A Novel Threshold-Based Transmission Control Scheme for WSNs

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1. Introduction

- Energy
  - WSNs are designated to collect data even in challenging scenarios where energy supply is the most critical issue
  - Energy efficient routing schemes are necessary to increase the lifetime of a network (source vs. table driven routing)
  - But most test results are based on theoretical models (like energy consumption per transmitted bit)
- Research basis
  - “low energy adaptive clustering hierarchy protocol” (LEACH)
  - “threshold sensitive energy efficient sensor network protocol” (TEEN)
- We present an extension of the TEEN protocol verified by simulations based on a more realistic energy model derived from measurements

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2. TEEN Protocol (1/2)

- Cluster-based, reactive routing protocol
- Based on two threshold values that trigger if a node becomes active or not
  - **Hard threshold:** If the measured attribute is beyond this threshold, the node transceiver is turned on
  - **Soft threshold:** Describes the necessary difference between two measurements so that the transceiver gets turned on
- WSNs would have to change their soft threshold value based on facts like daylight or season of the year
- Every time new cluster heads get selected, the threshold values can change

2. TEEN Protocol (2/2)

- **Advantage**
  - Reduces the amount of data that needs to be transmitted
- **Disadvantage**
  - Frequent variations of the measured values lead to numerous threshold changes
  - Increasing the soft threshold value would solve that issue
  - However, risk of missing a sensor using up all its energy and going down

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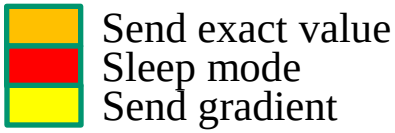
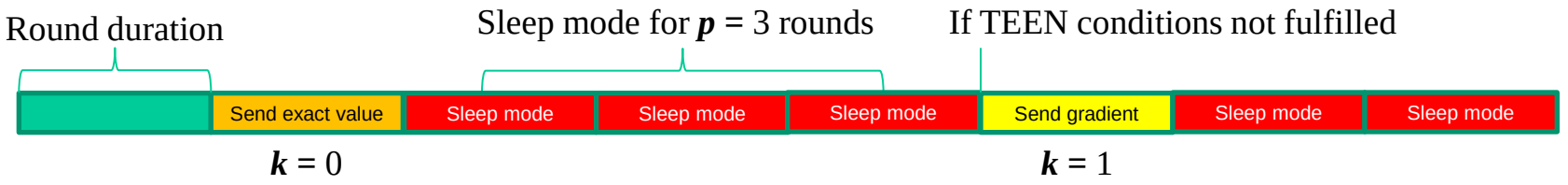
3. Event-Driven TEEN (ED-TEEN) Protocol

- Extension of TEEN with three additional node states

- New behavior after sending an exact value according to “basic” TEEN
  1. Node sleeps for ***p*** rounds
  2. Node sends only the gradient of the measured attribute
     - To let base station know that node is still alive
  3. If a node has to send no data packet for ***k*** times, it will turn its transceiver off for ***m*** rounds





3. Event-Driven TEEN (ED-TEEN) Protocol

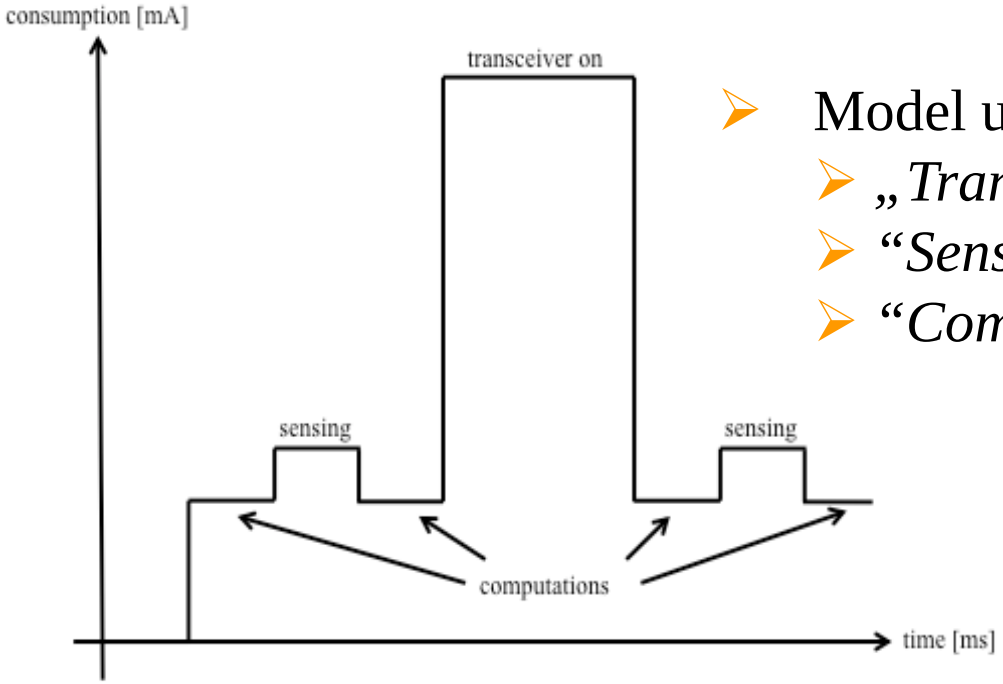
- Significant reduction of the power consumption in a WSN
- Our research is based on the temperature sensor value (16bit) of a Crossbow IRIS node
- Submitting a single flag (1bit) reduces the on-time of the transceiver
- Measurements without significant changes allow the transceiver to stay in sleep mode for a certain amount of rounds
- An additional TDMA scheme synchronizes all nodes in a cluster (like in LEACH)

3.1 Restructuring of the TEEN protocol

- Instead of picking new cluster heads every round, we determine new cluster heads every ***n*** (***n*** ≥ ***m***) rounds
- Cluster heads are not allowed to sleep
- The optimal choice of ***k, m*** and ***p*** depends on the desired application
  - If ***m*** and ***p*** are too large and ***k*** is too small: network looses its accuracy and important information can get lost
  - If ***m*** and ***p*** are too small and ***k*** is too large: advantage to TEEN gets lost

3.2 Energy Model

- Instead of using theoretical values from a datasheet, we derived a more realistic and precise energy model based on measurements



- Model uses three different energy states
  - „*Transceive*“
  - “*Sensing*”
  - “*Computing*”

***Figure 1**:* Model of energy consumption

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4. Results and Characteristics of ED-TEEN (1/2)

- Simulation is done with network simulator “NS2“ (Version 2.34)
- Simulation compares TEEN with ED-TEEN
  - We allow nodes to sleep for one period *(m=1)*
  - If they did not have to become active the last four periods *(k=4)*
- WSN with 100 nodes and 5 cluster heads
- Deployment area of 100 x 100 meter
- Nodes will only send a flag containing the gradient after three rounds *(p=3)*

4. Results and Characteristics of ED-TEEN (2/2)

- Performance evaluation between TEEN and ED-TEEN

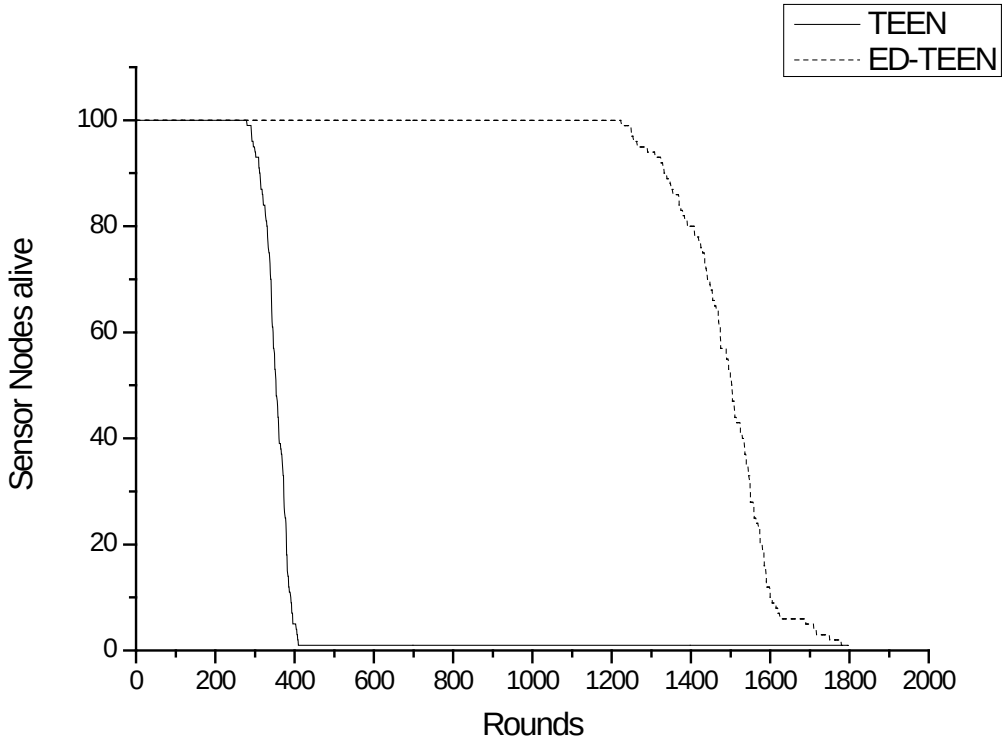

Figure 2: Comparison of network lifetime

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5. Conclusions and Future Work

- Conclusion
  - We presented an extension of the TEEN protocol verified by simulations based on a realistic energy model derived from measurements
  - In certain scenarios, ED-TEEN is significantly more efficient than TEEN
    - If the measured attribute has no significant changes
    - If p, k and m are chosen with respect to the application
- Future Work
  - More detailed energy model for a WSN's behavior
  - Energy consumption of executing computations and sensing processes on a sensor will be studied

Thank You for your attention!

Questions?