Power Management for Acoustic Underwater Networks

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Research Questions

- What are the efficient approaches to saving energy in sparse underwater acoustic networks with the minimum possible degradation of network performance?
- What impact does traffic load have on the power management scheme in underwater acoustic networks?

Power Management Approach

- Our scheme combines an asynchronous approach, where nodes work on their own wake up schedules without synchronized clocks, with an on-demand scheme where two acoustic modem are used.
- It uses a low power acoustic modem emitting beacons periodically to search for contacts within its neighborhood and remaining in sleep mode for the rest of the time.
- A high power acoustic modem remains in sleep mode until there is data ready to be delivered or received from another node.
- Once data exchange has taken place the high power acoustic modem once again enters the sleep mode.
- The high and the low power acoustic modems properties are shown in Fig. 3.
- Two alternative operations are considered in this scheme: neighbor discovery in which a node wakes up to search about neighbor nodes for data forwarding, and data delivery in which data is exchanged among nodes.

Fig. 3 denotes a scenario when node A and node B are both still in their active beacon periods and start to exchange data.

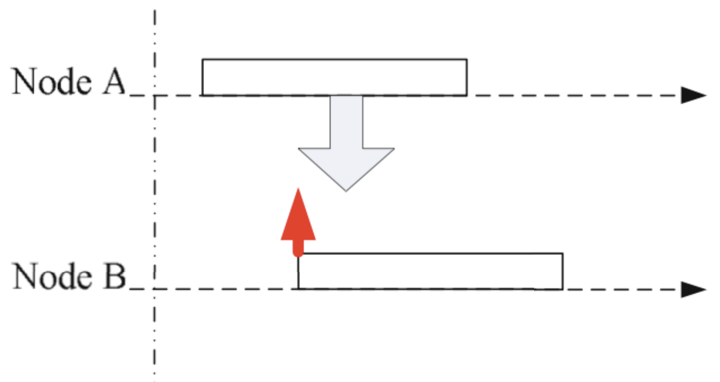

Fig.1 Data Delivery

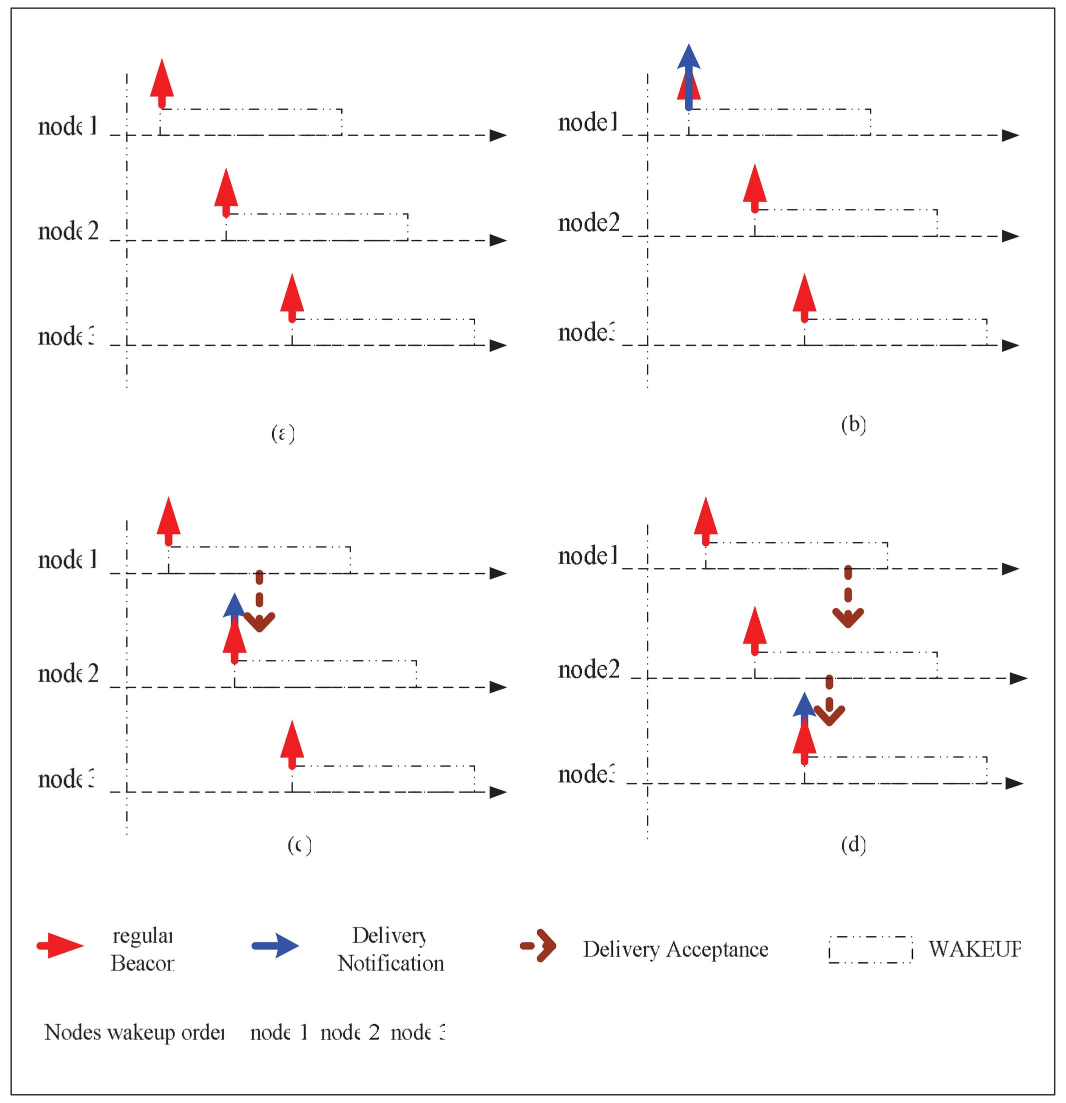

Fig.2 Neighbor Discovery [1]

Each node periodically wakes up for a period W in a fixed duty cycle of length C as shown in Fig. 2. Each time a node wakes up it transmits a beacon containing it's node identifier. In case the node has data available for delivery it piggybacks a delivery notification to the discovery beacon message.

Name	Tx Power	Rx Power	Type	Data Rate
WHOI	50 Watt	3 Watt	High Power	5600 bps
WHOI	10 Watt	80 mWatt	Low Power	80 bps

Fig.3 Properties of the WHOI modems[1]

Evaluation

This scheme is being implemented and evaluated by simulation in the ns2 simulator. We will investigate the impact of our power management scheme on the delivery ratio and the delivery delay under different traffic loads.

Evaluation Metrics:

- Delivery Ratio
- Delivery Delay
- Energy Cost
- Node Lifetime

Preliminary Results

We simulated a network consisting of 8 underwater nodes transmitting beacons of 4 and then 8 bytes. The nodes are distributed randomly such that the maximum distance between any of the nodes is 1 km. For our simulation the nodes are kept stationary. In order to achieve an indication of whether a high power or low power modem is suitable to a certain task, we set up the nodes to transmit beacons with a time period of one second and 50% duty cycle.

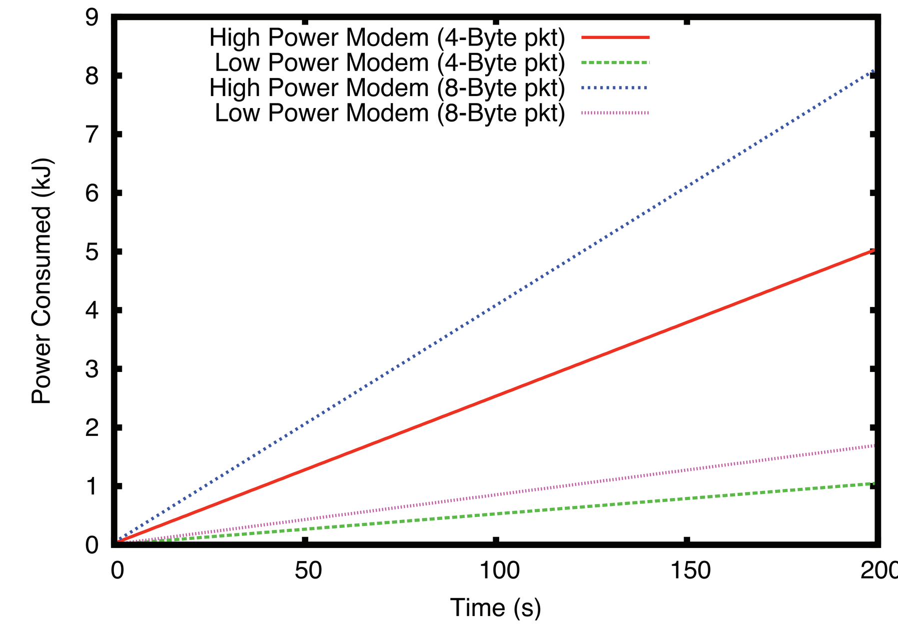

Fig.4 Total power consumed by a single node to transmit and receive beacons

Fig. 4 depicts the total power consumed by a single node in the network while the nodes are transmitting and receiving beacons in broadcast mode. It is clear from this graph that power utilization for the high power modem for sending and receiving beacons is magnitudes higher than that of the low power modem.

In Fig. 5 we use different data sizes in order to determine which modem would be appropriate to transmit data. As is clear in this graph, the high power modem consumes lesser power than the low power modem and this difference increases as the amount of data to be transmitted increases. Therefore, the high power modem is better for data exchanges.

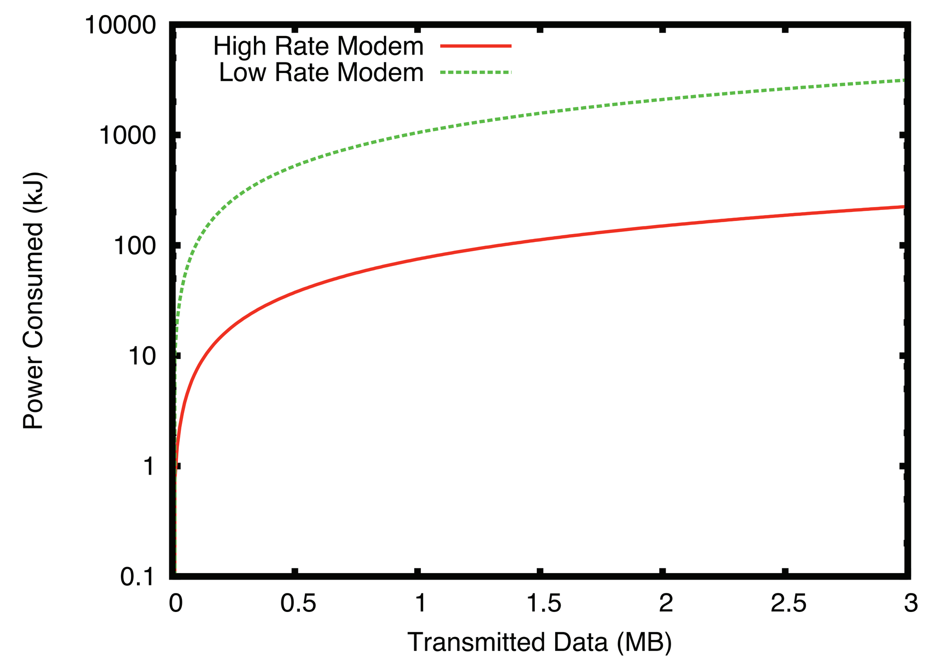

Fig.5 Power consumed to transmit data by a single node

Acknowledgment

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References

[1] A. Harris, M. Stojanovic, and M. Zorzi, "When underwater acoustic nodes should sleep with one eye open: idle-time power management in underwater sensor networks," in WUWNet 06: Proceedings of the 1st ACM international workshop on Underwater networks. New York, NY, USA: ACM, 2006, pp. 105108.

[2] Y. Xi, M. Chuah, and K. Chang, "Performance Evaluation of a Power Management Scheme for DTNs," Mobile Netw. Appl., vol. 12, no. 5, pp. 370380, 2007.

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