**Abstract:**

The goal was to get information about each meter’s current status to a central office. The main task was to design and implement a communication protocol, including packet formats and handling of errors and failures, to report monitoring information from the parking meters. The SAFE (Synchronized Adaptive-Forwarding Efficient) Routing Protocol is an on-demand routing protocol that takes into account the highly variable nature of wireless networks and allows the customer to decide on the best trade-off between energy efficiency and reliability.

SAFE (Synchronized Adaptive-Forwarding Efficient) Routing Protocol:

- Finds the most efficient path to the current head meter, represented by the choice of the next meter in that path to the head meter.
- Schedules a data packet to be transmitted before the time scheduled by the next hop determined in (i).
- Collects data sent by other meters, adds this information to the meter’s own data packet, and forwards this packet to the next meter at the scheduled time as determined in (ii).

Routing Table:

- Each meter maintains an on-demand routing table which contains information for each meter within transmission range (a neighbor).

### Adaptive-Forwarding and Data Fusion:

- Allows for the possibility of the same data traversing multiple paths simultaneously to reach a given destination in order to improve the probability of the data reaching the central station.
- If a meter receives a packet in which it was named as the destination, it will add the information to its own data packet and send that data packet at its scheduled time (fixed path).
- If any meter, y, overhears the information from another meter, x, where y was not the targeted destination of the information, meter y will choose to add meter x’s data to its own packet (if it has not yet sent its data packet) with probability $P_y$ determined by the central station.

To minimize the energy cost associated with the multiple paths, $P_y$ must be chosen so that it is higher for those meters whose information are most likely to be lost and lower for those meters who are more reliable.

**Experimental Results:**

**Best-Effort, Single-Path Routing:**

- Rate of data loss: 17.7%

**SAFE’s Probabilistic Multi-Path Routing:**

- Reliability threshold set to 90%, probabilities increased by an absolute value of 30% and decreased by an absolute value of 10%
- Rate of data loss: 2.0%