Volume 4, Issue 6, June 2014 ISSN: 2277 128X

International Journal of Advanced Research in Computer Science and Software Engineering

Research Paper

Available online at: www.ijarcsse.com

Energy Efficient Data Collection In Hierarchical Tree With Cache-Node Technique In Wireless Sensor Network

Rajeswari S.
Dept.of Computer Science,
Karpagam University,Coimbatore,Tamilnadu
,India

Dr.Ponmuthuramalingam,
Head of the Dept. of Computer Science,
Govt. Arts College(Autonomous), Coimbatore,
Tamilnadu, India.

Abstract :Wireless sensor networks have been identified as one of the most important technologies in the modern scenario. This paper traces the history of research in data collection in sensor networks, and presents a statistical report, based on the implementation of their algorithms and identifies the corresponding issues and challenges. Efficient data collection in sensor network is a challenging task. This paper addresses the problem of collection of sensed data to the sink[1] of a sensor network, and suggests ways and means to minimize the time and power consumption to complete the process as an essential need. On the basis of these issues, the best rate algorithms with new techniques are proposed. Irrespective of the size and volume of business , uploading or downloading large volume of data with least cost is essential. As sensors are battery powered devices, they consume a lot of energy during transmission than during processing. Hence, many researchers have attempted to formulate ways and means to minimize the schedule length and degree, power consumption, time delay, topologies and so on. Before venturing into the survey and suggestion of new techniques, conclusions of recent research papers have to be compared. This comparative analysis produces implemented values of the base paper and related papers. The comparative ratios of data collection rate are useful to identify the new trends. This will help us to formulate revised effective algorithms to implement and enhance ratio. The proposed technique will eliminate the negatives, and finally, lower bounds or eliminating interference. The higher bounds in data collection can also be authentically proved.

Keywords— Wireless sensor network, sink,topology, delay, tree reconstruction, cache node

I. INTRODUCTION

The present comparative analysis investigates three main areas . They are: 1) Topology – Constructing an efficient network with specific property is useful to enhance the rate tremendously, 2) Time and Power Consumption- Efficient management of power control protocols will reduce cost, and 3) Cache - Efficient cache-based data collection with different expiry time will reduce power consumption. Comparison is based on algorithms and graph-based protocol, attributes[6]like error-free, duplicate-free and loss-free, parameters like final throughput ratio, delivery ratio, packet delay and correlation factor.In this paper, the adaptive cache-based algorithm is introduced to reduce the reconstruction loss, delay, packet loss, error rate and traffic, thus improving the throughput, packet collection ratio and so on.

Computational finance is one of the most dynamically advancing fields of research over the last 60 years [5]. With the advancement in computational hardware speed and heuristic techniques,many problems, which were once believed to be intractable, have been solved, or sufficiently good approximations have been found. Recent research works in computational finance focus on finding fast approximations which can be applied in real-time, high frequency algorithmic trading applications ([15],[3],[4],[5]) and reliable approximate solutions to hard problems which have desirable runtime and generalization characteristics ([7],[8],[9],[10],[11]).

II. CACHE-BASED ALGORITHM

A new cache-based technique on wireless sensor network is proposed to conserve energy and time. Substantial research has been carried out in making an energy efficient fast data collection in WSN using cache. It is a technique which provides faster data access in any computing system. WSN are not centralized. Instead, there is peer to peer communication between the nodes, so that, it is not necessary to establish an infrastructure to deploy the network. As the node can be freely removed or added as required, drastic changes have to confine themselves only to network topology such as updating the path or tree, etc.

Cache-based algorithm is adopted in application or data link layer for reproducing the damaged or lost packets [12]. Application layer restores the packets during congestion. Data link layer corrects packets contaminated by propagation errors [13].Whenever the tree is updated, the structure is reconstructed[18]. The cache will retain the old structure and data. But, the parent cannot retain its old structure. In case the parent opts for old structure and data, it can obtain the same from the cache. To begin with, the papers on cache-based policy and parameters like power control, thorughput ratio, delay and error are surveyed, and then the limitations in existing methods are enlisted. Cache-based revised algorithm is used to find a better model to represent the problem. Simulation of comparative analysis proves that algorithms are better than the previous conflict graph-based approaches. The proposed algorithms will prove to be better

than the results of comparative analysis. Originality/value – This paper presents a new technique with hierarchical model with cache. This model is more efficient and includes more information, compared with the existing model, and it also proposes cache- based algorithms . The algorithms can reduce starvation ratio and improve bandwidth utilization and also reduce overall cost.

III. TOPOLOGY

This paper adopts a hierarchical grid structure[16] to reduce the total energy consumption, and utilizes a tree architecture and cache node to decrease the transmission delay.Wireless sensor networks drop the packets due to propagation errors that lead to reconstruction of traffic, retransmission of traffic and removal of related delays When a sensor network outdoors is tried, for purposes such as collecting information related to large-scale natural disasters and agricultural applications, it is often found that the communication distance is insufficient. Many sensor network users in Japan utilize sensor nodes that use 2.4 GHz frequency.

The communication distance of these sensor nodes is short (a few hundred metres). Therefore, to achieve long-distance communication, sensor network users need relay nodes. Sensors not only capture and send but also serve as relays for other sensor nodes. Finding multi-hop path from sensor node to base is one of the vital challenges and has received immense attention from the research community.

However, these relay nodes might cause an increase in cost and complexity, and need maintenance. Therefore, in this paper, the effect of cache memory based revised algorithms in wireless sensor networks is proposed. This technique improves the throughput by cache-based memory, depending upon the wireless topology reconstruction. The main aim is to achieve the best rate of throughput with less energy consumption and time. The other related parameters, namely, packet delivery ratio, packet loss, delay and error rate are also analyzed and compared. Finally, the proposed best rate is also suggested. The proposed algorithm reduces the delay to the maximum and helps to solve many of the related problems. Thereby, it improves the throughput and reduces the error rate and delay**.** The paper concludes by presenting specific recent research results in sensor network algorithms. Thereby, the findings of the current research could be evaluated properly by comparison. Hierarchical based WSN cache-based algorithm is adopted in application or data link layer for reproducing the damaged or lost packets [12]. Application layer restores the packets during reconstruction, and data link layer corrects packets, contaminated by a variety of errors [13].

IV. TIME AND POWER CONSUMPTION

Energy consumption: is also a parameter to be analyzed in wireless sensor networks. As the sensors gather information throughout the day, power saving is crucial. If there is a heavy load of retransmission, the power consumption will be more. This is not fair in case of tiny sensor nodes. The battery used is charged through environment, and hence, solar cells are mostly used in these sensors.

***Findings* –** In this paper, a new method of power management , based on wireless sensor network is proposed to conserve energy. The cache-node has proved to be an integral factor in the communication among nodes. Finally, the paper proposes regular patterns of the deployment of sensor nodes, based on the communication range and the sampling range.

***Originality/value* –** The experiment for providing real-time data on environment monitoring parameters indicates that the system is efficient. The idea and the design presented in the paper may help application of wireless sensor networks and research on the same. Sensor nodes are assumed to be uniformly distributed[17], homogenous and energy-constrained. Each sensor node also has the ability to adjust its transmission power. Practically, the proposed method needs information on location of sensor nodes. The radio interference between sensor nodes during data transmissions is also to be taken into account.

A primary challenge of such a network is that all the sensors operate on a finite energy supply, in the form of a battery. These batteries are rechargeable from sources like embedded solar panels, but the sensors still have a finite maximum power store. Any node that loses power, drops out of the communications network and may end up partitioning the network by severing the communications link from upstream sensors toward the data collector. Thus, the maximum useful lifetime of the network, at worst, is the minimum lifetime of any sensor. It is possible to complete the entire process within the stipulated time, using the cache policy.

V. CACHE

Two major stumbling blocks are the dynamic variance of the network caused by both the capacity constraint of sensor nodes and uncertainties of wireless links, and secure routing in the special security sensitive environment. Therefore, adaptable and defendable routing mechanism is in urgent need of the deployment of sensor networks. To solve the scheduling and topological problem, a virtual-cache node expansion is proposed to handle relay operations, and then cache-based algorithms are utilized. Regarding the hierarchical structures, a reconstruction algorithm is proposed to leverage possible parallel transmissions. Proposed algorithms are evaluated through simulations.

Data cached by the intermediate cache node will decrease the transmission delay when there is a need to broadcast data from publisher to subscriber. Network forms a hierarchical tree. Placing the data in an intermediate node provides asynchronous multicast. So, data supplied by the cache, and not by the source, will increase the speed of the data collection.

VI. PRACTICAL IMPLICATIONS

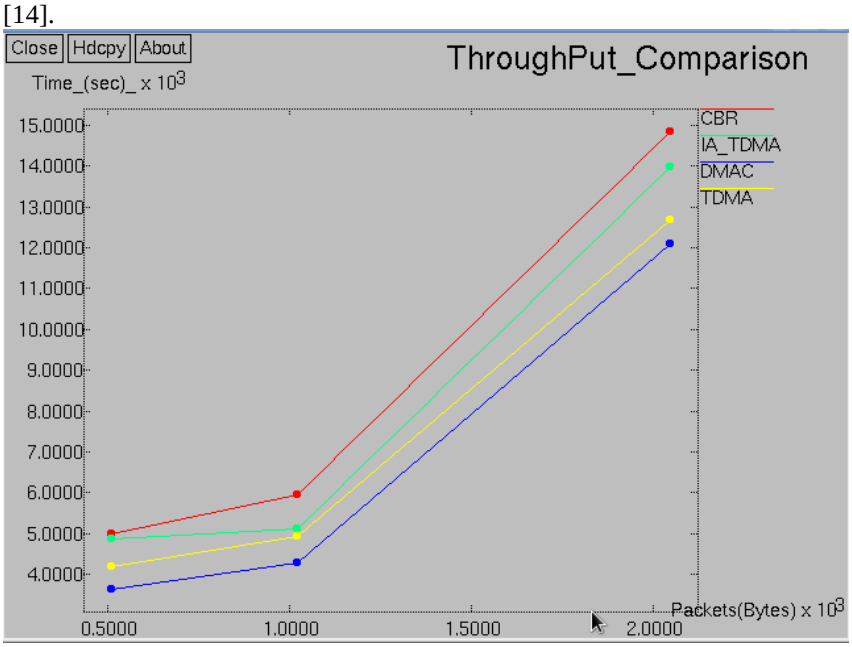
Practical implications – The proposed method can significantly reduce the delay time, length, reconstruction delay, traffic, error rate and cost and increase the throughput ratio. It may be suitable for real-time data collection applications. It is shown that the buffer size required to achieve the maximum possible rate decreases as the network size increases. It is also shown that this requires adequately combining shortest path tree routing and traveling salesman routing. The results of the present research show that such specially designed algorithms increase the collection rate for a given loss probability up to almost three times, on an average, with respect to the usual shortest path tree routing. [2]. In this paper, different parameters such as throughput, packet delivery ratio, packet loss, delay and error rate by varying the number of packets sent are analyzed. The error rate is corrected by this new algorithm. In this algorithm, the parameter analyzed is throughput with respect to the number of packets sent from source to destination [14]. The error rate decreases, thereby leading to improvement in throughput.

VII. PARAMETER ANALYSIS

1. THROUGHPUT RATIO

Throughput is the amount of work that a computer can do in a given time. Historically, throughput has been a measure of the comparative effectiveness of large commercial computers that run many programs concurrently. "Cost per million instructions per second (MIPS)" provides the basis for comparing the cost of raw computing by time or by manufacturer. Throughput theoretically tells how much useful work the MIPS is carrying out. The throughput is usually measured in bits per second or data packets per time slot. It can be calculated as maximum throughput, maximum theoretical throughput, maximum sustained throughput, peak throughput, normalized throughput and so on. When examining throughput, the term 'Maximum Throughput' is frequently used. Maximum throughput is essentially synonymous to digital bandwidth capacity. Four different values have meaning in the context of "maximum throughput", used in comparing the 'upper limit' conceptual performance of multiple systems.

They are, 'Maximum Theoretical Throughput', 'Maximum Achievable Throughput', 'Peak Measured Throughput' and 'Maximum Sustained Throughput'. Comparing throughput values is also dependent on each bit carrying the same amount of information. Data compression can significantly skew throughput calculations, including generating values greater than 100%. If the communication is mediated by several links in series with different bit rates, the maximum throughput of the overall link is lower than or equal to the lowest bit rate. The lowest value link in the series is referred to as the bottleneck. In this algorithm , the parameter analyzed is throughput, with respect to the number of packets sent from source to destination [14].



In the pictorial representation of the process, the increasing rate of throughput ratio are clearly specified.

Formula:

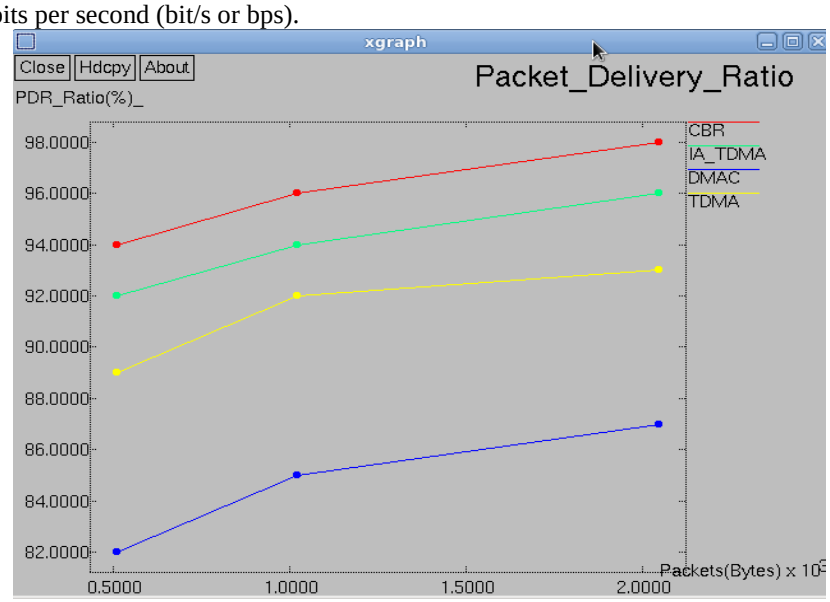
Transmission Time = File Size / Bandwidth (sec)
Throughput = File Size / Transmission Time (bps)

2. PACKET LOSS

Packet loss: occurs when one or more packets of data travelling across a network fail to reach their destination. Packet loss can be caused by a number of factors, including signal degradation over the network medium due to multi-path fading, packet drop because of channel congestion, corrupted packets rejected in transit, faulty networking hardware and faulty network drivers or normal routing routines. In addition to this, packet loss probability is also affected by signal to noise ratio and distance between the transmitter and receiver. In this algorithm, the packet loss is analyzed with respect to the number of packets sent.

3. PACKET DELIVERY RATIO

Packet delivery ratio: is the ratio of number of packets received to number of packets generated. The throughput is usually measured in bits per second (bit/s or bps).



In the pictorial representation of the process, the increasing rate of delivery ratio are clearly specified.

4. BIT ERROR RATIO

In data transmission, the **bit error rate** or **bit error ratio** (BER) is the number of received bits that have been altered due to noise, interference and distortion, divided by the total number of transferred bits during a particular time interval. If the bit error rate is more, the error correcting code should be more, and, if the BER is less the error correcting code is small enough to correct the erroneous packet

.

5. DELAY

Delay is another parameter where it is very important in case of real time data transfer. In audio and video, it does not matter much as it is soft real time, but in case of hard real time where a little delay leads to dangerous situation, delay plays an important role. So, depending upon the requirement, delay parameters are analyzed.

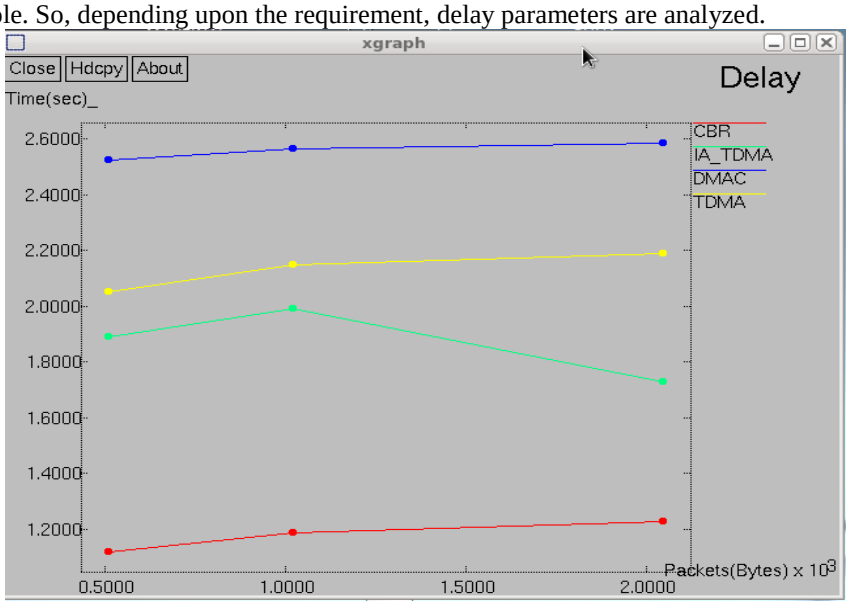


Figure : 1 - Comparison of Delay

	DMAC	TDMA	CBR
Processing Delay	3631.13	2978.42	2095.34
Processing Energy	12245.6	11106.2	10568.3
Aggregation Delay	74.39	69.98	50.56
Aggregation Energy	65.12	58.57	49.9

Table : 1 - Comparison of Delay and Energy

As seen in the above table, DMAC and TDMA are already existing algorithms. CBR is the algorithm born out of the present study. The mobility of the sensor network deserves more importance in the present research the algorithm specified has resulted inn further reduction of Aggregate Delay and Aggregate energy.The pictorial representation of the process, the reduction in delay and energy are clearly specified.

Performance comparison of proposed CBR with existing approaches based on Processing Delay

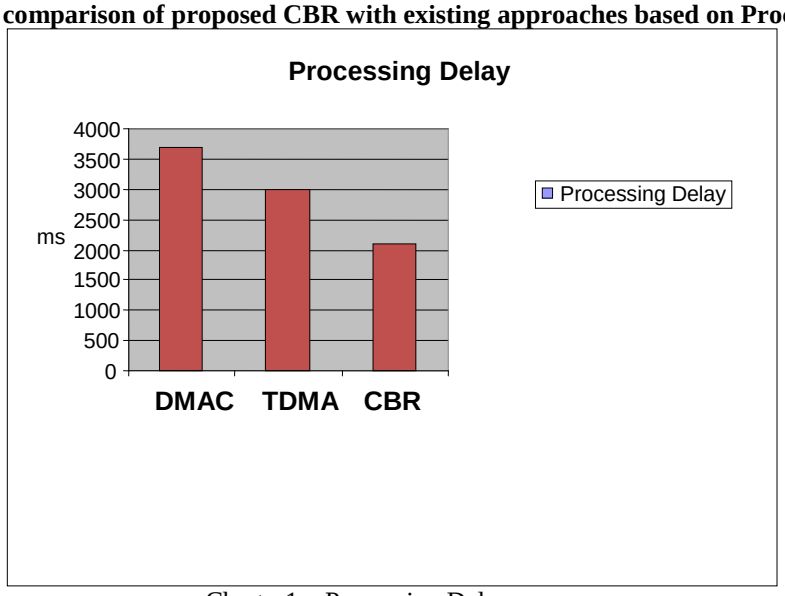


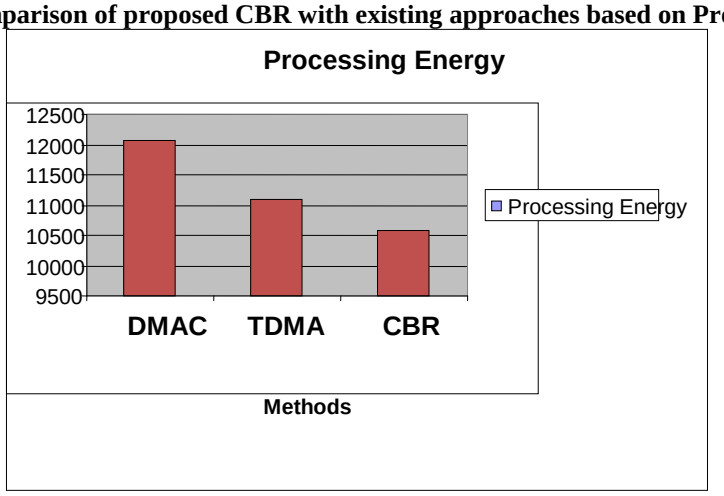
Chart : 1 – Processing Delay

The above chart shows the performance measure based on the processing delay. The proposed approach CBR consumed less time compared to the other methods, and the worst time complexity is DMAC.

6. ENERGY CONSUMPTION

Energy consumption: is also a parameter to be analyzed in case of wireless sensor networks. As the sensors gather information throughout the day, power saving is crucial.If the number of retransmission is more, the power consumption will be more, which is not fair in case of tiny sensor nodes. The battery used is charged through environment. So, solar cells are mostly used in these sensors. Energy saving is also an important parameter, especially where sensors are deployed in remote areas.

Performance comparison of proposed CBR with existing approaches based on Processing Energy



The chart shows the performance measure based on the processing energy.T
he proposed approach CBR makes use of less energy while comparing the other methods and the worst time complexity is DMAC.

7. DISTANCE

Distance between the transmitter and receiver is another parameter, which decides the number of errors. The decrease in error rate increases the throughput. The error rate is decreased with the help of the new technique. Packet delivery ratio increases as the number of packets sent increases. The performance of the network is better even though the packets sent are more, so that the cache technique improves the packet delivery ratio. If more number of packets are transmitted without loss, then the throughput and packet delivery ratio automatically increase.

Data size	DMAC	TDMA	IA_TDMA	CBR
512	3642	4190	4874	4995
1024	4286	4923	5130	5947
2048	12101	12687	13984	14836

Table : 2 – Comparison of Throughput Ratio

Comparative analsyis of four different research papers:

1. An adaptive energy-efficient and low-latency MAC for tree-based data gathering in sensor networks,
2. Enhancing the data collection rate of tree-based aggregation in wireless sensor networks,
3. Fast data collection in tree-based wireless sensor networks, and
4. Energy efficient hierarchical based .

	1 (DMAC)	***2 (TDMA)***	***3 (Interference-aware TDMA protocol)***	***4 (CBR)***
Abstract	*The paper proposed DMAC, energy efficient and low latency MAC that is designed and optimized for data gathering trees in wireless sensor networks.*	*Proposed TDMA scheduling on a single channel, reducing the original problem to minimizing the number of time slots needed to schedule each link of the aggregation tree.*	*In this paper, fast converge cast in WSN where nodes communicate, using a TDMA protocol to minimize the schedule length is studied. The fundamental limitations due to interference and half-duplex transceivers on the nodes and explored techniques to overcome the same are addressed.*	*In this paper, cache based revised algorithm is used to minimize the reconstruction delay, power consumption and so on.*
Tree Format	*Collects data from various sensor source nodes to a sink via a unidirectional tree.*	*Degree-constrained routing trees used.*	*Degree-constrained spanning trees and capacitated minimal spanning trees used.*	*Hierarchical trees used.*
Approach (Scheduling)	*This utilizes active/sleep schedule of a node, an offset that depends upon its depth on the tree.*	*Introduces a simple receiver-based frequency and time scheduling approach.*	*This combines the scheduling with transmission power control to mitigate the effects of interference along with the single frequency channel.*	*This utilizes the cache memory when tree get reconstructed.*
Data Collection	*Sensor source nodes send the data to a sink via a unidirectional tree.*	*Sensor source nodes sends the data to a sink via a tree topology.*	*1.Aggregated converge cast where packets are aggregated at each hop.* *2.Raw-data converge cast where packets are individually relayed towards the sink.*	*Sensor source nodes sends the data to a sink via hierarchical topology*
Aim	*DMAC is designed to solve the interruption problem.* *DMAC is proposed to deliver data along the data gathering tree, aiming at both energy efficiency and low latency.*	*The aim is to find a TDMA schedule which can support as many transmissions as possible in each time slot.*	*Aims to minimize the number of time slots required.Another main objective is to calculate the minimum achievable schedule lengths using an interference-aware TDMA protocol.*	*Aims to enhance the data collection rate high, minimize the time and power consumption.*
Advantages	*DMAC also adjusts node duty cycles adaptively ,according to the traffic load in the network, by varying the number of active slots in a schedule interval.*	*TDMA can eliminate collisions and retransmissions and provide guarantee on the completion time as opposed to contention-based protocols.*	*IA-TDMA reduces the schedule length.*	*Reduces the power consumption and manage the sensor nodes mobility.*

Disadvantages	*The interference between nodes with different parents could cause interruption in traffic flow.*	*The gains with the degree constrained trees may be costly in terms of latency due to the increased number of hop distances to the sink node. Another issue to be considered is that some nodes may have a lot of data that require more than one time slot per frame while some others do not have any data to fill a time slot. Hence the bandwidth may be wasted*	*Fails if the sensor nodes are highly movable and the IA-TDMA is not reliable for dynamic updation.*	*Mobility rate increases can disturb the collection rate.*

Table : 4- Comparison of Various Parameters with Respect to Number of Packets Sent

VIII. RESULTS AND ANALYSIS OF SOFTWARE

This paper utilises ns2(network simulator) for carrying out research in computer networks. The simulator is written in C and implements the Random Mobility Model. It is an event driven simulator which is an open source simulator used for network research. Here, there are many possibilities to simulate many protocols before the process is implemented. Typically, it can be customized according to the specific analysis. ns2 support is used for famous protocols like IPv4,IPv6 UDP and TCP. Most of them are GUI-driven and some of them are input network parameters.The events (nodes meeting, node arrival at its selected destination and alarms time-out) are pushed to and pulled from an ideal time-line. Initially, nodes are assumed to be randomly deployed over a network area. Then, until the simulation ends, for each node, a random speed and destination location are randomly chosen (within the bounds set by the user): this implies analysis and ordering all the meeting events and the node arrival events with reference to the time-line. While the time goes by, the events on the time-line are processed. The events corresponding to node arrival are processed as previously described (choosing a destination, a node speed and analyzing the new generated events). The data aggregation events are processed as the core part of the protocol. Updating the data and cache, tree information with the retrieved hops are examples.

In The Tree with Cache based Data Aggregation all nodes are organized in the form of a tree, i.e., hierarchical, with the help of intermediate node. This can perform data aggregation process and data transmit leaf node root node. Tree-based data aggregation is suitable for applications which involve in network data dynamic and fast aggregation.

Here, the performance of the routing protocol is evaluated, using the NS-2(version 2.35) stimulator.

IX. CONCLUSION

The research scholar is confident that this humble research work will add to the already existing list of highly advanced algorithms.

REFERENCES

[1] OzlemDurmazIncel, Ghosh.A, Krishnamachari .B , Chintalapudi.K, “Fast Data Collection in Tree Based Wireless Sensor Networks”, Vol. 11, issue :1 Pp. 86-99, Jan 2012

[2] Jong-Suk Ahn, Seung-Wook Hong and John Heidemann, An Adaptive FEC CodeControl Algorithm for Mobile Wireless Sensor Networks, Journal of communications and networks, Vol. 7, no. 4, December 2005.

[3] d’Aspremont, A.(2011) Identifying small mean-reverting portfolios. Quantitative Finance,11:3, 351-364

[4] Liang, Li (2011). Parallel implementations of Hopfield neural networks on GPU. Tech Rep.DépótUniversitaire de MémoiresApres Soutenance.

[5] Seydel, R. U. (2006) Tools for computational finance. Springer, 3rd edition

[6] Holger Karl, Andreas willig, “Protocols and architectures for Wireless sensor networks”,1970.

[7] Akyol, D.E., & Bayhan, G.M. (2008) Multi-machine earliness and tardiness scheduling problem: an interconnected neural network approach. International Journal of Advanced Manufacturing Technology, Springer-Verlag London Limited 37:576-588

[8] Brucker, P. (2007) Scheduling Algorithms. Fifth Edition, New York: Springer.

[9] Chang, T.-J., Meade, N., Beasley, J.E. and Sharaiha, Y.M. (2000). Heuristics for cardinality constrained portfolio optimisation. Computers and Operational Research, 27: 1271–1302.

[10] Di Tollo, G., and Rolli, A. (2008) Metaheuristics for the portfolio selection problem.International Journal of Operations Research, 5:13–35.

[11] Dr. P. C. Jain et al. / International Journal of Engineering Science and Technology (IJEST) ISSN : 0975-5462 Vol, 5 No.01 January 2013.

[12] Rahman.M.A. "Effective Caching in Wireless Sensor Network" Advanced Information Network and App. Workshop Vol 1. No.1 May 2007.

[13] O. Akan and I. Akyildiz, "Event-to-Sink Reliable Transport in Wireless SensorNetworks", IEEE/ACM Transactions on Networking, Vol. 13, No.5, pp. 1003–1016,Oct. 2005.

[14] Andreas Kpke, Andreas Willig and Holger Karl, "Chaotic Maps as Parsimonious Bit ErrorModels of Wireless Channels", Proceedings of the IEEE Infocom, Vol.22, no. 1, Pp.513-523, March 2003.

[15] Anagnostopoulos, K.P. and Mamanis, G. (2011) The mean-variance cardinality constrained portfolio optimization problem: An experimental evaluation of five multi-objective evolutionary algorithms. Expert Systems with Applications, 38:14208-14217.

[16] Shiow-Fen Hwang, Kun-Hsien Lu, Tsung-Hsiang Chang, Chyi-Ren Dow, (2008) "Hierarchical data gathering schemes in wireless sensor networks", International Journal of Pervasive Computing and Communications, Vol, 4 Iss: 3, pp.299 – 321

[17] A.Ghosh, O. Durmaz, V.A.Kumar and Krishnamachari "Multi Channel Scheduling Algorithms for fast aggregated convergecast in Sensor networks" IEEE Conf. mobile ad hoc and sensor system 2009.

[18] Carla-Fabina Chiasserinica, Politecnico di Torino C.Duca " On Data Acquisition and Field Reconstruction in Wireless sensor network" , Department of Electronica 24,I-10129.

