Issues with State-based Energy Consumption Modelling

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State-based Energy Consumption Model

- State 1, e.g., receiving
- State 2, e.g., active idle
- State 3, e.g., power saving
- State 4, e.g., active idle
- State 5, e.g., transmitting

Current vs. Time Graph:
- \( T_1 \) for state 1
- \( T_2 \) for state 2
- \( T_3 \) for state 3
- \( T_4 \) for state 4
- \( T_5 \) for state 5

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Current Draw of a Sensor Node

S-MAC Trace (obtained with SNMD)
3 States Model for Sensor Node Energy Consumption

![Graph showing energy consumption in three states: SLEEP, RECEIVE, and TRANSMIT. The graph illustrates current (mA) over time (ms).]
Measured vs. Estimated Energy Consumption
Current modelling by 3 States Model with State Transitions
Absolute Mean Estimation Error vs. Traffic Rate

- Three States Model - **example measurement parameters**
- Three States Model - **OLS estimator parameters**
- Three States Model w. Transceiver Switches - **OLS estimator parameters**
Simplified IEEE 802.11 State Diagram

- TX
- RX
- IDLE
- SLEEP
- INIT (DISCONNECTED)
IEEE 802.11 Network Card Power Consumption with Power Management
States Transition Power Consumption Pattern with Power Saving: Connecting
States Transition Power Consumption Pattern with Power Saving: End Transmission/Reception
Discussion and Conclusions

> Presentation of energy measurements from previous work in wireless sensor / local area networks.

> Observations

1. Energy consumption during state transitions can significantly differ from previous and subsequent states.
2. During active states (e.g., transmitting, receiving, active idle/connected without traffic) energy consumption can vary dependent on current traffic. This includes reception of control messages, e.g., IEEE 802.11 beacons.

> For accurate evaluation of energy consumption in either software-based energy estimation or simulation, where state-based energy consumption models have been applied previously:

1. More accurate modelling of state transitions and dynamic fluctuations, e.g., by considering state transition behaviour.
2. Further improvements by considering other parameters such as number/size of received/transmitted data/control messages.
Thanks for Your Attention!

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