
Wireless Sensor Networks for Equipment Fault Diagnosis in Process Industry

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Background- *Equipment Fault Diagnosis in Process Industry*



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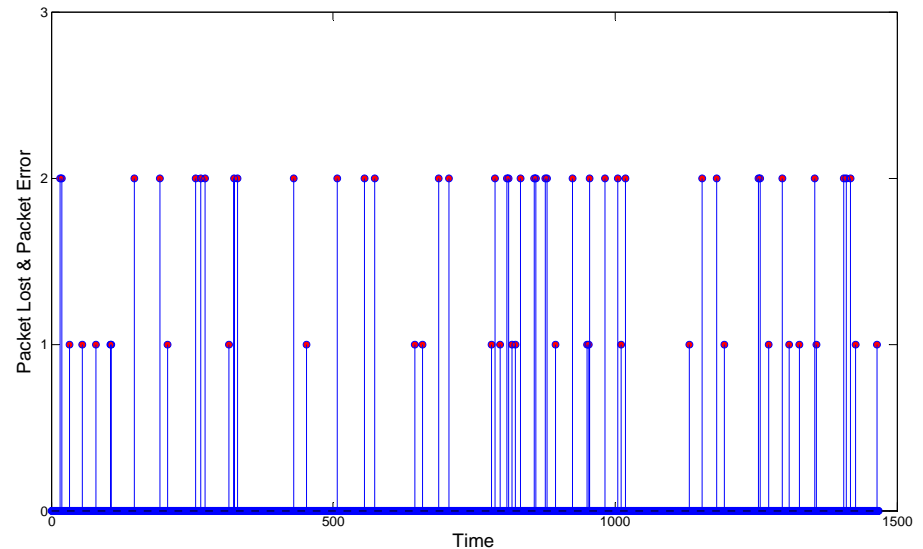
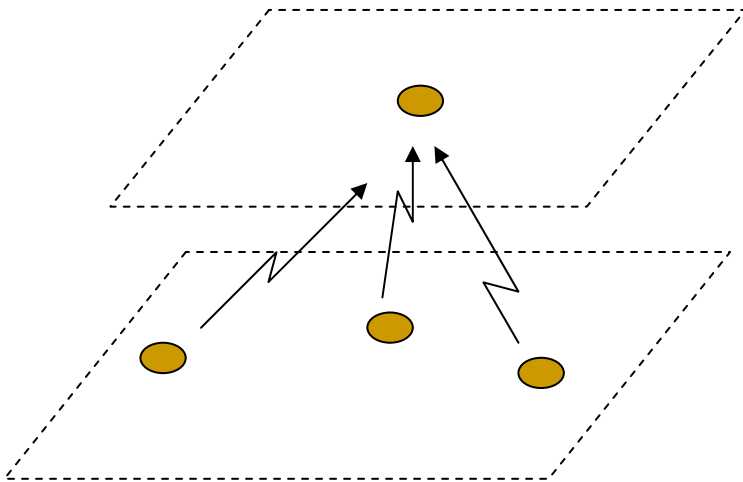
Background- *Equipment Fault Diagnosis in Process Industry*



- 350 rollers;
- an area of a $200 \times 15 \times 30$ meters space, including underground space.
- about 700 bearing monitoring points, each point corresponds to one end of a roller.

Background- *Real Field Characteristics*

- 1. Monitoring points are featured with placement constraints, static and uneven distribution.** The horizontal distribution is dense, usually 0.5~2m distance between two points, and in the extreme case the distance is 20~30cm. The vertical distribution is sparse, i.e. 10-20m between two nodes.
- 2. Communication environment is very tough.**
- 3. Sensor nodes on the monitoring points are difficult to install and maintain.**
- 4. Most of the sensor values are suitable for periodical collection.**



Packet drop rate is more than 10%

Background- *Design Consideration*

Reliable

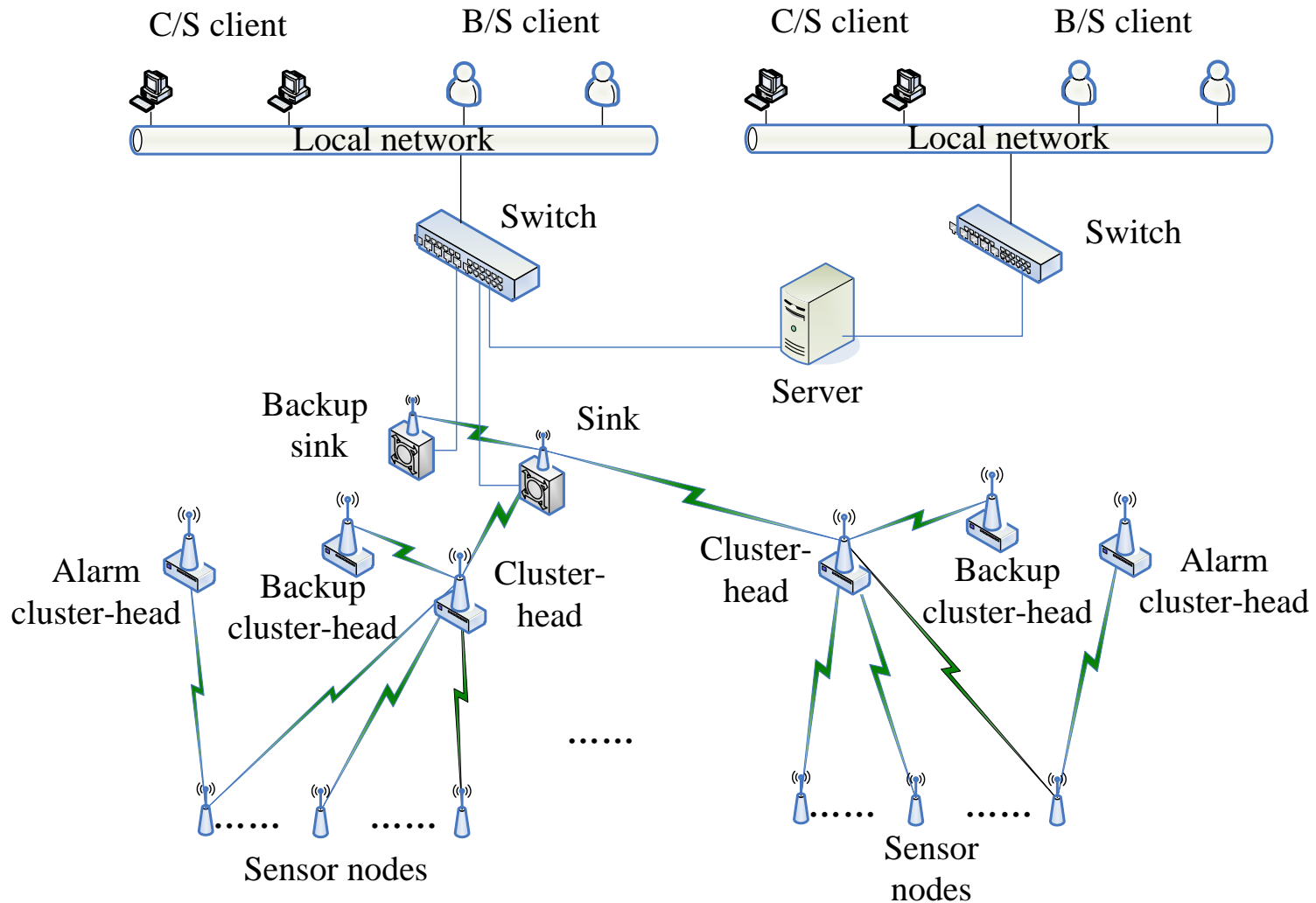
$$\Theta \in [0, 2],$$

$$\Phi > 99\%.$$

Energy efficient

Lifetime should be longer than maintenance period ,i.e. one year

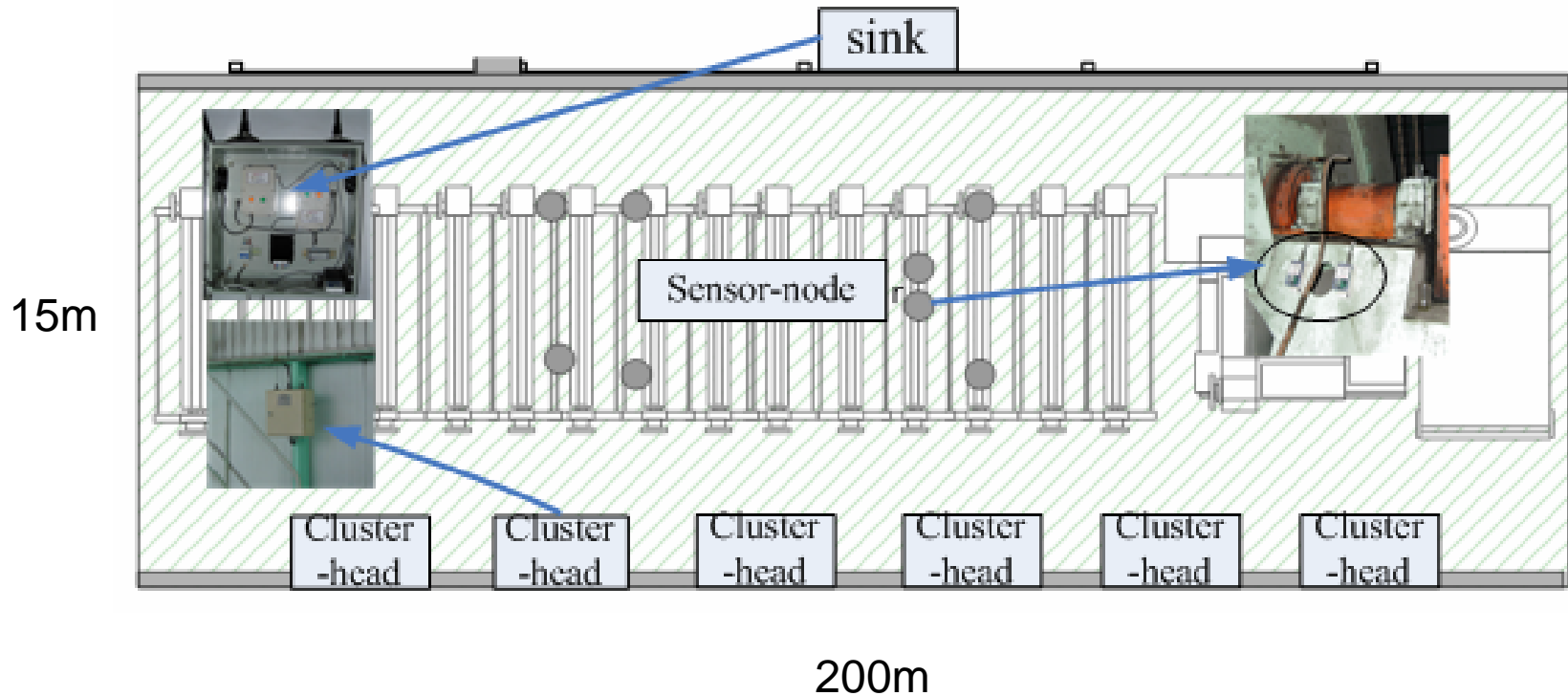
System Overview - System Architecture



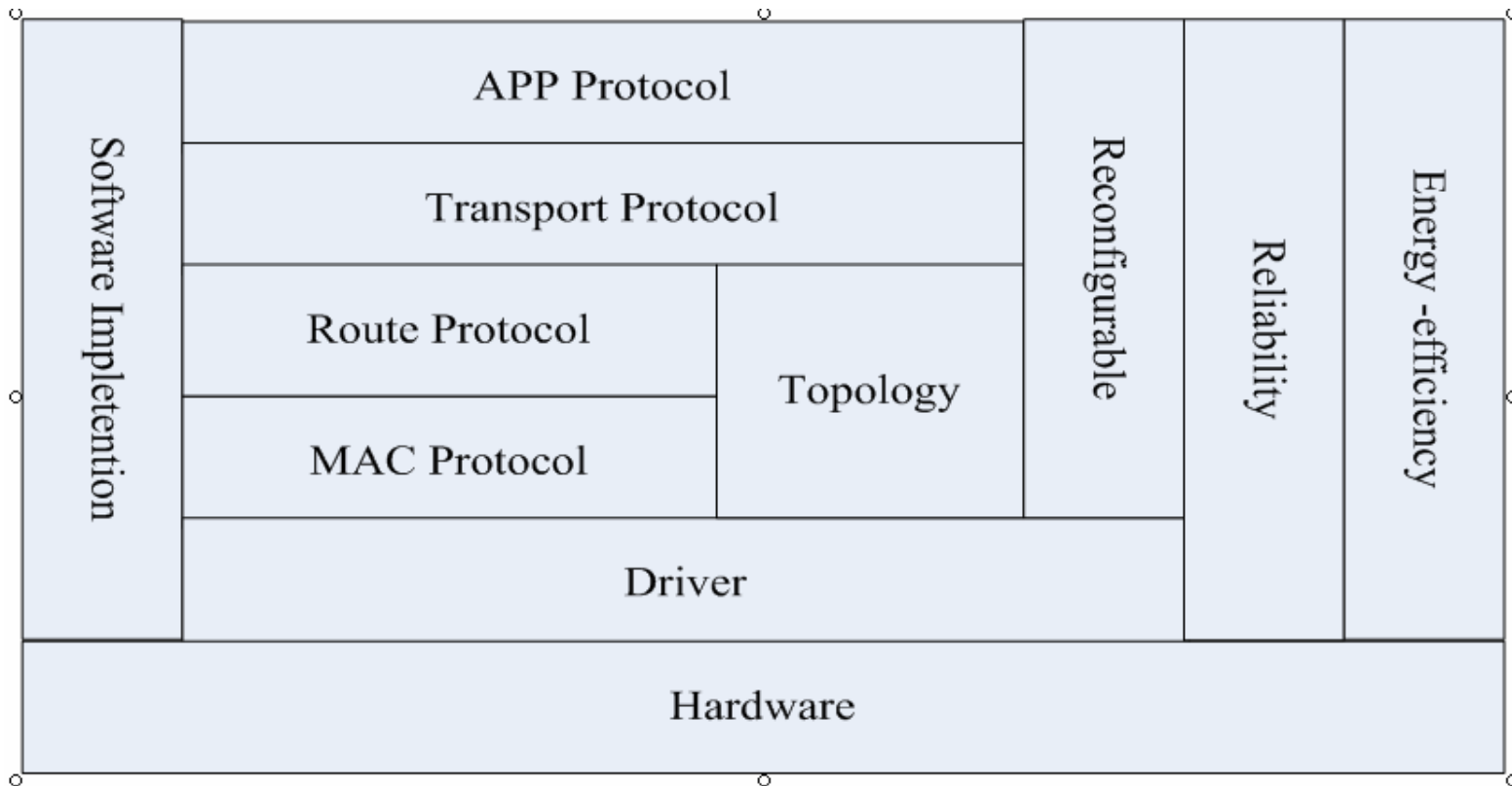
System Overview -Node



System Overview -Deployment

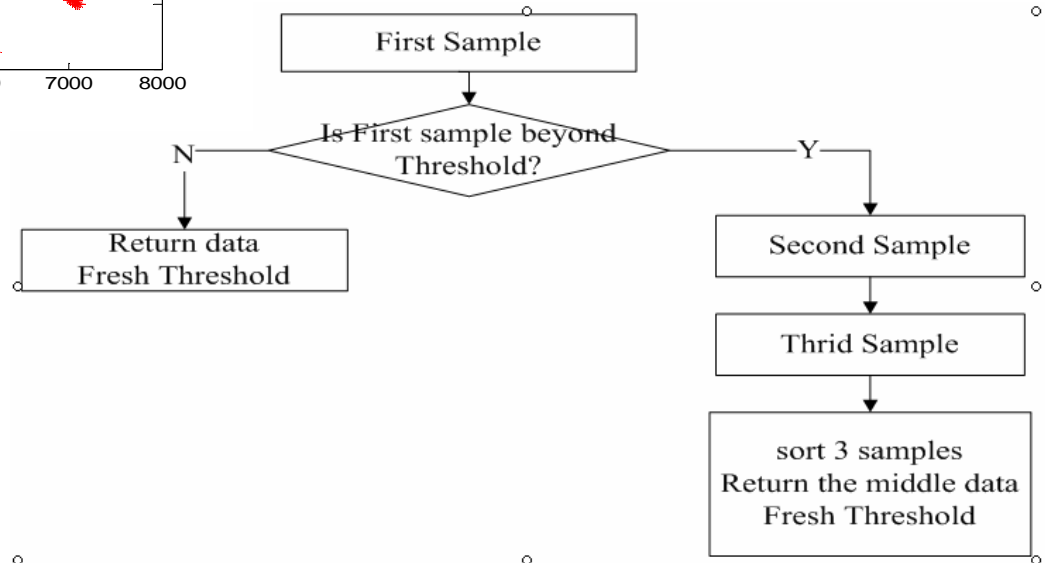
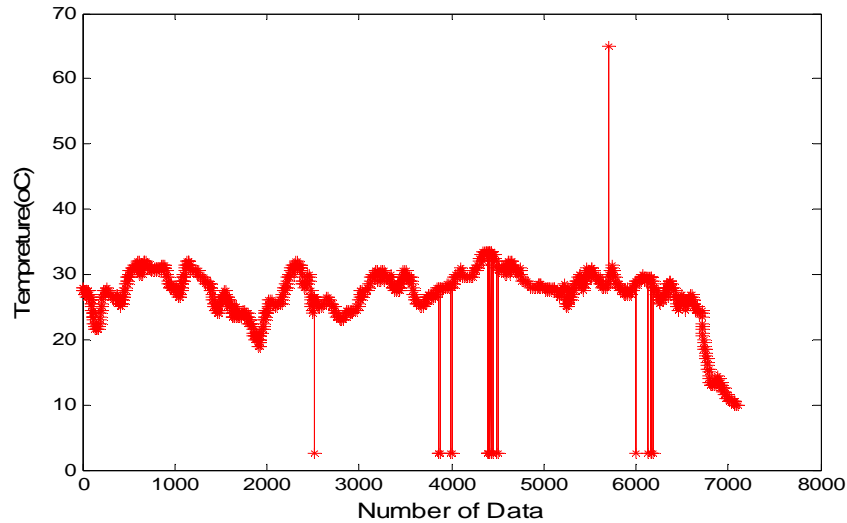


System Overview – System Design Consideration



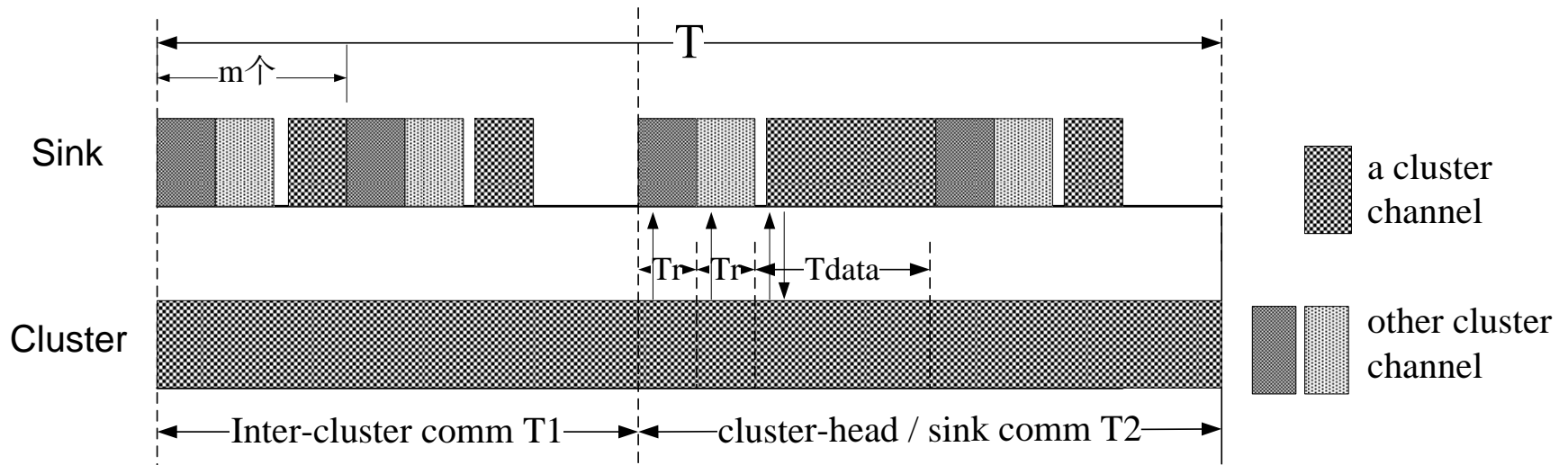
DRE : Design for Reliability & Energy-efficiency

-- Reliability & Energy-efficiency in Data Sensing



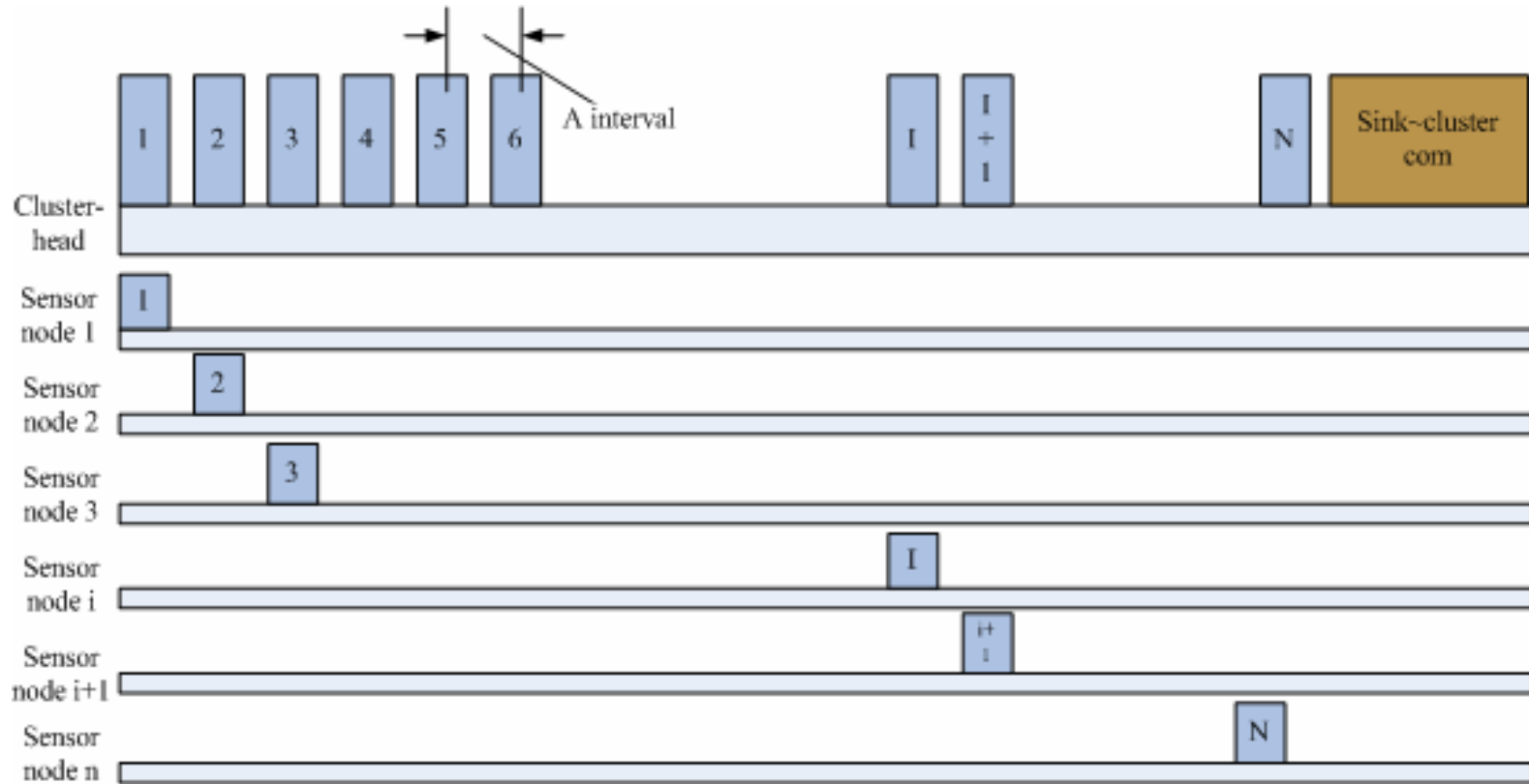
DRE : Design for Reliability & Energy-efficiency

-- Reliability & Energy-efficiency in Networking



DRE : Design for Reliability & Energy-efficiency

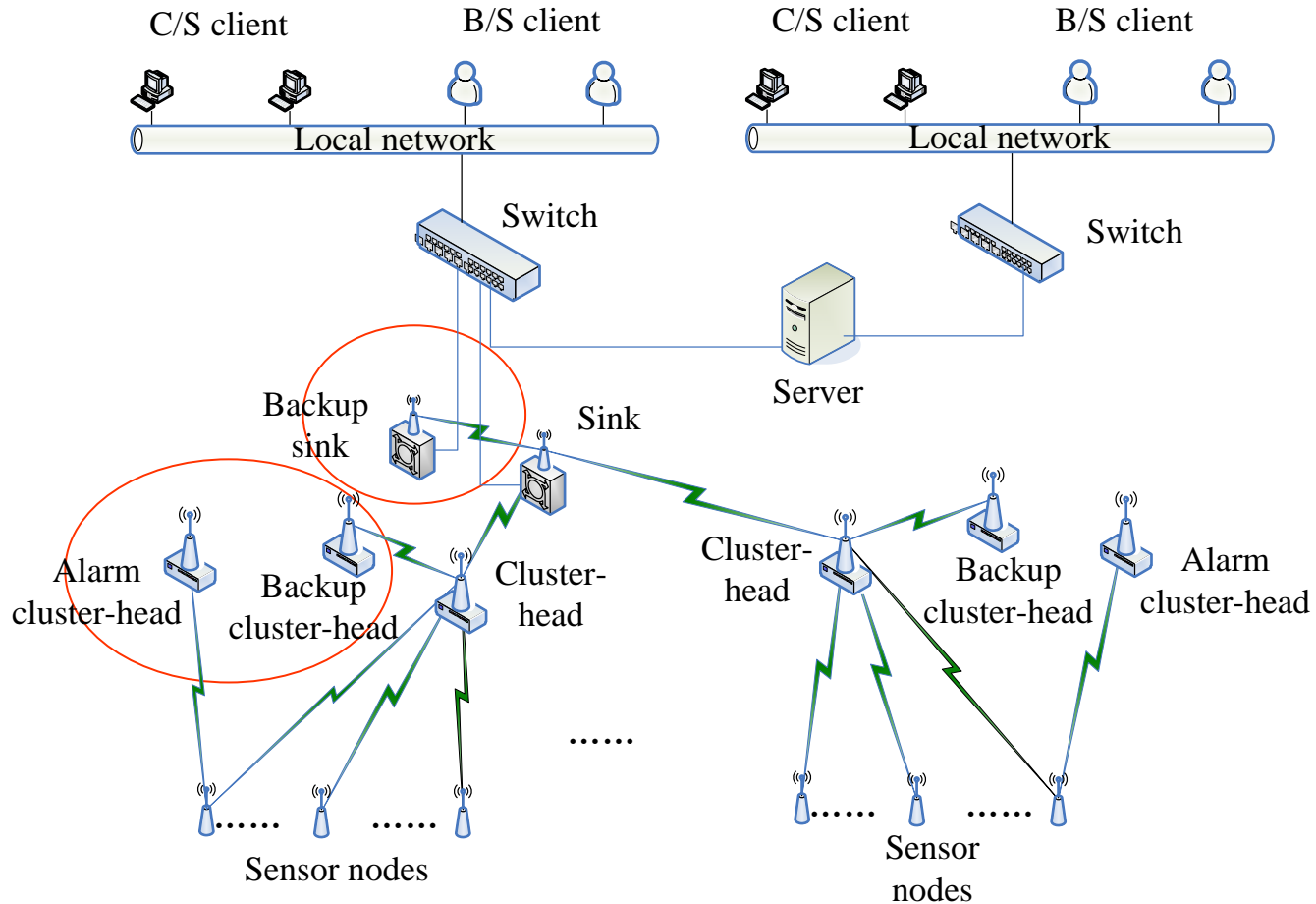
-- Reliability & Energy-efficiency in Networking (cont.)



DRE : Design for Reliability & Energy-efficiency

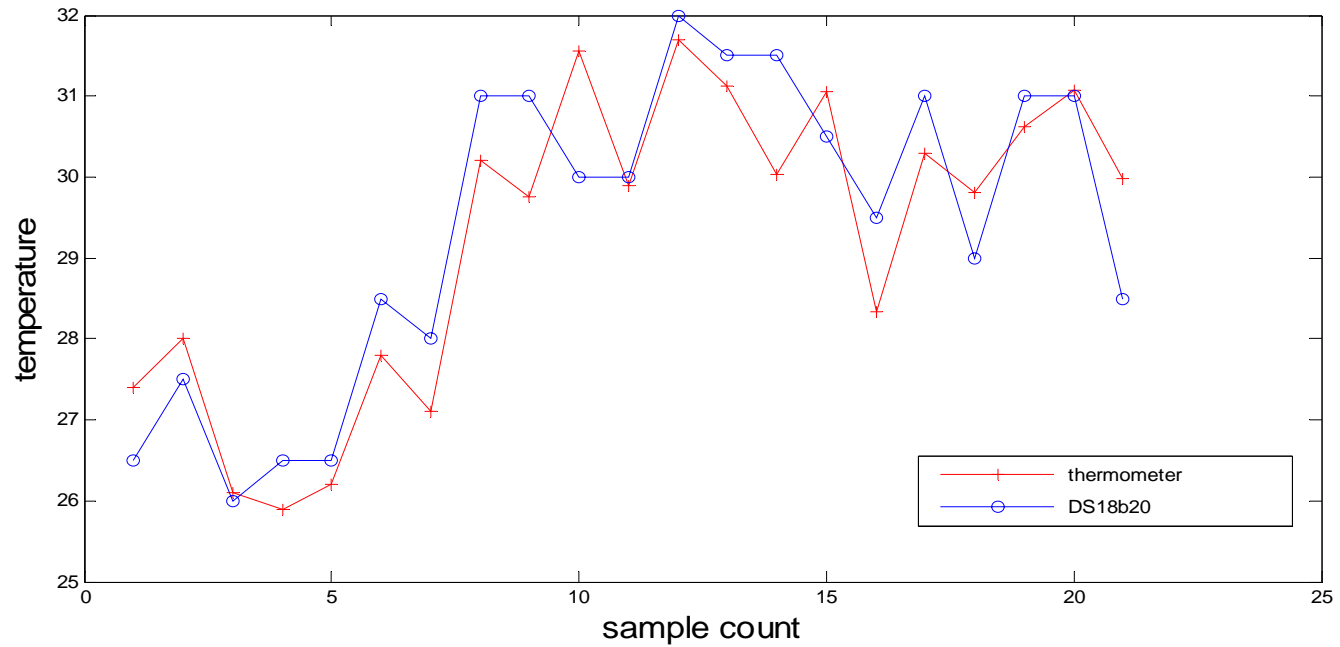
--Transportation Protocol and Backup Transfer Path

-- Redundancy and Emergency Channel



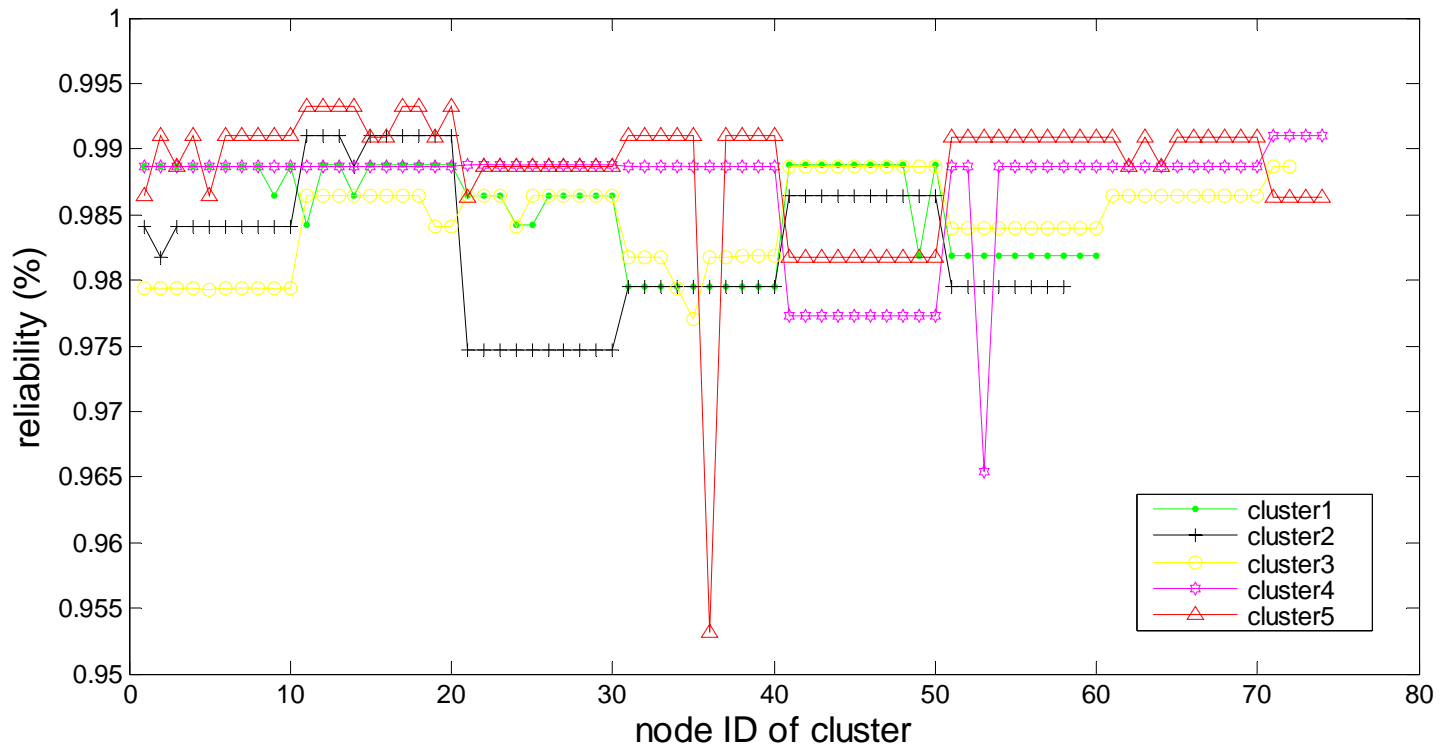
Performance Discussion

--Data Sensing Reliability



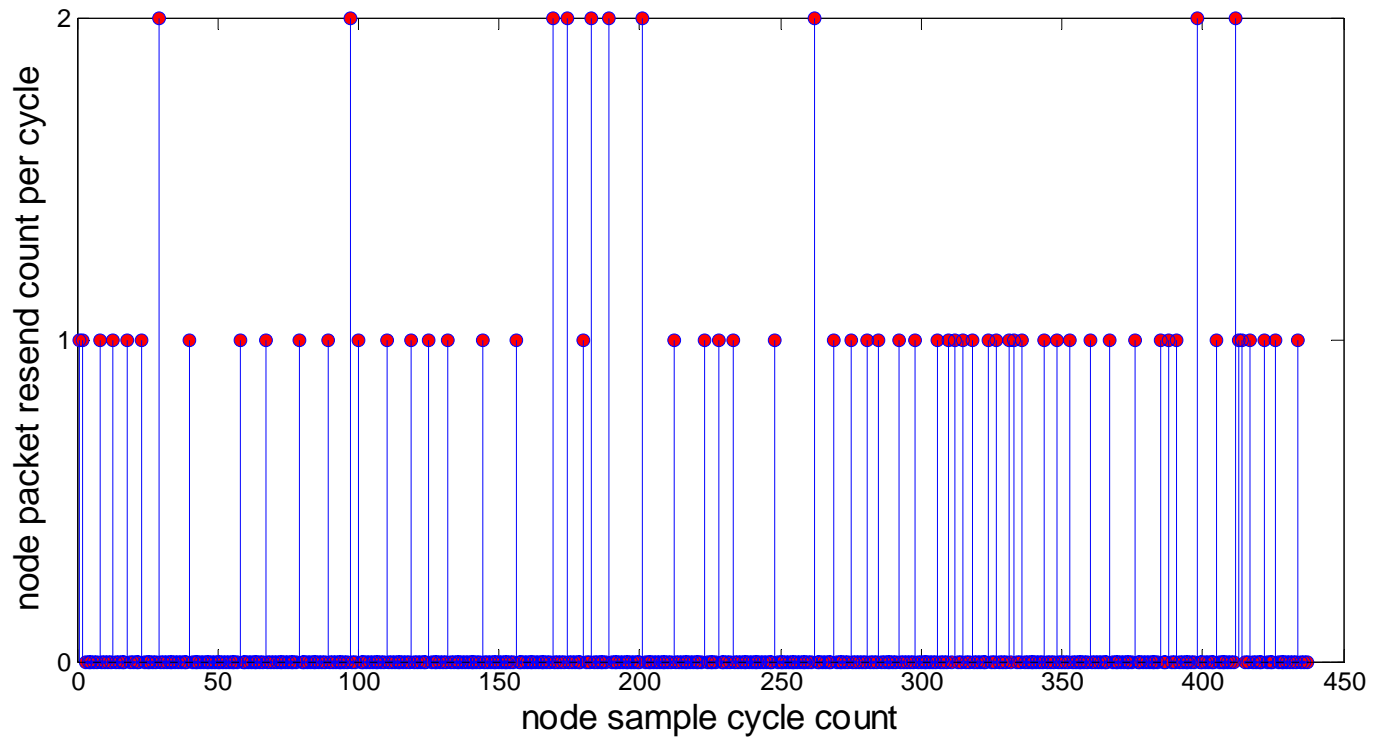
Performance Discussion

--Network Reliability



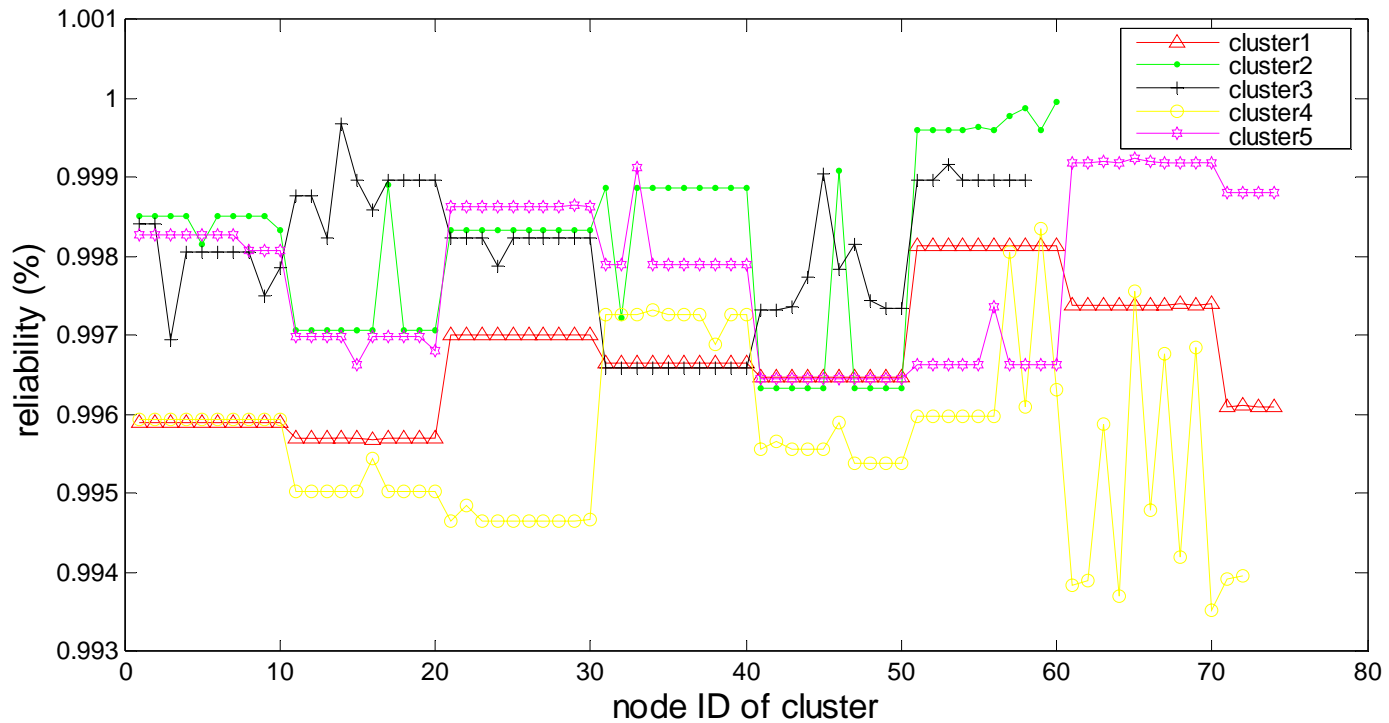
Performance Discussion

--Network Reliability (cont.)



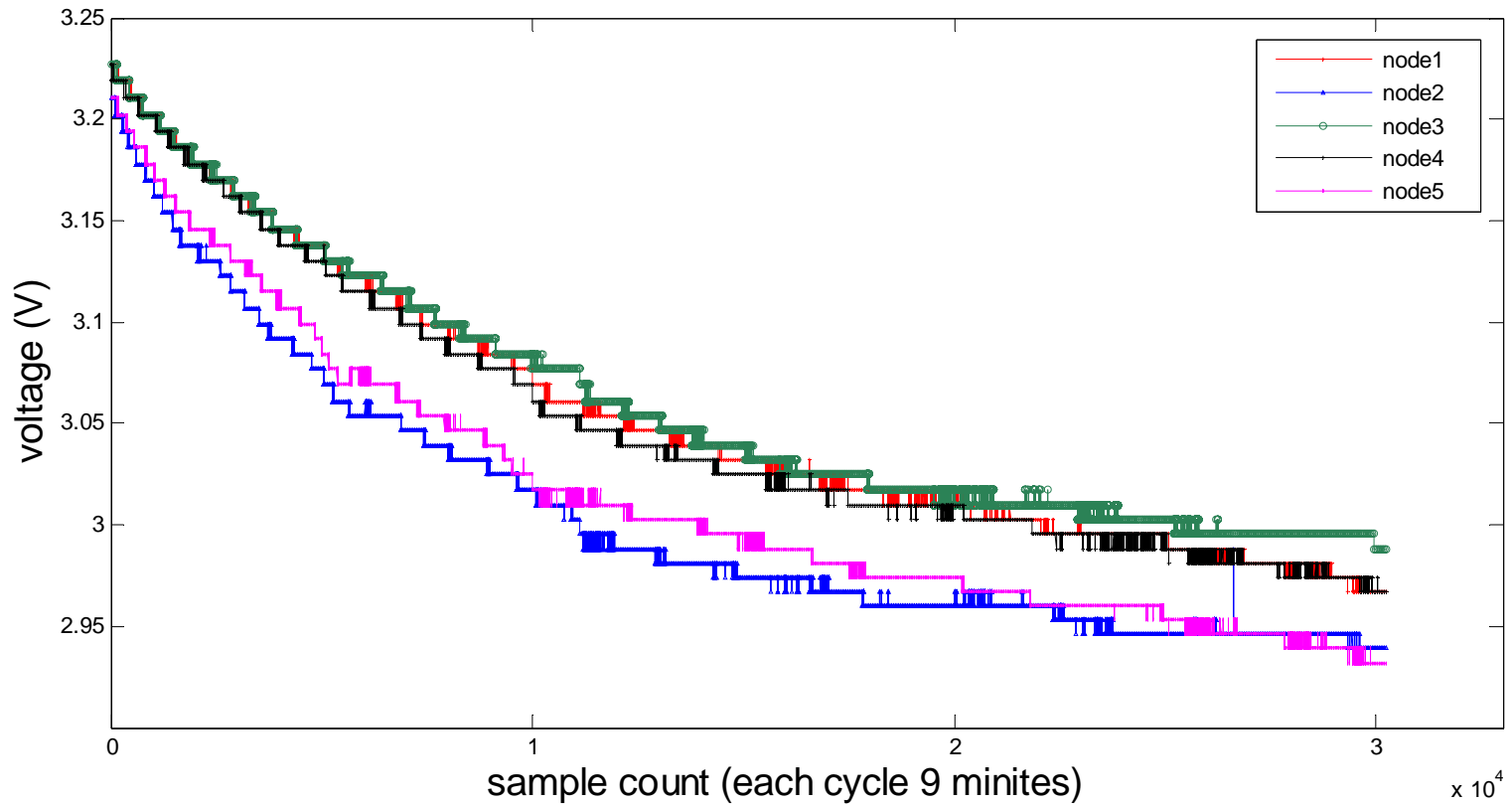
Performance Discussion

--Network Reliability (cont.)



Performance Discussion

--Energy Efficiency



Conclusion

DRE: reliability & energy-efficiency

- 433MHz RF
- Redundant communication path and emergency channel
- FDMA/TDMA
- Combine re-sending and communicating via backup path
- Data Sensing and filtering
- Implementation

Performance

- 406 Monitoring Points
- > 99 % of communication reliability
- 15 months network lifetime

Question?