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Delineate a Technique to Maintain Consistency in Cache Based Wireless Sensor Network

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Abstract: ***Wireless Sensor network have many different properties unlike other wireless networks. WSN's are highly distributed networks where cooperative caching can act as an important feature in handling the communication effectively making WSN to use its energy efficiently. WSN is collection of large number of sensing nodes that sense the environment they are deployed in and after sensing, computation, transmit the data over the transmission channel comprising of sensor network and sink node. In this paper we present a technique called push based technique for caching data in wireless sensor network. The sink node uses a cache discovery algorithm to find the node who has cached the data item that the sink needs to access. It also employs cache consistency, cache replacement algorithm that improves the overall performance of the system. Simulation experiments show the better results as compared to the other caching techniques.***

Keywords: WSN, Cooperative caching, push method, cache consistency.

1. Introduction

A wireless network is the collection of mobile nodes deployed in a region in order to monitor physical aspects like temperature, pressure etc. basic unit of WSN is sensor nodes that sense the change in the environment without the intervention of humans. Nowadays, wireless networking is used for the commercial uses like disaster relief applications, medical environment control, tracking etc. WSN has emerged as an important innovation for the military, tactical and security sensitive operations.

Secure routing is an essential issue in the routing applications. The wireless network uses the communication protocols [2]. It uses the medium of air for the operation of the Communication protocols. Wireless networks use a carrier sense protocol for the synchronization and these protocols are similar to the Ethernet standard. These protocols are used to enable the group of wireless computers to share the same frequency and space. The wireless is a shared media technology as all users share the available bandwidth here.

In clustering, the sensor nodes are partitioned into different clusters. Each cluster has cluster head that manage the rest of the cluster nodes in the cluster. Cluster head is selected on the basis high residual energy. Cluster nodes send their data to the cluster head as there is no direct transmission between the cluster nodes and the sink node. Cluster head will aggregate the data, received from cluster nodes and transmits it to the base station. Hence minimizes the energy consumption and number of messages transmitted to base station. Also number of active nodes in communication is reduced that helps to increase network lifetime that is the ultimate goal of the method of clustering [8].

2. Review of Literature

I.F. Akyildiz, W.Su*, Y. Sankarasubramaniam, E. Cayirci [1], in this paper authors have discussed the basic concept of sensor network which has been made possible with the help of micro-electro-mechanical system technology, wireless communications and digital electronics. Firstly, they have explored the sensing task and the potential sensor network application and a review of the factors affecting the design of sensor network then the architecture, various protocols employed, the algorithms for each layer are explored.

Edwim Prem Kumar Gilbert, Baskaran Kaliaperumal , Elijah Blessing Rajsingh [2], in this paper authors have discussed about the recent issues in the wireless sensor networks based applications like in military, health related, environmental and other commercial uses.

Naveen chauhan, l.k. awasthi, Narottam chand [3], in this paper they have firstly, discussed about the sensor node and the components of sensor node. Secondly, they have presented a technique called GCCS (global cluster cooperation for wireless sensor network). This technique caches the data in WSN. It caches the data queried by sink node for the calculation of the various aspects for which the WSN has been employed in the region. GCCS also employs the other techniques to ensure the accurate calculation namely, cache admission control, cache consistency to improve the overall performance of the system and significant improvement in byte hit ratio, average query latency as compared to other existing techniques.

Md Ashiqur Rahman, Sajid Hussain [4], in this paper author has discussed about the effective caching techniques in wireless sensor network. They have used an energy efficient routing protocol for continous monitoring applications. The proposed improvements are (1), data negotiation; (2) data change expectancy; (3) data vanishing. Firstly, a sensor sends its sensed data over the communication channel only when the data changes. Secondly, it checks the probability that at what time its data might change and adjust its frequency accordingly in order to avoid useless sensing. Thirdly, delete the duplicate sensed data in the sensor nodes.

Ginni Tonk , S. S Tyagi [5], in this paper they have discussed the performance of the network routing protocols like AODV, DSR,DSDV, results depicted in this paper clearly shows that AODV gives best throughput.

Vivek katiyar , narottam chand, naveen chauhan [6], in this paper authors have discussed about the recent advances and future trends of wireless sensor networks briefly. Recent advances in WSN's have enabled the wide application of WSN in military applications, surveillance , environment monitoring etc.

3. Caching in Nodes

In the method of caching in nodes all the cluster heads cache the data of all those frequently accessed data items. They maintain a database for all those frequently accessed items. On receiving the query from the sink node nearest cache node respond to the sink with required data.

4. Cooperative caching

In cooperative caching, multiple sensor nodes share their cached data with other nodes and the cluster heads in order to cut communication cost and exploit the aggregate cache space of cooperating sensors. The plain assumption we make, that is each sensor node has a moderate local storage capacity associated with it, i.e., a flash memory or cache memory. Each sensor node caches the frequently accessed data items in its cache memory. The data items in the cache respond to not only the node's own requests but also the data requests of other nodes coming in its path. For a data miss in the local cache, the node first checks the data in its cache before forwarding the request to the next node that lies on a path towards the data source. The process of cache admission control is based on the distance criteria of a node from the sink node and higher priority is given to the node that is nearer to the sink node. Popularity based data replacement policy has been devised to make certain that more useful data is retained in the local cache of a node.

Providing incessant information to mobile sinks with unremitting communication is a big challenge in designing large-scale sensor networks. A lot of research in data routing, data compression and in-network aggregation has been proposed in recent years. If caching is implemented optimally, it can reduce a lot of network traffic and provides higher data availability to the sink [4].data storage in the each concentric circular layer of caching node is decided on the basis of token provided to each layer. The algorithm searches for the geographical coordinates of the nodes around the sink, by flooding request messages to determine their distance from the sink. The discovery of cached data is operated by a simple cache discovery scheme. Finally, a data replacement policy is used which helps in removing obsolete data from the caches. This helps to decrease availability, lessen requirements for bandwidth and decide which data should be cached in WSN [10].

4.1 Cache Consistency

The scheme proposes to use consistency model based on time-to-live (TTL). TTL of a data refers to time period after which data gets expired. Sink node considers a cached copy up-to-date it its TTL has not expired. If the TTL has expired sink node discards it and cluster head checks its cluster for data renew and it checks other clusters too[5].

4.2 Cache Replacement Policy

Replacement policy is based on popularity value of the data item(s) at a node. On the basis of data frequentation caching node either keeps that data or discards it [4].

$$P_i = a_i / \sum_{k=1}^{n} ak$$

a_i = access rate of data d_i ; it can be calculated by sliding window method to last k access time.

$a_i = k/t^c - t^k_i$

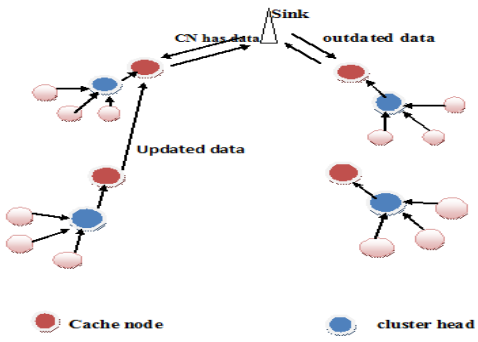
t^c= current time;

t_i^k=timestamp of oldest access to data d_i .

5. Proposed Methodology

The proposed work is to sustain the consistency among the caches in the different part of the network. If the data present in the cache memory is not same among all the caching nodes then there occurs the outdated data on the sink node when it will query the data from the nearest caching node that will result into the reduction in the reliability of the network. To enhance the reliability of the network, it is obligatory to maintain the consistency between the all the caches which is on the different parts of the network. Cluster of similar data are made within a network and every cluster has cluster head and a caching node which will cache the data that is frequently used. When sink request for a particular data from the nearest caching node it will report the outdated data at the sink which will result into the network inconsistency within the network. The sink node will flood a message of data inconsistency the network and all the nodes will start publishing their time at which the last time data was updated. And they will publish the data too which was last cached in the caching nodes of all the cluster heads. Then the node having data cached before the outdated data will update the latest data in the sink node by sending the information to the sink reducing the time of going all the way to the original sink sensing that particular data queried by sink. Sink will again flood the updated data to the all the nodes and outdated node will update its data and will communicate with the sink. In push technique cache node checks consistency at regular interval of time without sinks query. If update data is available than data is shared between all the cache nodes regularly and maintain cache consistency.

After applying this algorithm the sink node will have updated data.



The explained is push method.

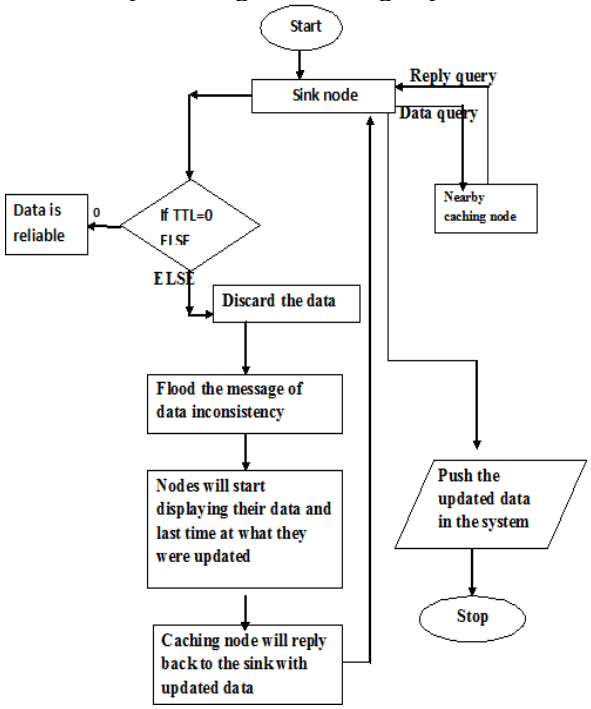
Algorithm of push pull consistency model:

Push method:

1. On receiving outdated data at the sink.
2. Sink will flood the message of inconsistency in the system.
3. Nodes will start publishing their time at which the cache on its node was updated and the data that was last updated.
4. The node having new data will reply to sink with the latest data.
5. The sink will send the updated data to all the nodes and the outdated node nearby sink will update its data and will start communicating with sink.

Figure 1: Updated data at the sink

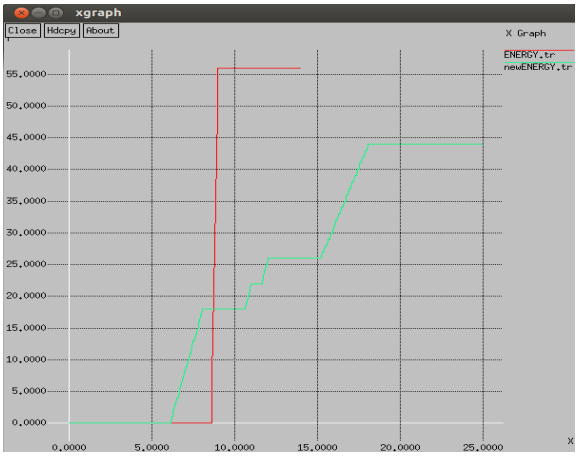
Flowchart representing the working of push method:



6. Results

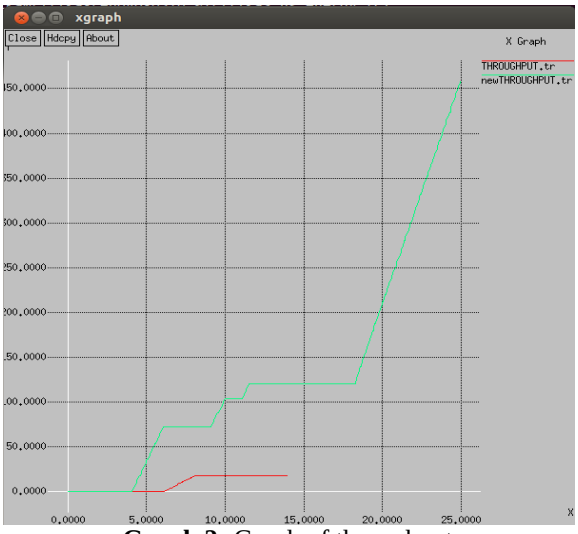
Figure 1.2: NS2 simulation parameters

Area of sensor field	**800×800 m**
IFQ	**Drop tail/priqueue**
IFQ length	**50 packets**
MAC layer protocol	**802.11**
Routing protocol	**AODV**
Number of sensor nodes	**25**
Caching nodes numbers	**5,9,15,17**
Cluster head numbers	**20,21,22,23**
Sink node number	**24**



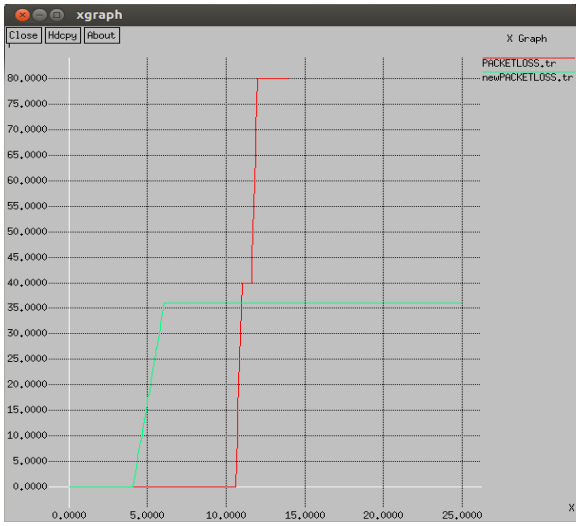
Graph 1: Graph of energy

In graph 1 green line depicts the results produced by the push based technique. In the graph X-axis represents time in milliseconds and Y-axis represents energy consumption in joules. The initial energy of every node is 1 joule and the node having high residual energy is selected as cache head.



Graph 2: Graph of throughput

In graph 2 green line in the graph depicts the new throughput calculated with the push based technique. In the graph X-axis represents the time in milliseconds and throughput of the system. The produced results show the increase in average throughput of the system.



Graph 3: Graph of packet loss

In graph 3 green line shows the amount of packet loss during the whole round of sensing. The X-axis represents the time in milliseconds and Y-axis represents packets lost. The IFQ length is 50 packets and packets size is 1000 bits then using push based scheme the results are far better.

7. Conclusion

The main objective of this research paper is to discuss various challenges and technique of WSN. We also focused on cache cooperative technique and its procedure. We believe that proposed algorithms discussed in this paper will give benefit for various research scholars. Its experimental results show that proposed technique gives better result which has better throughput and energy as compare to existing techniques.

8. Future Scope

Improvement in future, we can increase the battery life of the nodes. Improvements in selecting another caching head if present one becomes dead.

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