Enhancing Reliability in Duty Cycled Wireless Sensor Network

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ABSTRACT

Chinese remainder theorem is used as packet forwarding technique in duty cycled wireless sensor network. This is a novel packet forwarding technique to grade reliable delivery and saves energy of this duty cycled wireless sensor network. This forwarding technique reduces the burden of the node by transmitting only few message bits. The duty cycled wireless sensor network is the network in which node switches to active and power saving state to save energy. By Chinese remainder theorem(CRT) the packet splitting will be done in which the number of message bits is modular division with the set of Prime numbers and a mask will be added to the message and this is called CRT component .Mask gives the index of the splitted message. A simple reconstruction which satisfies the computation complexity level of processor in duty cycled wireless sensor network . Node switches between active state and power saving state and if the CRT component is passed within the active state of node then the node will receive else packet will be lost. Using this CRT method CRT component loss is admissible and also message could be reconstructed and so reliability could be improved. The objective is to save energy and improve reliability.

Keywords

duty cycled WSN, Chinese remainder theorem, multipath routing **.**

1. INTRODUCTION

A wireless sensor network is a self organised network which includes collection of wireless sensor nodes. Each wireless sensor node has less capable processors, limited memory, RF transceivers, power source (battery powered) and sensors. The nodes deployed in an ad hoc fashion. The ad hoc fashion is infrastructure less network. Since ad hoc network, nodes could be joined in the network without complex network configuration. Nodes communicate in wireless fashion. Wireless sensor nodes communicate to the local peers and not directly to the base station in multi hop fashion. Operations like sensing computation and communication are done by this tiny wireless sensor node. The main issues in wireless sensor network are network lifetime, reliability and security. Since WSN is the battery powered application, the power consumption matters strongly. The power conservation has to be done mainly duty cycling mechanism is adopted for power conservation. In real time the information should reach within the deadline and also successful delivery is very much important. Reliable delivery is very important concern since communication plays vital role.Since in wireless communication easy tapping could be done hence security also matters. As a remedy encryption algorithm could be used this satisfies the processing capability constraints. Failure of the sensor node decreases the network performance and considered this failure an approach of sending multiple copies of same data over multipath results in robust routing. But this strategy occupies more bandwidth and energy. Hence as an alternate, splitting the packet into sub packets and proper error correction coding are done for effective reconstruction. Effective reconstruction will make the communication successful.In Synchronous duty cycling global message has to be sent periodically and so overhead increase accordingly Dealing with On demand sleep awake scheduling an additional secondary low power receiver is necessary to listen' wake up 'message[1]. Considering Asynchronies duty cycling, this is independent of neighbors and this technique cause increased delay. As the Penalty of the above methods network latency occurs. SENSOR-MAC is a MAC protocol in which node periodically broadcast its schedule to maintain synchronization. TRAFFIC-MAC is the adaptive duty cycling technique in which idle listening mitigation is done. Low Latency MAC in which common global schedule is given and along with RTS/CTS, data to come notification is sent within active period .The above said MAC protocols requires tight synchronization. B-MAC is the unsynchronized duty cycling technique in which long preamble is sent which results in latency and energy consumption increases. Idle listening is also a penalty here. In C-MAC, the DRTS packet is any casted and when converged to unicast end to end delay increases. Data aggregation technique involves election of node as aggregate point and preferred direction for forwarding the data .Routing combined with data aggregation technique reduces number of transmissions but robustness is low. Multipath routing algorithm along with some erasure codes is remedy. Erasure codes are reed Solomon codes, luby transform. Reed Solomon codes perform polynomial operation which requires memory luby transform performs simple XOR operation which suits WSN but ensures success in decoding for large encoded packet and in this condition of communication path is not considered. Asynchronous duty cycling increase delay and Any cast forwarding mechanism results in reduction in one hop delay and when relayed through time consuming routing path results in end to end delay hence there is tradeoff between one hop delay and network lifetime so optimize any cast forwarding policy and wake up rates. In Cross layer approach, MAC-CROSS is a technique interaction between MAC and routing layer results in fast packet delivery and saving energy in duty cycle mechanism. In interaction between physical, MAC and routing layer interacts results in power control, proper scheduling and only minimum overhead occurs. In this Energy efficient cross layer clustering scheme routing and scheduling are two phases. Routing involves setup phase, reconfiguration phase and steady state phase. Scheduling involves optimization of node close to base station. When considering more data to be transmitted and it consumes more energy. Automatic repeat request (ARQ) is scheme in which receiver fails in receiving then retransmission occurs. Forward error correction (FEC) is the proactive scheme for error correction. Hybrid ARQ(ARQ combined with FEC) technique holds HARQ1 and HARQ2.In HARQ1, packet is sent with low power FEC code. Then Packet will be sent with high power FEC code if NACK is received results in more bandwidth usage.In HARQ2, previously sent FEC coded packets are stored and retransmit only redundant bits and this occupies memory.

2. CHINESEREMAINDER THEOREM

Chinese Remainder Theorem; in the simplest case, this theorem can be described as follows (Giuseppe Campobello,):Given N primes pi< 1, which iє {1... N}, M will be primes product, i.e. M=Πipi. By assuming m as original packet, then set of integers {m1, m2….mN}will be sub-packets, considering the condition m >M, m can be obtained from the equation shown below. mi= m (mod pi);Ci= Qiqi where Qi= M/pi, qi is Qi modular inverse; m = Σci mi(mod M).

3. FORWARDING STYLE

In a wireless sensor network instead of transmitting the entire packet, the packet is splitted into several packets and then forwarded .This reduces the burden of nodes by transmitting only minimum number of bits. To the splitted packets an identification is given and by processing with prime number to have optimum reconstruction with proper sequence of splitted packet. The main MAC header is not splitted and that is encapsulated to avoid computational complexity and also to reduce the delay. Several layers are involved in this operations of routing, splitting, individual sub packet header processing**.** The packet to be sent from source to sink is routed using multipath . The source send the message to the nodes in next cluster level and the nodes by applying the Chinese remainder theorem approach splits the packet. The fragmented message reach the sink through multipath. The nodes in the network knows its neighbours through initialization message. The nodes based on the number of packet size selects the p-rime set accordingly and performs manipulation resulting in CRT component. The sink node equipped with the processing unit for reconstruction of the CRT components received. In duty cycled mechanism the nodes alternates between sleep and awake node and so there is the chance of losing any of the component of the message and so the wake up scheduling should be made accordingly. But in this approach few component failure could be accepted based on the prime set selected accordingly. Energy aware multipath routing is made here that is the neighbours are selected based on residual energy and distance as metric.

Consider packet of n words of w bits to be transmitted then for all words of the same packet uses the same prime number. For all possible values of m_i there will be removable zeros so that its value wont change. The nodes processing the received bits consumes more energy than the nodes acting as relayers in which transmission energy alone is considered. The number of CRT component depends on the node density. The number of CRT component should not exceed the threshold .If it exceeds the threshold then ERF reduces. The number of CRT component increases then the number of bits in the component decreases. The reliability is quantified in terms of the probability that sink can reconstruct properly. In this forwarding technique limited number of failure is admissible and if failure exceeds the admissible limit then it shows it shade on reliability. Increase in admissible failure sometimes increase reliability but causes more energy consumption since prime number set selection is uniquely chosen if failure is admissible.

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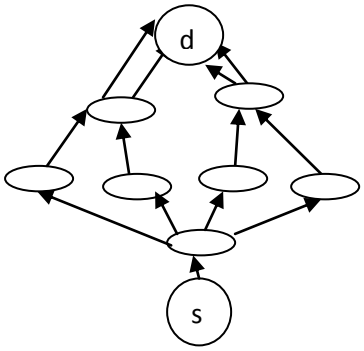

Fig 1. Forwarding style

The figure shows the forwarding style. Here the node knows the next hop through initialisation procedure and based on the number of next hop available the splitting of packet is done and the fragmented packet is routed by energy aware multipath routing.

4. SIMULATION RESULTS

NS2 which is event driven simulator is used and the results are obtained accordingly. Energy consumption by a node =$\sum_{i=1}^{M}$(einitiali-eresi)/M*N ,Where M is number of nodes,N number of packets to be received by sink. Figure 1 shows the Packet delivery ratio for both the approach such as SP and CRT and implies the increased ratio for CRT based approach in duty cycled WSN. Figure 2 implies that CRT works well for both with and without duty cycled WSN. Multipath routing with splitting procedure is better when compared to taking single path to traverse.

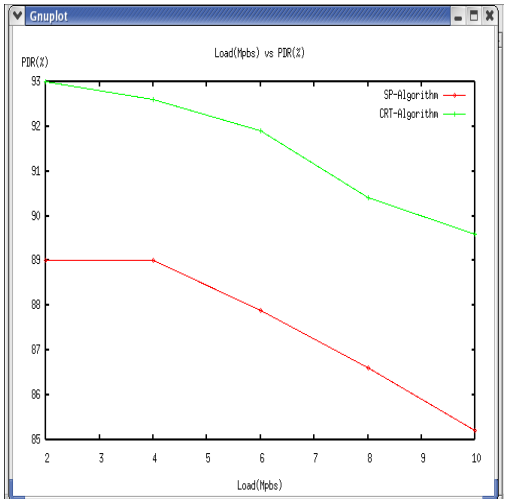

Fig.2 Load Vs PDR

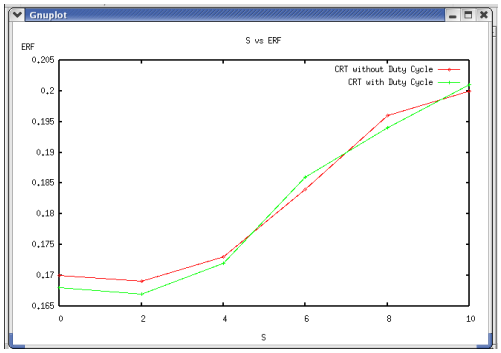

Fig.3 S Vs ERF

5. CONCLUSION

Forwarding technique for duty cycled WSNs based on the Chinese Remainder Theorem (CRT) increases reliability. This technique significantly reduces the energy consumed for each node, and consequently increases the network lifetime. Here considering the computation complexity the splitting is done only one time. The splitted packets are then relayed over multipath to reach the sink and here the robustness in routing also increases. This splitting technique increases the reliability and saves energy thus improves network lifetime.

6. ACKNOWLEDGMENTS

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