Energy Efficient, Delay Sensitive, Fault Tolerant Wireless Sensor Network For Military Monitoring

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Presentation Plan

1. Introduction
2. Literature Survey
3. Newly Proposed System
4. Performance Results
5. Conclusion

Introduction

•In this work, a new wireless sensor network system for military monitoring is proposed.

•The main design considerations of the new system are

- Energy consumption,
- Fault tolerance,
- Delay
- Scalability.

Literature Survey

- LEACH : LEACH assumes that all the nodes can hear each other. So LEACH is not suitable for using in large areas.
- SMACS : SMACS needs FDMA as well as TDMA, but sensor nodes are so tiny and limited that current sensor nodes cannot meet the requirements of SMACS.

Literature Survey

- TRAMA or FLAMA : It distributes slots in its contention based period. It consumes considerable amount of energy.
- DTSM : It is not fault tolerant.

Literature Survey

Collision based WSNs…

•B-MAC : Its delay and energy consumption of preamble signal is very high.

•D-MAC : Collision may occur, when the neighbor nodes try to send data to the same node.

•SyncWUF : It relies on local synchronization. Hidden terminal problem and delay are the main problems.

Newly Proposed System

- The most interesting assumption is the existence of high range transmitter of the sink.
- In a typical military monitoring scenario, large numbers of unattended, limited powered sensor nodes can be deployed near the borders of a base. Sensor nodes synchronize themselves to the sink directly and they organize themselves, so that, when sensor nodes detect an intruder, they send their data to a sink. In this way, soldiers can defend against the intruders.

Newly Proposed System

- There are three main parts of the new system:
  - Synchronization with High Range Transmitter (SyncHRT)
  - Data Indicator Slot Mechanism (DISM)
  - Distributed Time Slot Assignment Algorithm (ft_DTSM).

Synchronization with High Range Transmitter (SyncHRT)

- If the sink transmits its signals to a higher range, many sensor nodes can receive the beacon of the sink. Sensor nodes that can receive the beacon of the sink synchronize themselves with the sink directly.
- It uses MAC layer time stamping algorithm of FTSP (Floooding Time Sync. Protocol).

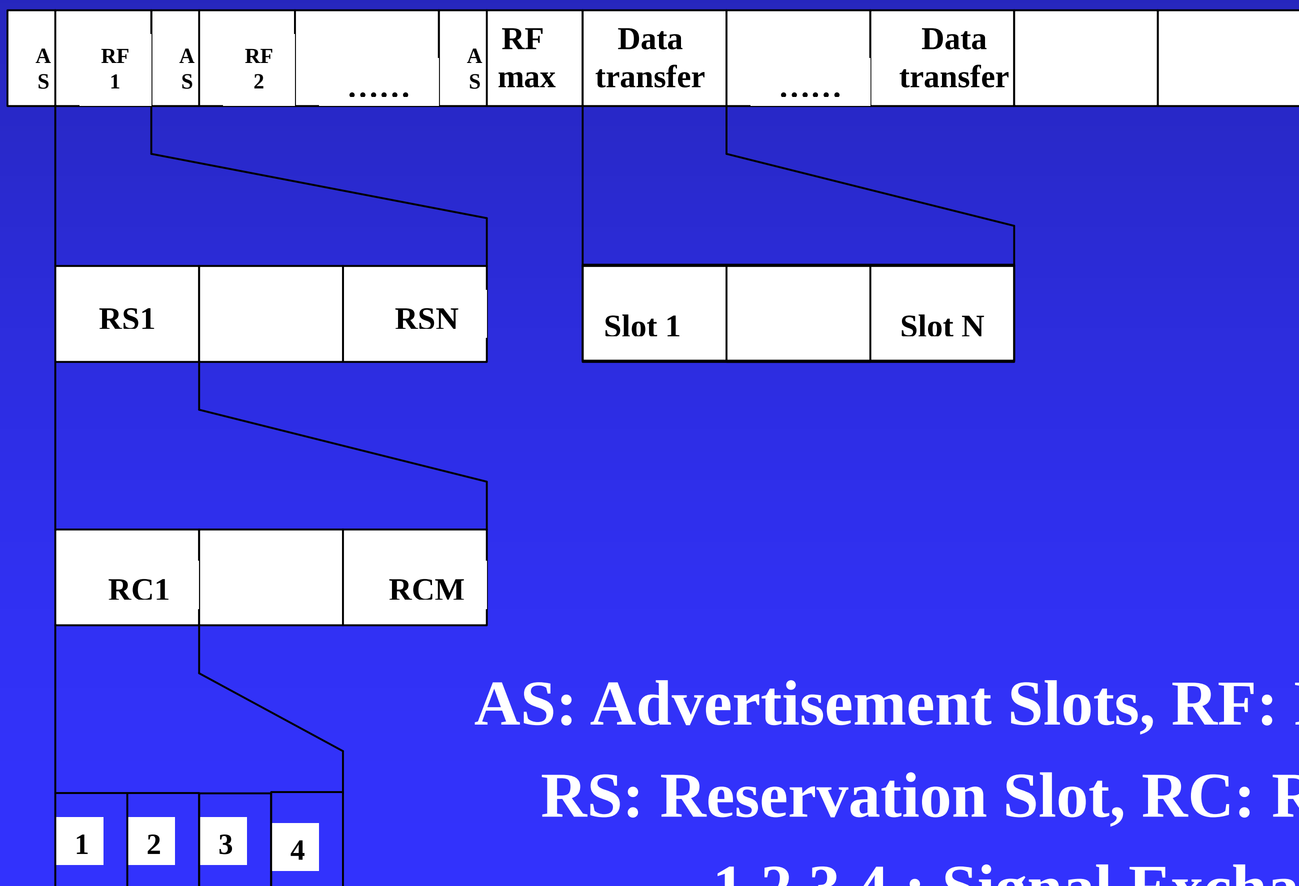
Data Indicator Slot Mechanism (DISM)

- In a tree based TDMA WSN, parents must listen to their children to check whether children have data or not.
- According to DISM, one special slot is reserved for data indication. When a sensor node senses an event or when it has data to send, it sends a signal in the data indicator slot (DIS).
- When a node needs to check its children for data existence, it only listens to DIS.

Fault Tolerant Distributed Time Scheduling Mech. (ft_DTSM)

- It assumes convergecast traffic to reduce delay.
- The failure of a single node does not affect the functionality of the entire network.
- Scalability is satisfied with the distributed structure of ft_DTSM.

Slot Organization of ft_DTSM



AS: Advertisement Slots, RF: Reservation Frame,

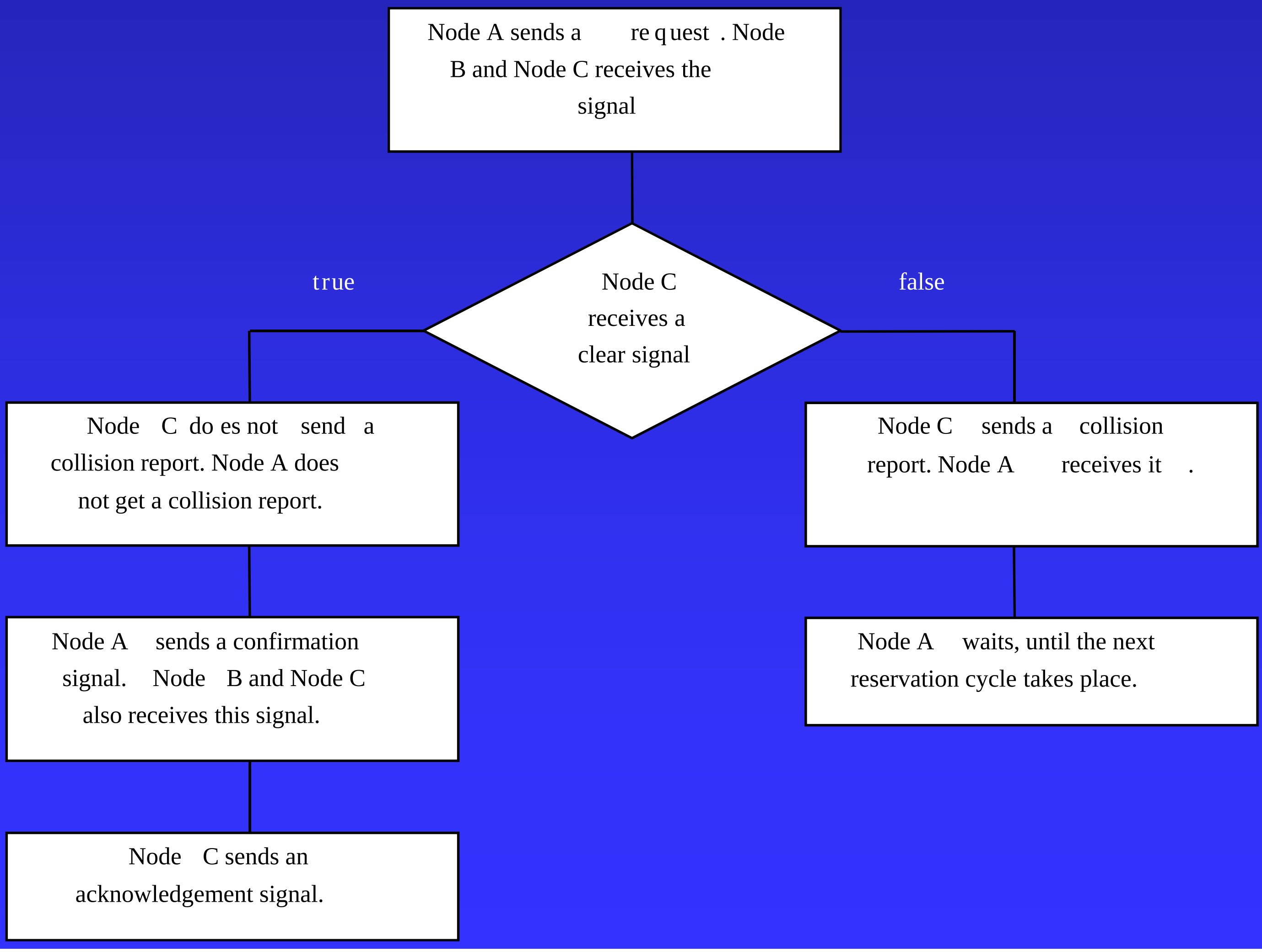
RS: Reservation Slot, RC: Reservation Cycle

1,2,3,4 : Signal Exchange Phases

Advertisement Slots and Fault Tolerance

- A node can request a slot, if it receives adv. signal.
- If a node receives only one adv. signal, it means there is only one alternative parent, and it is not fault tolerant.
- Nodes waits for a certain number of adv. signals to create more fault tolerant structure.

Signal Exchange

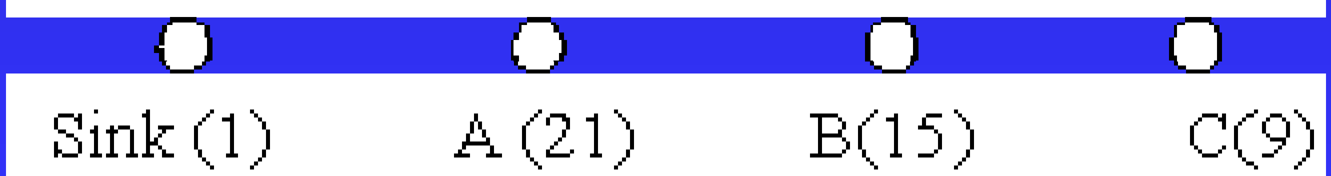


Handling Delay Problems

- Reducing delay is possible by the help of assigning time slots carefully.

(a)

Delay = 70 slot



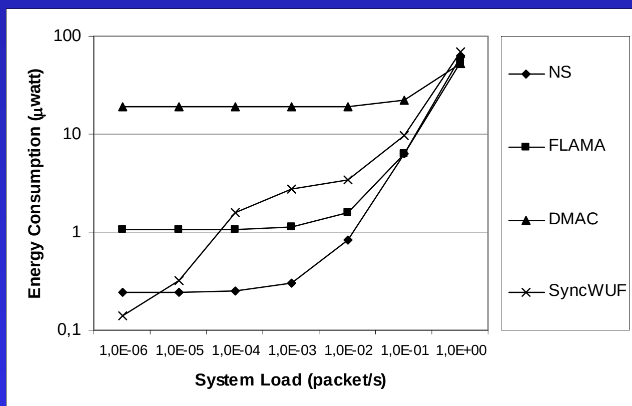
(b)

Delay = 21 slot

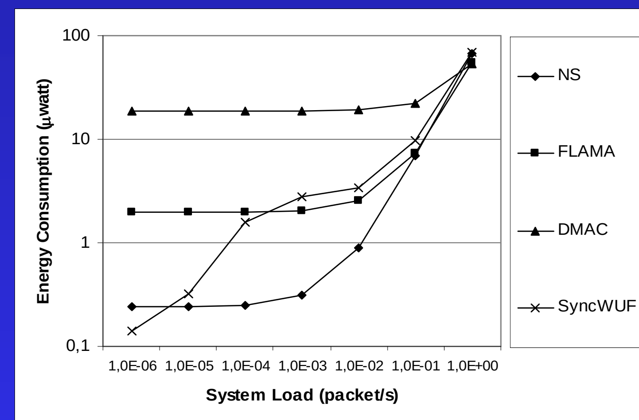
Performance Results – Energy Consumption

- Energy consumption of newly developed monitoring system is compared with SyncWUF, D-MAC, and FLAMA.
- Energy consumption of different WSNs is investigated with analytic models.

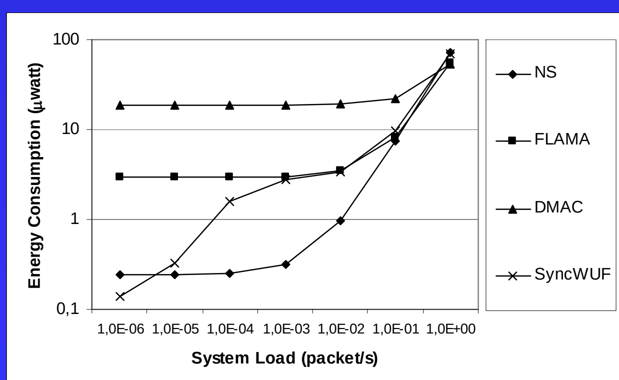
Performance Results – Energy Consumption



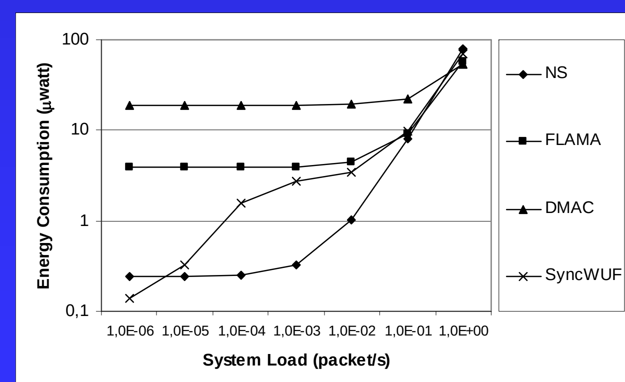
(a) Energy consumption of a node with one child.



(b) Energy consumption of a node with two children.

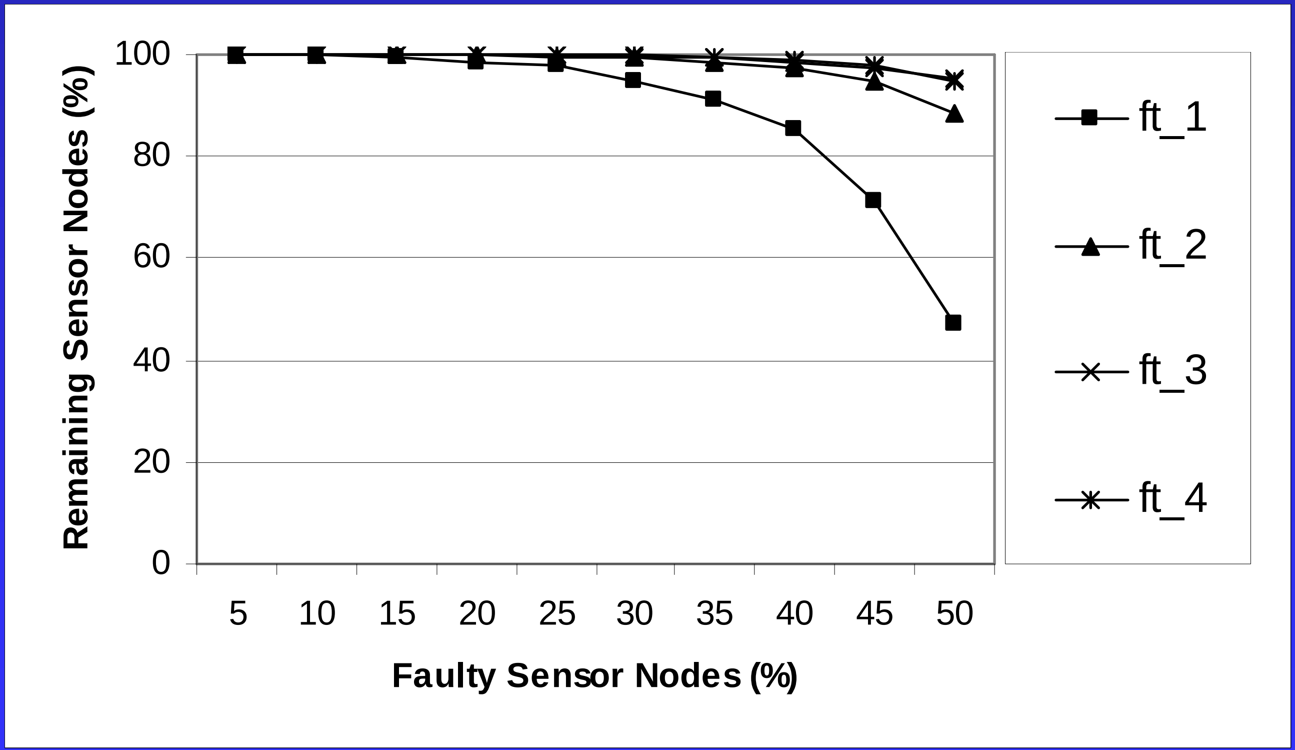


(c) Energy consumption of a node with three children.



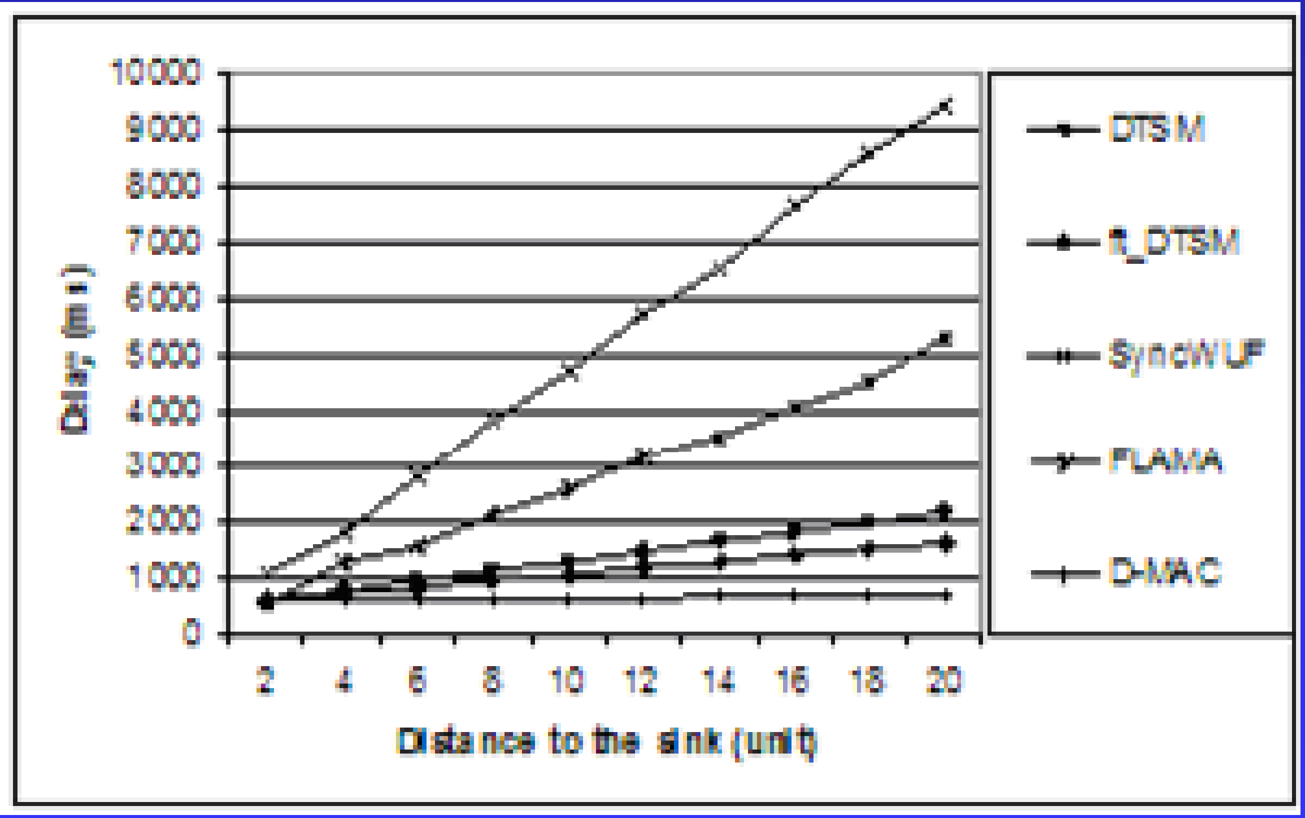
(d) Energy consumption of a node with four children.

Performance Results – Fault Tolerance



Fault tolerance of different fault tolerance parameters.

Performance Results – Delay



Delay performance of different systems.

Conclusion

- In this work, a new TDMA based wireless sensor network for military monitoring is proposed.
- Design objectives of the new system are energy efficiency, delay, fault tolerance and scalability.

Conclusion

- Analytic energy consumption model shows that energy consumption of the new system is superior to SyncWUF, D-MAC, and FLAMA for low system loads.
- Only SyncWUF performs better than the new system, if system load is very low.

Conclusion

- While our system can produce up to 6 times lower delay than SyncWUF and FLAMA, D-MAC can produce lower delay than our system.
- Fault tolerant slot assignment mechanism can improve fault tolerance of our system.

Conclusion

•Although there may be other architectures which perform better than our system for certain performance metrics, the newly proposed military monitoring system can operate with a good optimization on energy consumption, delay and fault tolerance.

Questions