A Feedback-Based Power Control Algorithm Design for VANET

INFOCOM 2008 workshop

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Outline

- Introduction
- Problem definition
- Algorithm design
- Simulation
- Conclusions

Introduction

- Given the critical safety nature, the safety messages need to be delivered reliably and timely to a desired range
- If all messages were broadcast with enough power to cover 300 meters in the DSRC channels, messages loss rates caused by MAC collision is between 20% and 40%
- The aim of power control algorithm is to match the transmission power to the target communication range

Problem definition

- Vehicles are equipped with GPS
- Safety-related information
  - Speed
  - Position
  - Brake information
- For Cooperative Collision Warning application ,the message is broadcasted periodically
- The communication distance is designated in the V2V safety message, and is called the target range
- The goal of power control algorithm is to tune the transmission power so that safety messages can reach the target range without much excess

Algorithm design

- To adjust the transmission power level of safety messages based on feedback from other vehicles
- The information required for power control is piggybacked as a header on the safety messages
- The Target Range denotes the valid range up to which the application would like the message to be transmitted

ID	Position Data	Target Range	Feedback Beacon	Payload

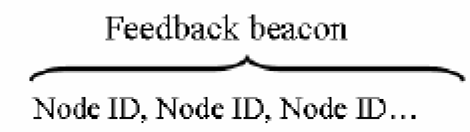


Figure 1. Packet format

Algorithm design

- When a message is received, the receiver node computes the relative distance between itself and the sender. If the relative distance is larger than the Target Range , the receiver node includes the sender ID in its speaker list
- When a node broadcasts, it chooses some of the node IDs from the speaker list, and assembles them to constitute the Feedback Beacon

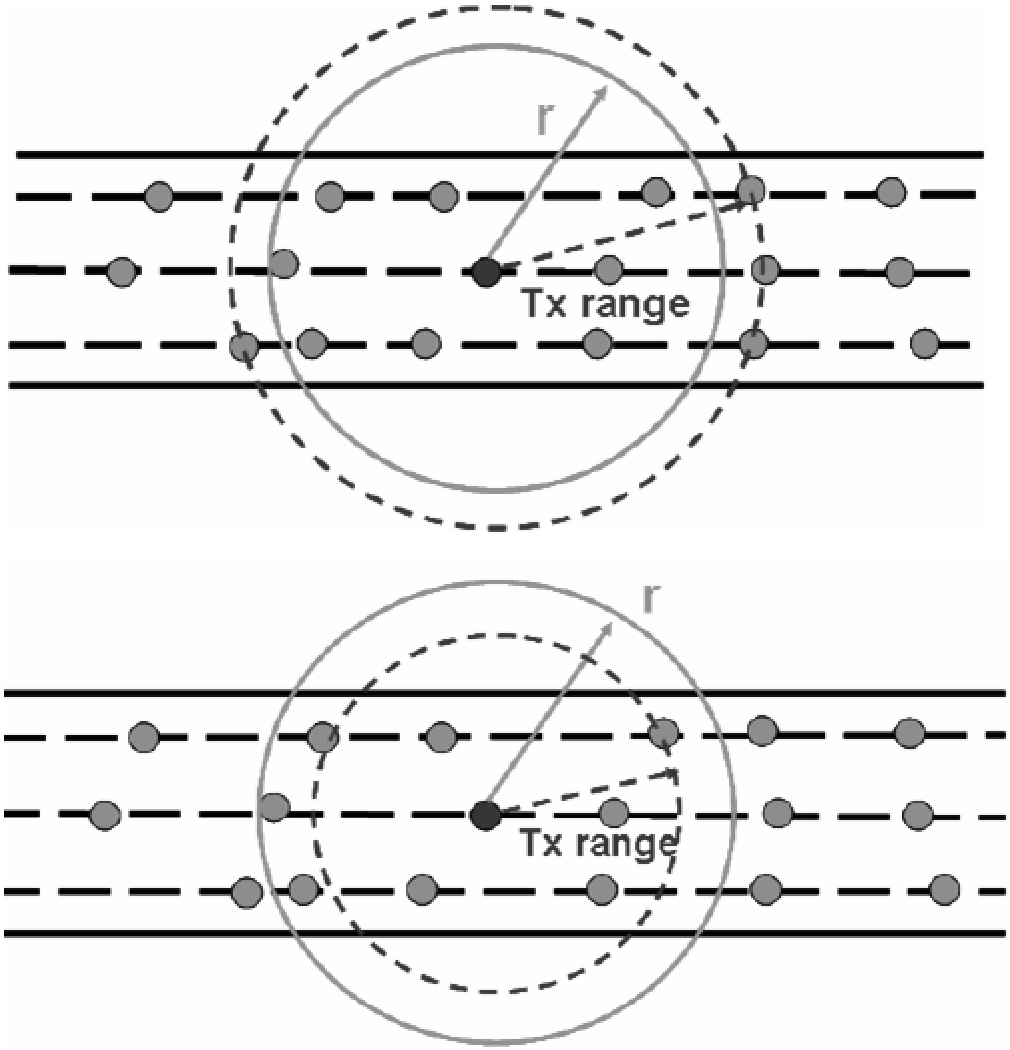
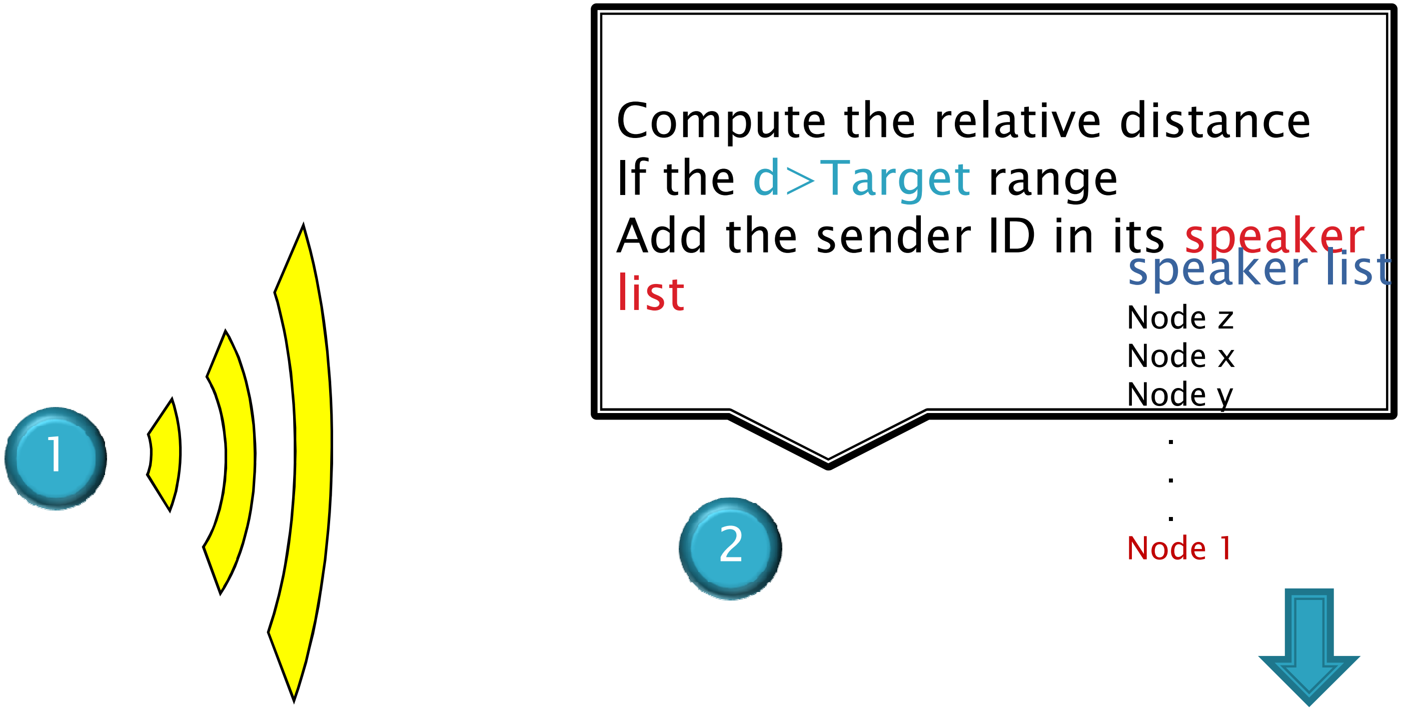


Figure 3. Demonstration of the algorithm



ID	Position Data	Target Range	Feedback Beacon	Payload

Feedback beacon

Node ID, Node ID, Node ID…

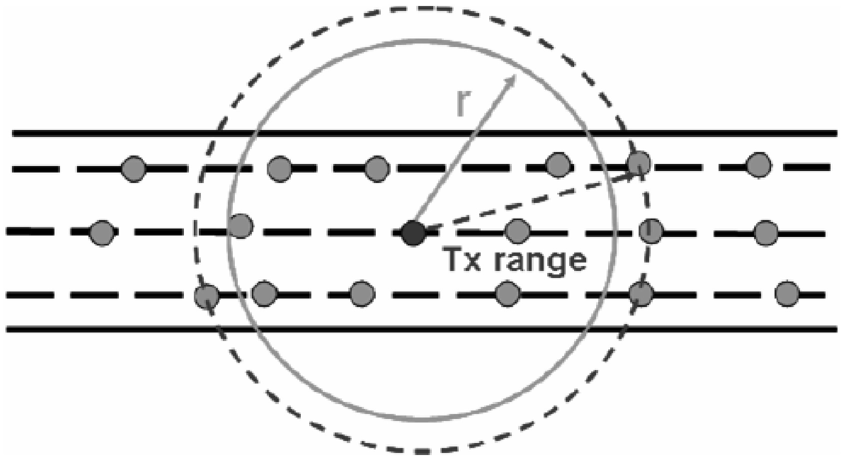
Power control algortithm

```
During the beacon time interval:
update the speaker list
search in the received beacons for ones own ID
        if ID is found
                counter++
At the end of the beacon time interval:
        if(counter>N)
                power level=power level-delta
        else
                power level=power level+delta
        if(power level>MAX)
                power level=MAX_POWER
        if(power level<MIN)
                power level=MIN_POWER
        counter=0
        clear the speaker list
```

Figure 2. Pesudo code of the power control algorithm

Scheme analysis

- The wireless channel is non-deterministic due to multi-path and other fading effects
- A good selection of N will result in selection of the required transmission power that yields and effective transmission range slightly larger than the required Target Range, with much chattering
- Size of Beacon



Simulation

Figure 4. Single node to single node transmission

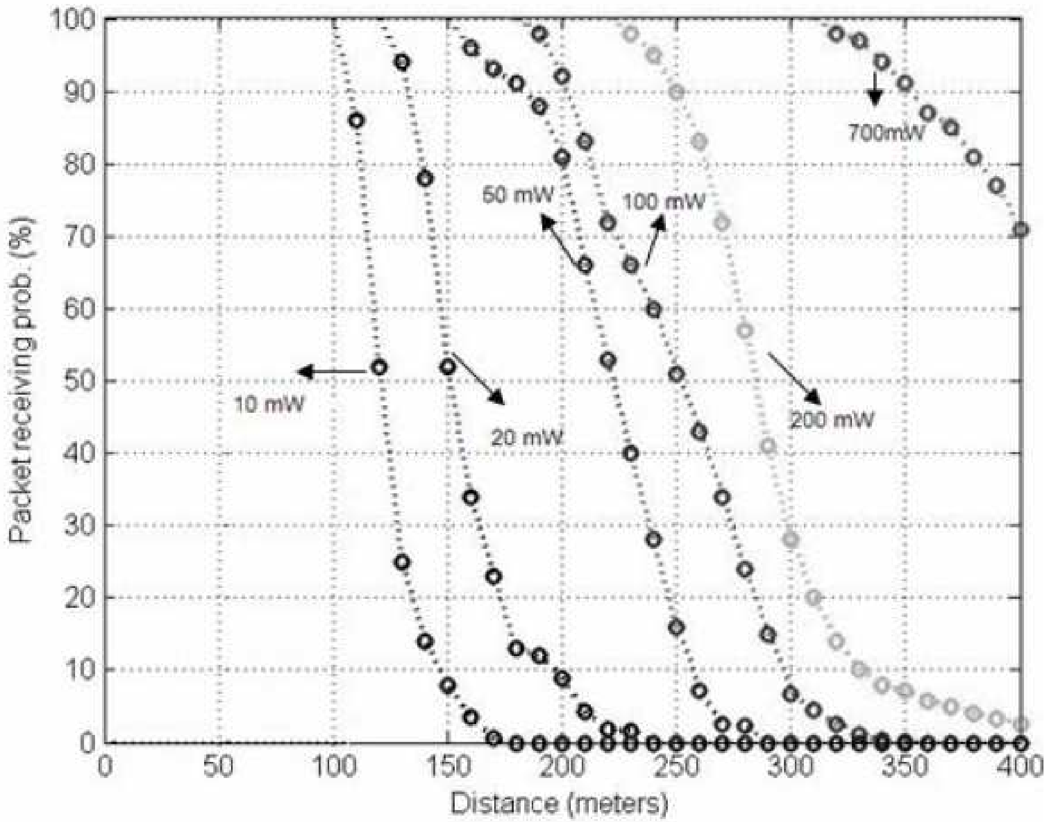


Figure 5. Packet receiving prob. vs. Tx power

TABLE I. SIMULATION PARAMETERS

Lanes	4
lane length	1600m
average spacings	17.0m
average speed	11.6m/s
traffic flow	1920vph/lane
receiver sensitivity	-87dBm
data rate	6Mbps
payload size	300 bytes

TABLE II. POWER CONTROL ALGORITHM PARAMETERS

maximum transmission power	1W
minimum transmission power	10mW
N	5
delta power	10mW
Feedback beacon size	60 Bytes*

* The beacon at most contains ten nodes ID. Each node ID is its MAC address of 6 bytes.

TABLE III. PACKET LOSS RATE IN DIFFERENT SCHEMES

message sending interval(ms)	packet loss rate using power control (%)	packet loss rate using optimal operating power (%)	packet loss rate using maximum power of 700mW (%)
500	1.33	1.11	1.38
300	2.71	1.99	4.10
200	3.92	2.59	9.61
100	20.5	6.70	45.1
50	61.3	13.0	78.0

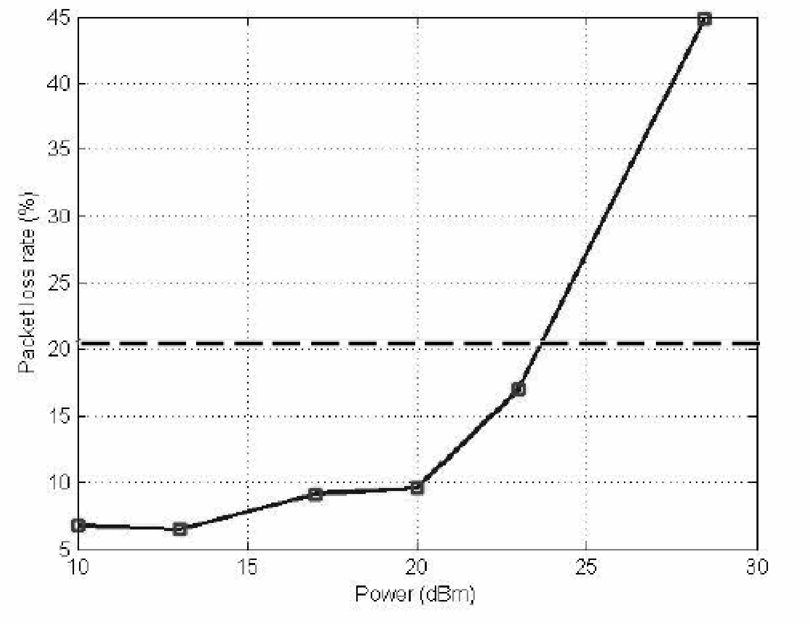


Figure 6. Packet loss rate vs. power level (packet sending interval=100ms)

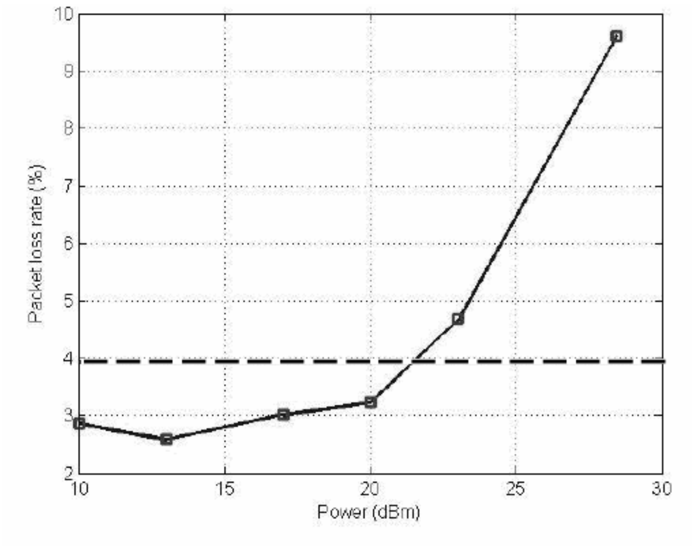


Figure 7. Packet loss rate vs. power level (packet sending interval=200ms)

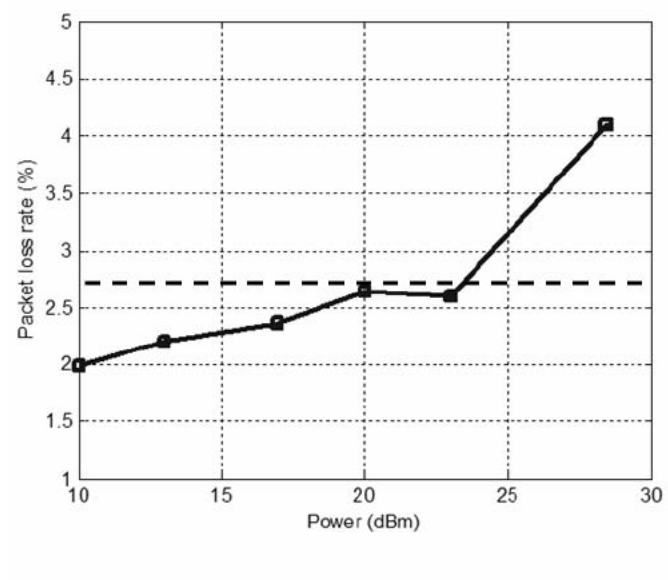


Figure 8. Packet loss rate vs. power level (packet sending interval=300ms)

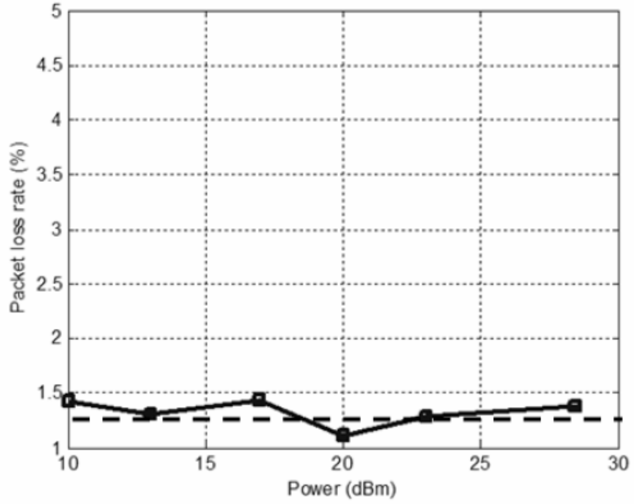


Figure 9. Packet loss rate vs. power level (packet sending interval=500ms)

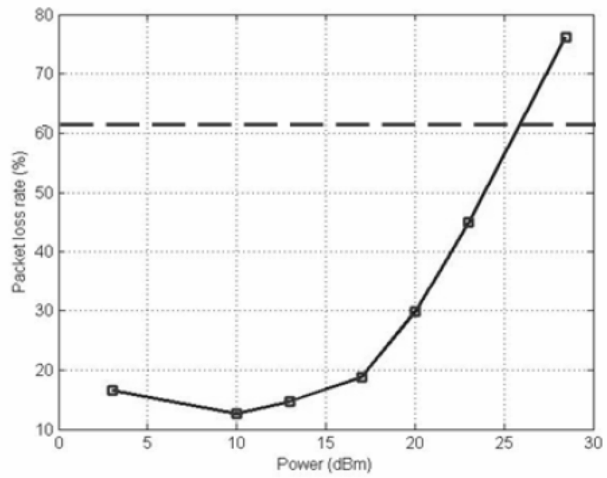


Figure 10. Packet loss rate vs. power level (message sending interval=50ms)

Conclusions

- We have developed a power control algorithm and protocol to determine the transmission power for reliable vehicle safety communication
- We find that the more the data traffic loads on the channel , the greater the potential for improvement to our current design