ACM: A Transmission Mechanism for Urgent Sensor Information

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Wireless Sensor Networks as a Social Infrastructure

- Sensor nodes are deployed in a region to monitor to collect environmental information
- Sensor nodes have limited computational capabilities and power resources
- Carry various types of information
  - Security, disaster, weather, health, ...
- Based on unstable radio communications
- Need to transmit urgent information with higher reliability and lower latency


→ differentiated and prioritized services

Overview of the Mechanism

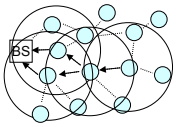
Application Layer	Disaster detection system etc.
Our mechanism	Assured Corridor Mechanism
Network Layer	Data gathering scheme Multihop routing + Sleep scheduling
MAC Layer	Contention based MAC

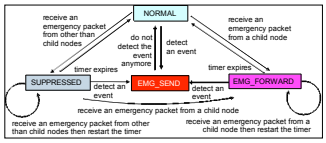
We focus on

- Packet loss by collisions in radio communication
- Delay by sleeping nodes

"Assured Corridor" Mechanism

- Keep surrounding nodes quiet
  - Avoid packet loss caused by collisions
- Keep forwarding nodes awake
  - Avoid delay caused by sleeping of forwarding nodes
- Incorporate hop-by-hop retrasmission

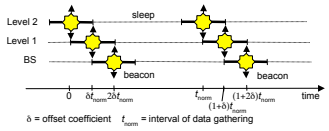


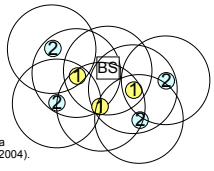


State transitions

Synchronization-based Data Gathering Scheme

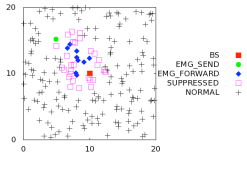
- Transmission is synchronized among nodes at the same hop-distance from the BS
  - Involve delay δt_{norm} per hop
  - Adopt pulse-coupled oscillator model for synchronization
- Sensor information propagates from the edge to the BS





[11] N. Wakamiya and M. Murata: "Scalable and robust scheme for data gathering in sensor networks", in Proc. of Bio-ADIT 2004, pp 412-427 (2004).

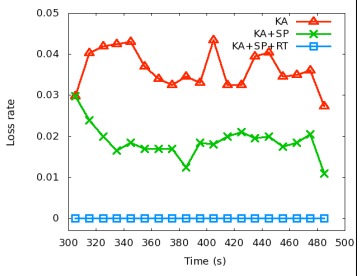
Simulation



- ns-2 with IEEE 802.15.4 MAC
- Parameter Settings
  - 200 nodes in 20 m x 20 m region
  - Transmission range R = 2.5 m
  - Interval of data gathering t_{norm} = 10 sec.
  - Offset coefficient δ = 0.1 δt_{norm} = 1 sec.
  - After 300 sec. for initialization, make a randomly chosen node move to *EMG_SEND* and get back to *NORMAL* state 180 sec. later. Terminated at 500 sec.
  - Interval of emergency packet transmission t_{emg} = 0.5 sec.
  - Maximum number of retransmission: 2
  - 100 simulations

Loss Rate of Emergency Packets

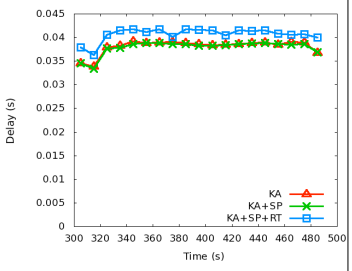
- Ratio of emergency packets which are not received by the BS
- Decreases by half in 30 seconds with suppression (KA+SP)
- 15% more packet transmisson with RT but no loss



KA keep awake
SP suppression of normal packets
RT retransmission

Delay of Emergency Packets

- End-to-end delay from an *EMG_SEND* node to the BS
- Improved by KA
  - compared to 1 sec. per hop for normal packets
- Slightly smaller with SP
  - due to less intense contention in MAC layer
- Larger with RT



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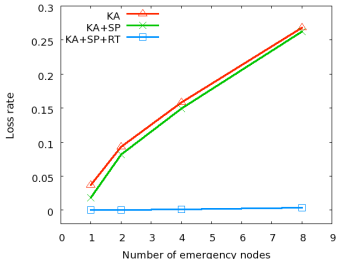
Loss Rate with multiple EMG_SEND Nodes

- Less contribution of SP with more *EMG_SEND* nodes
  - collisions among emergency packets in a corridor
- Less than 0.4% for 8 nodes with RT



KA keep awake
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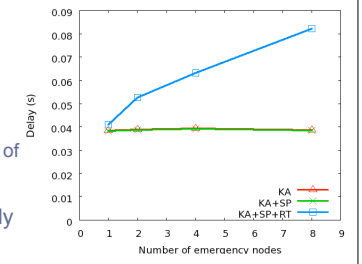
Delay with multiple EMG_SEND Nodes

- Almost constant in KA and KA+SP
  - Increse by contention with more emergency nodes balances with decrease by reduction of average hop count of delivered packets
- Increases proportionally in KA+SP+RT



KA keep awake
SP suppression of normal packets
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Conclusion

- We propose ACM for transmission of urgent sensor information
  - ACM establishes a preferential route in a fully-distributed and self-organizing manner
  - Surrounding nodes refrain from transmitting normal packets and forwarding nodes suspend sleeping
  - Emergency packets are forwarded preferentially in the corridor
- Simulation results show that emergency packets are transmitted with high reliability and low latency once a corridor is established

Future Work

- Introduce some techniques to control collisions among emergency packets and mitigate congestion in the event of a large emergency
- Construct a WSN architecture for urgent information transmission by integrating ACM and techniques stated above
- Implement our architecture onto off-the-shelf sensor nodes to prove its feasibility

Thank you