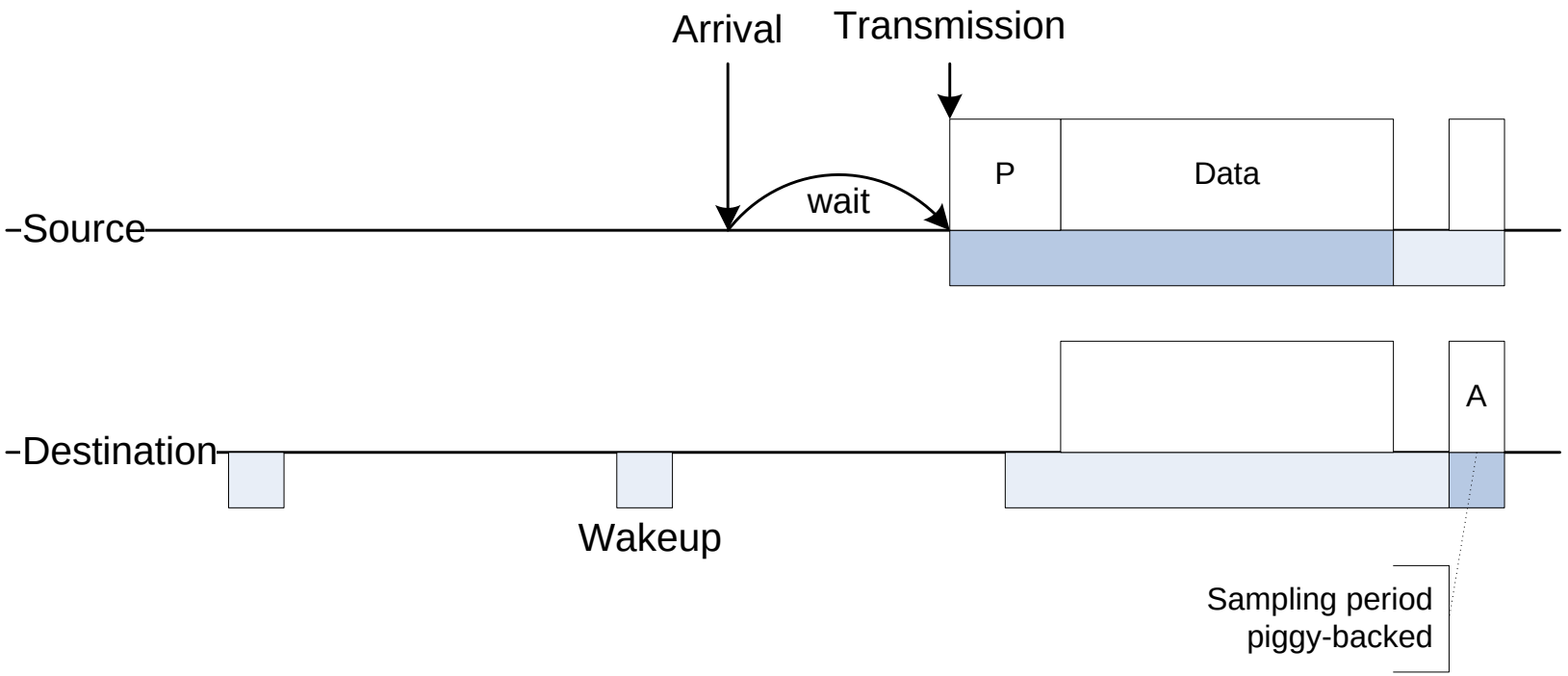
Low Power Listening



- **Example** WiseMAC (*erweitertes B-MAC*)
- **Variation** MFP-MAC (*Micro Frame Preamble MAC*)

WiseMAC

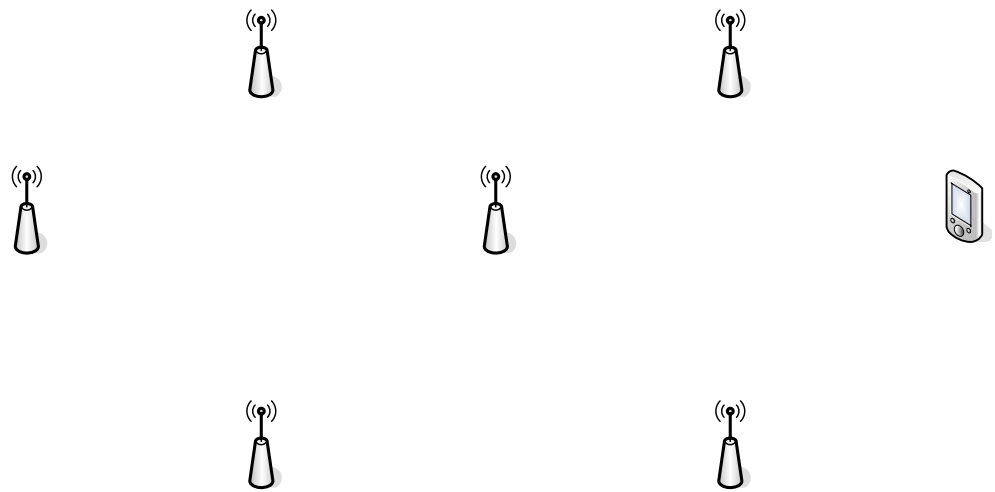
- **Problem:** long preamble times (*waste of energy*)
- **Solution:** adaptation to receiver sampling period



Directed Diffusion

Used gradiants to control data flow from source to sink during interest dissemination.

1. Propagate Interest
2. Set-up Gradiant
3. Send Data



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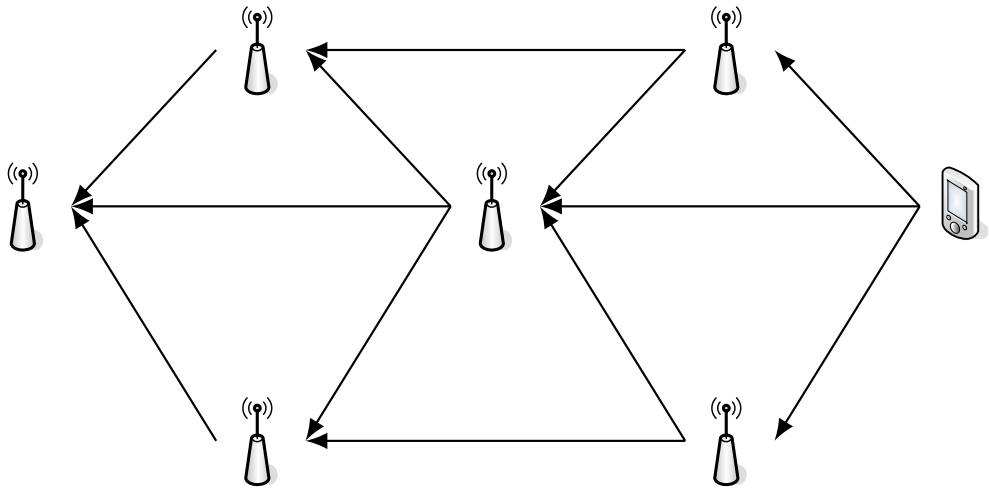

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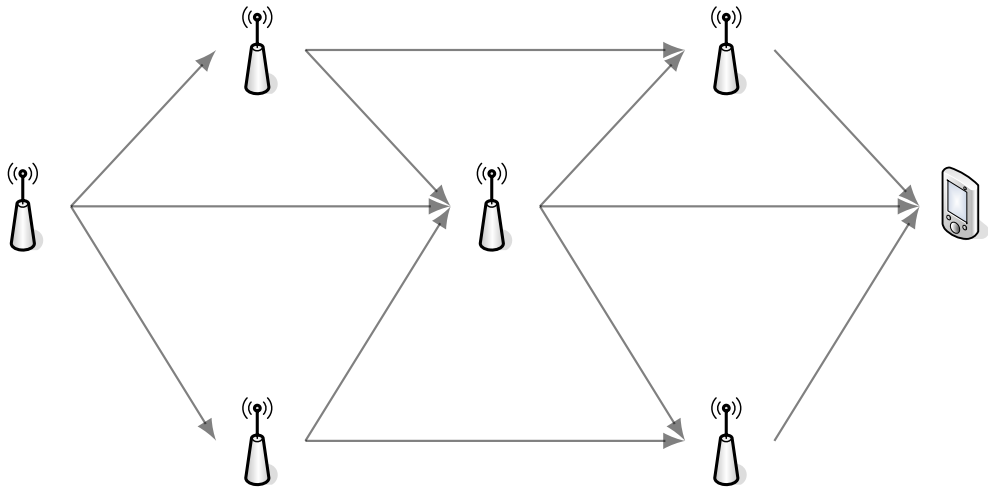

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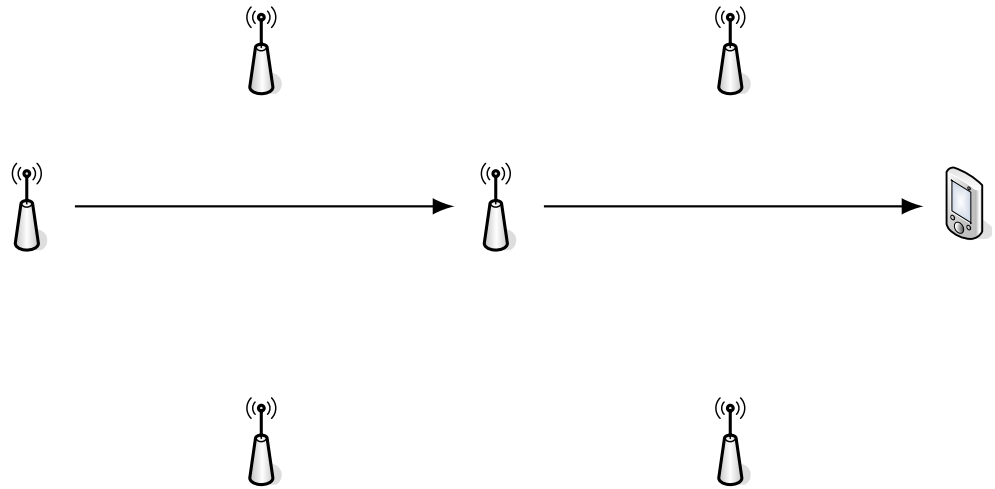

LEACH

Clustering-based protocol that minimizes energy dissipation in sensor networks.

Phases

1. **set-up phase**
   - chose clusterhead (*random number n between 0 and 1 if* $n < T(n)$)
   - determin membership for cluster
   - inform cluster of membership
2. **steady phase** send and receive data

SPIN

Sensor nodes operate more efficiently and conserve energy by sending data that describes the sensor data instaed of sending the whole data.