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Wireless Sensor Networks as a Social Infrastructure
Sensor nodes are deployed in a region to monitor and collect environmental information. Sensor nodes have limited computational capabilities and power resources. Carry various types of information, such as security, disaster, weather, health, etc. Based on unstable radio communications, need to transmit urgent information with higher reliability and lower latency. Differentiated and prioritized services.

Design Methodology

Objectives
- Reliability and latency
- Self-organizing and localized behavior
- Simplicity

Integration of simple mechanisms working in different topological and time levels.

UMIUSI Architecture

Application Layer
- Disaster detection system etc.

UMIUSI
- uTonous Mechanisms Integrated for Urgent Sensor Information

Network Layer
- Data gathering scheme
- Multi-hop routing + Sleep scheduling

MAC Layer
- Contention based MAC

UMIUSI Architecture (contd.)

Three classes of sensor information:
- Normal
  - Non-urgent information
- Important
  - Urgent but tolerate loss and delay when the network is congested
- Critical
  - Most important information

Assured Corridor” Mechanism (ACM)

Keep surrounding nodes quiet
- Avoid packet loss caused by collisions

Keep forwarding nodes awake
- Avoid delay caused by sleeping of forwarding nodes

State transitions:
**Contribution of Mechanisms**

- Small scale emergency
  - It takes a while for ACM to take effect
  - Priority queueing and rate control do not help much

- Large scale emergency
  - ACM does not work since collisions occur among emergency packets
  - Rate control is effective to mitigate congestion

**Loss Rate in a Small Scale Emergency**

- One critical class EMG_SEND node sends 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 transmission with RT but no loss

**Loss Rate in a Large Scale Emergency**

- Four critical class and 28 important class EMG_SEND nodes send emergency packets simultaneously
- SP does not help
- RT takes immediate effect
- RC comes into effect in 50 seconds

**Delay in a Small Scale Emergency**

- End-to-end delay from an EMG_SEND node to the BS
- Much smaller than in normal state by KA
- Slightly smaller with SP
due to less intense contention in MAC layer
- Larger with RT

**Delay in a Large Scale Emergency**

- Delay is smallest in KA and KA+SP
- No retransmission involved
- Delay rises in 30 seconds with RT
due to collisions
- Smaller for critical class thanks to scheduled retransmission
- RC decreases the delay
  - Fewer retransmission and backlog in MAC

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**Simulation**

- ms-2 with synchronization-based data gathering scheme [5] and IEEE 802.15.4 MAC
- Parameter Settings
  - 200 nodes in 20 m x 20 m region
  - Transmission range $R = 2.5$ m
  - After 300 sec. for initialization, make randomly chosen nodes 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

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Conclusion

We propose a design methodology of a sensor network architecture supporting differentiated and prioritized services for urgent information.

- Several simple mechanisms working in different time and topological ranges are integrated to adapt to the scale of emergency.

We propose UMIUSI architecture.

- Sensor information is classified into three classes and five mechanisms collaborate to prioritize urgent information.

Simulation results show that UMIUSI successfully improved the delivery ratio and the delay of emergency packets independently of the scale of emergency.