Dynamic Multilevel Priority Packet Scheduling Using Hybrid Seec

Sonam Gupta, Kanika Sharma

Abstract: The process of scheduling is indispensable for efficient use of resources available with the wireless sensor networks such as battery lifetime available with the wireless sensor networks. Numerous scheduling techniques are usedincluding dynamic multilevel priority packet scheduling technique which is a great solution for providing fairness and minimizing delay for the network involving both real time and non-real time data. Dynamic multilevel priority packet scheduling scheme makes use of zone based routing algorithm in which the sensor nodes are arranged in zones. Although this technique presents great results but still the energy efficiencycan be improved by inculcating the pros of a stable and energy- efficient clustering algorithm with the above mentioned scheduling technique. The clustering technique makes use of advanced nodes along with normal nodes. The advanced nodes are equipped with extra energy and are responsible for the maximum data aggregation. The node arrangement is done in such a way that the energy of normal nodes is utilized minimally and no data is aggregated by them. The advanced nodes are in close proximity to the base station and their energy is utilized efficiently. Thus network lifetime is improved as the nodes remain alive for more time.

Index Terms : Wireless sensor networks, dynamic multilevel priority packet scheduling, hybrid stable and energy efficient clustering, TDMA, advanced nodes.

1. INTRODUCTION

Wireless Sensor Networks (WSNs) seem to have substantial prospective in almost every application domain extending from military applications and health monitoring to home automation. Wireless sensor networks constitute the backbone of IOT. The essential components of wireless sensor networks constitute sensors and sometimes actuators which promptly interact with the environment to pursue some purpose. A wireless sensor network is a group of so called wireless sensor nodes which can further be defined as sensing, computing and communicating elements. Sensor nodes are distributed in a sensor field. To procure data, individual sensors sense physical phenomena from the physical environment in vicinity and route data to variety of sensors i.e. sink, cluster heads and other users. Data are transmitted to the end user either via multihop architecture or via singlehop architecture through the sink. The sink can interact with the task manger node via Internet or satellite and ultimately the sensed data is made available to the end user for his access. Sensor nodes coordinate among themselves to generate processed and relevant information about the area under observation wherein appropriate routing protocol is being used for the same. They have become indispensable part of our daily life and energize numerous applications as miscellaneous as animal welfare, medical supervision, forest fire detection, home automation, data tele-monitoring, smart industries, and a lot more[1], [2].

The pace of world adoption of sensor networks is restricted due to a no. of cons including real time data mismanagement, packet dropping, unwanted delays, lesser network lifetime, large waiting time and inefficient energy utilization. Problem of inefficient energy utilization is overcome by considering sensor nodes with their sleep wake times and schedule them as mentioned in different research studies. So for idle nodes, for efficient energy utilization, the sleep scheduling can be applied [3], [4], [5], [6], [7]. Dropping of packet bundles will rely on upon the qualities of system including parcel size, data transfer capacity, packet arrival rate, deadline of packet. Thus packet scheduling can be used to schedule the packets in order to reduce the rate of packet drop as shown in figure 1. However what remain the main restraints while designing the scheduling schemes for the networks are the prioritization of data, minimization of end to end delay, network lifetime maximization, efficient energy consumption, reduced waiting time and delivery of data before expiration of deadline as if all the parameters can be minimized further. Conventionally used packet scheduling schemes do not show any adaptability to the dynamic environment. For instance, the priorities assigned to the real time packets are kept fixed and are not altered during WSN operations. [8], [9], [10], [11].

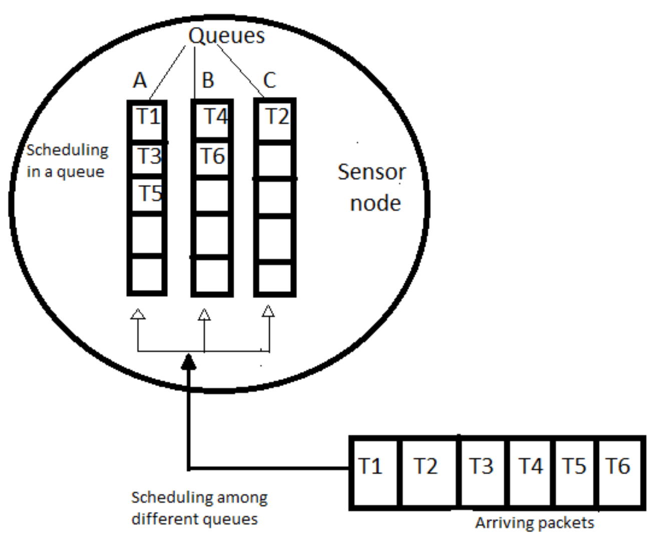

Fig. 1 *Packet scheduling at a sensor node.*

- *Mrs. Sonam Gupta is pursuing M.E.(ECE) from National Institute of Technical Teachers Training and Research, Chandigarh, India. She is currently working as Assistant Professor at Model Institute of Engineering and Technology, Jammu, India. She has eight years of teaching experience. Her research areas include wireless sensor networks and communication. Ph-9796462010. E-mail: sonam.gupta2188@gmail.com*
- *Dr. Kanika Sharma is currently Assistant Professor at National Institute of Technical Teachers' Training & Research, Chandigarh, India. She has completed her PhD from Panjab Technical University, Jalandhar, India. She has completed her M.E. from PEC, Chandigarh, India, B.E. from Vaish College of Engineering, Rohtak in 2001. She has 12 years academic experience. Her research interests include routing protocols in wireless sensor networks and energy-efficient MAC protocols in WSNs.e-mail:kanikasharma80@yahoo.com*

The Dynamic Multilevel Priority (DMP) packet scheduling technique exists for WSNs in which the sensor nodes are arranged into a hierarchical structure. Nodes at the same hierarchical level are ones having same no. of single hops from the BS. TDMA scheme is used for processing of data packets at different levels. Three level priority queue is being maintained at each node. These levels constitute topmost priority level with real-time preemptive data, lower priority level with non-real-time preemptable data packet received from other nodes and least priority level with non-real-time local data packets sensed at the node itself. Real time data is being scheduled and processed using First Come First Serve (FCFS). Non-real-time data traffic is being scheduled and processed using Shortest job first (SJF). This technique ensures the packet delivery on the basis of their priority with lesser delay in contrast with different types of Schedulers like First Come First Served (FCFS), Earliest Deadline First (EDF) which involves the arrival time and deadline as their basis of data processing respectively. It somehow reduces the delivery time of packets to the destination and also reduces the consumed energy [12], [13]. In this article, an improved dynamic multilevel priority packet scheduling inculcated with a hybrid SEEC protocol that combines the advantages of multilevel priority based scheduling with that of energy efficient protocol is proposed. The network comprises of a no. of clusters. Each cluster contains a special node called as advanced node (AN) and few randomly organized normal nodes (NNs). The NNs perform sensing operation and AN perform data aggregation. The scheduling scheme results in the reduced waiting time and reduced end to end delay and the hybrid SEEC protocol improves the throughput, increases the no. of alive nodes for a particular time period resulting in the increased network lifetime and reduces the energy consumption thereby improving the overall performance of the network. The performance of DMP with hybrid SEEC is compared by conventional DMP scheme employing zonal routing protocol [14], [15]. The remaining paper is arranged as follows: Section 2 provides a detailed literature review. In section 3, the preliminaries are discussed. The proposed technique DMP with hybrid SEEC protocol is presented in Section 4. Lastly, the conclusion is presented in Section 5.

2 RELATED WORKS

In this section, existing packet or task scheduling schemes are presented. A priority scheduling based real time architecture for sensor networks has been proposed. Priority was allotted to the data based on longest travelled distance and shortest deadline. The network traffic was reduced thereby reducing data processing overhead but the processing delay was increased [16]. Another packet scheduling based real time algorithm for sensor networks was presented. It used loop free Bellman- Ford algorithm to minimize traffic load and delay between nodes. It was based on EDF scheduling. The data packets with expired deadline were dropped but prioritization at each node was not satisfactory [17]. Researchers proposed a dynamic priority based packet scheduling to be used in Tiny OS which can ultimately be either cooperative or preemptive. The former ones are based on EDF and ADRS. Thus they are widely used in the applications where there are no stringent real time requirements.. The latter ones are based on Emergency Task First Rate Monotonic scheme. This scheme exhibits long execution time and starvation of real time packets [18]. An improved priority scheduling algorithm was presented in which the schedulers navigate the packet containing waiting queue and the small packets are chosen as high priority tasks.. This scheme makes the high priority packets to get executed easily and non-implementation of low priority packets [19]. On the basis of number of queues, a multilevel queue scheduler was proposed in which variable number of queues based on the sensor node site in the network. Multi- FIFO and priority based scheduling were used in this algorithm. The former consisted of maximum three queues and the priority was decided on the basis of hop count of the packet. A high starvation rate was exhibited in this scheme[20]. Another priority queue scheduling algorithm for wireless sensor networks without the concept of variable number of queues. Four queues were considered with the first three having the highest priority and scheduled in the round robin fashion. The limitation of overall end to end delay existed in this technique[21]. A priority based Dynamic Multilevel Priority Packet Scheduling scheme for wireless sensor networks was proposed which involved sensor nodes that are organized hierarchically. Zonal routing protocol was inculcated for routing packets. This routing protocol was selected to increase the efficiency of proposed scheme with the properties of energy efficiency and balance in energy consumption. The processing of different level sensed data packets was done using Time Division Multiple Access scheme. Three level priority queue was considered for real time data, non-real time local data and non- real time remote data. Shortest Job First was used for processing non real time data with similar priority. Average task waiting time and end-to-end delay was improved. Deadlock condition persisted. End-to-end delay was increased. Tasks with expired deadline s increased the processing overhead unnecessarily[22]. Some existing routing protocols are presented. A heterogeneous stable and efficient clustering protocol was presented. The characteristics of energy efficiency and stability are both incorporated in this protocol. Two types of nodesi.e. advanced nodes and normal nodes were used in this scheme. Normal nodes perform sensing and advanced nodes perform aggregation of data and transmission of aggregated data to base station. Energy saving is achieved using this protocol. It provided high throughput, prolonged network stability period, less energy consumption, overhead in a reduced manner and ultimately enhanced energy efficiency[14]. A Threshold Sensitive Stable Election Protocol [23]for Wireless Sensor Networks is proposed which is a stability oriented protocol that incorporates nodes within a three level energy arrangement. This sis a threshold based scheme and if not achieved, no information is generated at the user end. In comparison, a better Energy Efficient heterogeneous[24] clustered scheme was devised for sensor networks which was based on the random selection of cluster headstherefore not depending upon the threshold whereas in Modified Stable Election Protocol[25], the selection was done on the basis of weighted probability. From the above discussion, conclusion can be drawn that some studies involve efficient scheduling algorithms and other studies involve stable routing algorithms. The objective of this paper is to implement an efficient scheduling algorithm along with an improved routing algorithm by reducing the average task waiting time and end to end delay with reduced energy consumption and increased stability of the network.

3 PRELIMINARIES

This section presents the assumptions being made and explains various terms used in the proposed technique.

3.1 Assumptions

Following assumptions are being made for designing and implementing DMP scheduling technique using hybrid SEEC

- Only two types of data i.e. real-time and non-real-time data is considered.
- Data packets are taken with same size.
- Only sensing with no data aggregation is performed at normal nodes.
- Nodes positioned at different levels are based on their hop count measured from BS such that the normal nodes lie at the lowest level, the cluster heads at next higher level and lastly the advanced nodes at the highest level.
- TDMA is used to allocate timeslots to the nodes at different levels.
- MAC protocol is used to send the multiple packets simultaneously in order to alter the data size.
- No node lies in between the advanced nodes and the base station.

3.2 Terminologies

This section explains the various terms that are used in the proposed technique. Routing Protocol: To maximize the energy efficiency and network lifetime and throughput of the network, we have employed hybrid SEEC protocol. In this protocol, a number of clusters are combined to form the network wherein a cluster head represents each cluster. Normal nodes are distributed randomly in each cluster. The cluster head after receiving the data coming from normal nodes forwards it to the powerful advanced nodes deployed to form a circle with base station at the center. The advanced nodes aggregate all data and transfer them to base station. This routing protocol increases the network lifetime, reduces average waiting time and reduces the average energy consumption. TDMA Scheme: At each node, TDMA scheme is used for scheduling the packets at different levels. The cluster heads and advanced nodes perform data aggregation and have more processing requirements and thus timeslots with longer length are allotted to these nodes whereas the normal nodes with lesser processing overhead are allotted shorter length.

Metrics: Following metrics are used in the proposed scheme.

- End-to-end Delay- It is defined as the delay encountered by data packet in reaching the destination from source. Precisely, it is the interval between the source sending time and the destination receiving time of considered packet.
- Total task waiting time- It is the total time taken by a group of tasks lying in a queue at a time before their completion.
- No. of alive nodes per given rounds-It is the no. of nodes whose energy has not completely expired and ultimately exhibit network lifetime.
- No. of dead nodes per given rounds- It is the no. of nodes whose energy has completely expired[26].

5 PROPOSED ALGORITHM

1. Problem Statement

The average waiting time for non-real time applications is high and it leads to the deadlocks in some cases where if the real time data streams continuously. Also network throughput is reduced. Some cluster heads are lying far from base station which leads to more energy consumption while transmission and ultimately result in reduced network lifetime. To eradicate such limitations, a dynamic multilevel priority packet scheduling technique inculcated with hybrid SEEC is proposed.

2. Problem Scheme

This paper resolves various existing issues and also improves the performance of the network. This scheme offers a three level heterogeneous wireless sensor network that uses dynamic multilevel priority packet scheduling scheme inculcated with hybrid stable and energy efficient clustering as shown in fig. 2. The network is divided into a number of clusters each headed by a node called as Cluster Head (CH). Various randomly deployed normal nodes from a cluster. The normal nodes sense data and transmit them to cluster head. Thus various cluster heads aggregate data and forward to special powerful nodes called as Advanced Nodes as shown in fig. 3.

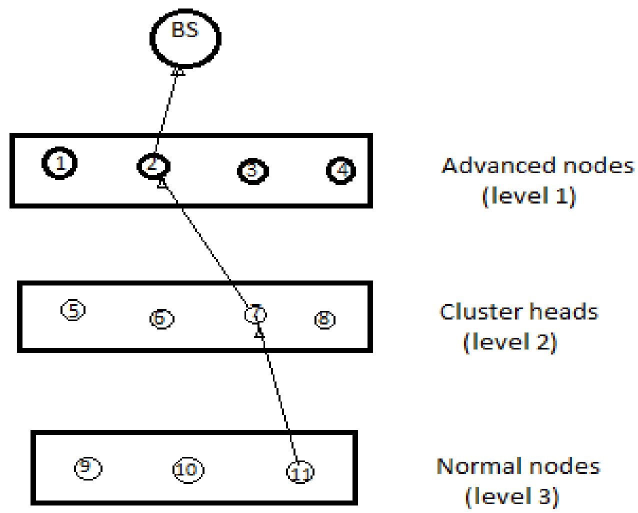

***Fig. 2** Hierarchy of three level heterogeneousnetwork*

The advance nodes are few in numbers there by possessing more energy than normal nodes and lie very close to the base station. Thus data aggregation and processing is done at two levels i.e. Advanced Nodes and energy consumption is reduced since Advanced Nodes lie in close proximity of base station thus requiring lesser energy to transmit data. Also memory possessed by advanced Nodes is more as compared to normal nodes. Thus more packets are stored and transmitted to base station thereby reducing the end to end delay for various packets. Since most of the processing is done at Advanced Nodes, normal nodes will have to spend lesser energy thereby increasing the network lifetime. The cluster heads are dynamic and new cluster heads will be formed after each round depending upon the distance from functional nodes. The optimum number of Advanced Nodes that are required without increasing the cost of the network will be determined analytically. The number of the Advanced Nodes is considered to be a percentage of the total nodes in the network. This percentage is calculated after keeping a tradeoff between cost involved and the advantages offered by

the network over conventional networks. More the number of Advanced Nodes more will be the cost involved and lesser the number of Advanced Nodes, lesser will be the advantages inherited in the network. The advantages offered by them are more available energy, bigger memory stack, and lesser energy consumption due to smaller distance from base station. The advanced nodes are arranged forming a circle with base station as center. Base Station is generally located in center of the network in order to form a symmetric network. The nodes are randomly deployed in the network area. Before designing the network, it is ensured that no normal node must lie in between the circle formed by Advanced Nodes around the base station, since Advanced Nodes are the only nodes connected to the base station and in the close proximity of base station. This is also done to avoid any extra routing from CH to normal nodes thereby reducing the consumed energy. Let N be the total no. of nodes, N_{AN} be the no. of advanced nodes, N_{NN} be the no. of normal nodes, E_0 be the initial energy of normal nodes, $E_0(1+□)$ be the initial energy of advanced nodes, N_C be the no. of normal nodes in each cluster (where $N_C = N_{NN}/ N_{AN}$), E_{DA} is the cost indulged in the data aggregation for a bit to the base station, E_{dis} be the energy dissipated per bit, $□_f$ be a constant depending upon transmitter amplifier, R be the distance between AN and BS and d_{NA} be the distance between normal node and connected AN. The number of advanced nodes and the required energy for these nodes are calculated analytically for optimal values.
The optimal no. of advanced nodes N_{AN} is

$$N_{ANoptimal} = 0.7668\sqrt{N_{NN}} \quad (1)$$

It is evident from the equation that the optimal value for N_{AN} is a function of number of normal nodes $N_{NN.}$

The value of □ is

$$□ \geq (□/\beta) -1 (2)$$

$$\text{Where}□ = N_C E_{dis} + N_C E_{DA} + E_{dis} + □_f R^2 \quad (3)$$

$$\text{and} \quad \beta = E_{dis} + □_f d_{NA}^2 \ (4)$$

After the network design has been implemented dynamic scheduling scheme has to be designed too.
When the data in the form of packets are collected by a single node either by sensing or receiving from other nodes, scheduling of real- time and non-real data has to be performed among number of levels. We are considering multilevel queue which is dynamic in nature. The nodes are assumed to be arranged level wise forming a hierarchy. Normal nodes are said to be a lower level, cluster heads are said to be a slightly higher level and Advanced Nodes are at highest level since they are the closest ones to the base station. TDMA scheme is applied for processing of data packets at different levels. Multilevel queue is formed at each node containing three levels Priority A, Priority B, and Priority C. The arrived real time packets are assigned the topmost priority A queue, non –real time remote data packets are assigned the second highest priority B queue and non-real time local data packets are assigned the lowest priority C queue. Here Advanced Nodes and Cluster Heads are both treated as nodes that receive remote data. Thus in case of non-real time data streaming, both nodes will send their data to B queue that contains non-real time remote data packets. For instance, if real time data packets are sensed, they will be processed first using FCFS i.e. first come first served. Whereas in case of non-real time data arrival, we use SJF i.e shortest job first scheme to process the data. Thus this technique will help to reduce the end to end delay and also minimize average task waiting time.

5 RESULTS AND DISCUSSION

In this section, the performance of dynamic multilevel packet scheduling with hybrid SEEC is compared by dynamic multilevel scheduling with zone based routing on the basis of end to end delay of real time tasks, average waiting time of real time tasks, no. of dead nodes for same number of rounds and no. of alive nodes for same no. of rounds. The network is simulated using Matlab. No. of nodes were taken as 300. The network size is taken to be 100m*100m with no. of rounds 11000. Initial normal node energy is taken to be 2Joules and advanced node energy is taken to be 5J.The energy required for transmission and reception is taken as 50nJ/bit. The energy of transmit amplifier is taken as $10pJ/bit/m^2$. Fig.3 shows the comparison between the end to end delay between DMP using hybrid SEEC termed as 'Moded SEEC' in the graph and DMP using zone based routing as 'base routing'. It can be clearly seen that delay shows a clear difference using hybrid SEEC routing. The delay was comparable at 5 no. of levels but it keeps on reducing drastically as the no. of levels goes on increasing. Hence, the end to end delay is improved considerably.

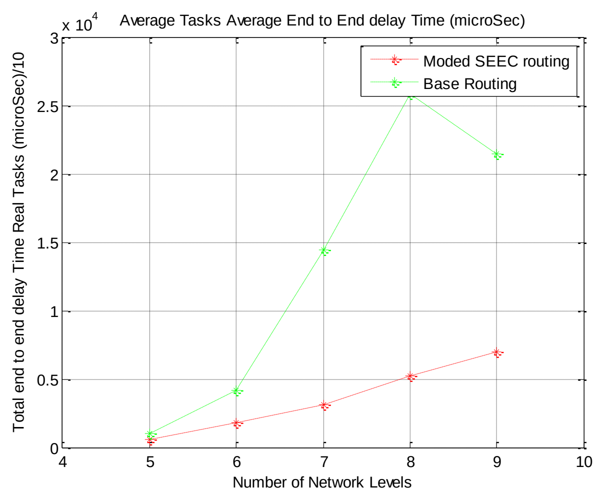

Fig. 3 *End to end delay over a number of levels.*

Fig.4shows the comparison between total waiting time of real tasks between DMP using hybrid SEEC termed as 'Moded SEEC' in the graph and DMP using zone based routing as 'base routing'. It can be clearly seen that waiting task time showsreduced values using hybrid SEEC routing for same no. of levels. The delay using proposed scheme however increases at 5 and 6 no. of levels in comparison to base scheme but it keeps on reducing drastically as the no. of levels goes on increasing. Hence, the task waiting time for real tasks shows an improvement.

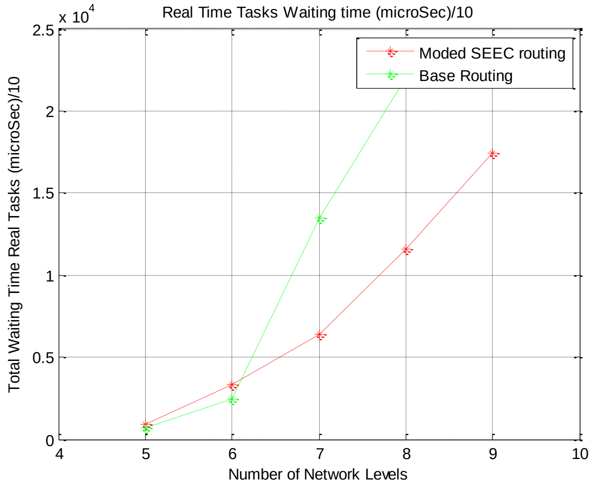

***Fig. 4**. Total waiting time of real tasks*

Fig. 5 shows the comparison between total no. of dead nodes for a given no. of rounds. On viewing the graph, we can see that the nodes started dying on reaching 400 no. of rounds in the base scheme whereas the nodes started dying on reaching 1200 no. of rounds. Also, all the nodes in the base scheme are dead at2200 no. of rounds and at 3800 no. of rounds in the proposed Hybrid SEEC. Thus, the network lifetime i.e. the time from the first dead node till death of last node is much more in case of prosed Hybrid SEEC.

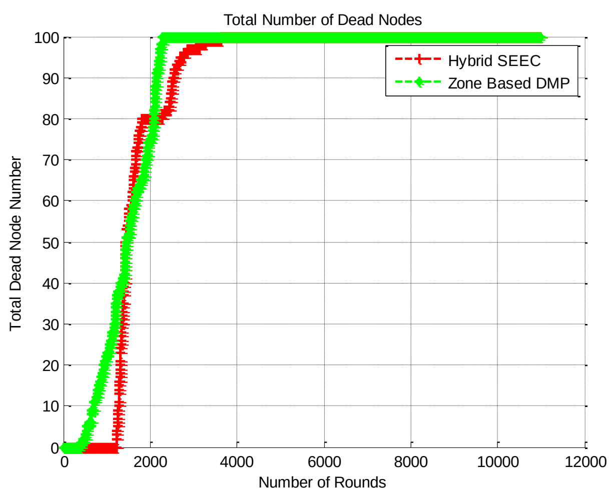

***Fig. 5** Total no. of dead nodes*

Fig. 6 shows the comparison between total no. of alive nodes for a given no. of rounds. On viewing the graph, we can see that the nodes started dying earlier in zone based DMP in comparison to the Hybrid SEEC. Also, all the nodes died in case of base scheme but the few nodes were still alive in case of hybrid SEEC. Thus, the network lifetime i.e. the time from the first dead node till death of last node is much more in case of proposed Hybrid SEEC.

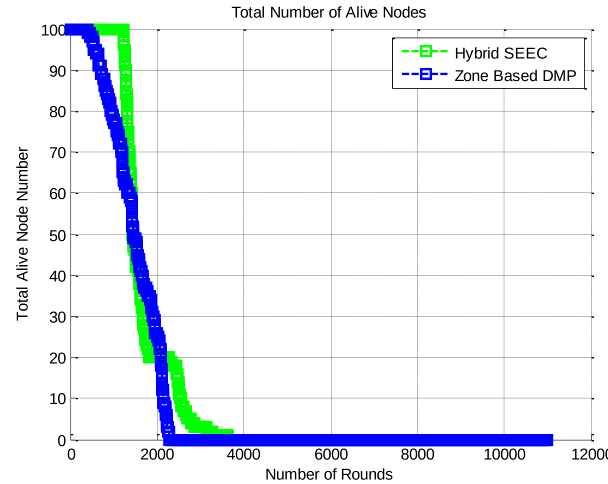

***Fig. 6** Total no. of alive nodes*

Thus, on comparing all the results, an overall improvement is shown in case of Hybrid SEEC when compared to the base scheme zone based DMP. Also, we can conclude that if the network lifetime is prolonged along with the reduction in delay and task waiting time, then the energy of the network is used more efficiently in the proposed scheme.

6. CONCLUSION AND FUTURE SCOPE

In this paper, a packet scheduling scheme is being combined with a clustering technique to ensure the advantages of both to be inculcated in a single technique. For efficient delivery of the data packets, a multilevel priority packet scheduling technique that is dynamic in nature is used along with a hybrid stable and energy efficient clustering technique. This improved technique results in reduced end-to-end delay and reduced average waiting time of data. It also guarantees the consumption of lesser energy and a prolonged network lifetime. Thus, overall performance of the network is improved by using this technique. In future, the super nodes with more energy than the advanced nodes can be inculcated along with the normal and advanced nodes for much better results.

REFERENCES

[1] I.F. Akyildiz, W. Su, Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks,"IEEE Communications Magazine,vol. 48, no. 8, pp. 102-114, Aug. 2002.
[2] P. Papageorgion, "Literature Survey on WSN,"IEEE Communications Magazine,July 2003.
[3] E. Bulut and I. Korpeoglu, "DSSP: a dynamic sleep scheduling protocol for prolonging the lifetime of wireless sensor networks," International Conference of Advanced Information Networking Application, vol. 2, pp. 725– 730, Aug. 2007.
[4] P. Guo, T. Jiang, Q. Zhang, and K. Zhang, "Sleep scheduling for critical event monitoring in wireless sensor networks," IEEE Tranctions on Parallel Distributed System, vol. 23, no. 2, pp. 345–352, Feb. 2012.
[5] F. Liu, C. Tsui, and Y.J. Zhang, "Joint routing and sleep scheduling for lifetime maximization of

wireless sensor networks," IEEE Transactions on Wireless Communications, vol. 9, no. 7, pp. 2258–2267, July 2010.

[6] S. Paul, S. Nandi, and I. Singh, "A dynamic balanced-energy sleep scheduling scheme in heterogeneous wireless sensor network," IEEE International Conference on Networks, pp. 1–6, 2008.

[7] A.R. Swain, R.C. Hansdah, and V.K. Chouhan, "An energyaware routing protocol with sleep scheduling for wireless sensor networks," IEEE International Conference on Advanced Information Network Applications, pp. 933–940, 2010.

[8] S. Jagabathula and D. Shah, "Fair Scheduling in Networks Through Packet Election", Information Theory, IEEE Transactions, vol. 57, pp. 1368-1381, March 2011.

[9] X. Yu, X. Xiaosong, and W. Wenyong, "Priority-based low-power task scheduling for wireless sensor network," International Symposium on Autonomous Decentralized System, 2009.

[10] N. Edalat, W. Xiao, C. Tham, E. Keikha, and L. Ong, "A price-based adaptive task allocation for wireless sensor network,"IEEE International Conference on Mobile Adhoc Sensor Systems, pp. 888–893, 2009.

[11] F. Tirkawi and S. Fischer, "Adaptive tasks balancing in wireless sensor networks," International Conference on Informative Communication Technology Applications, pp. 1–6, 2008.

[12] L. Karim, N. Nasser, T. Taleb, and A. Alqallaf, "An Efficient Priority Packet Scheduling Algorithm for Wireless Sensor Networks,"IEEE International Conference on Communications, Nov. 2012.

[13] W. Yantong and Z. Sheng, "An Enhanced Dynamic Priority Packet Scheduling Algorithm in Wireless Sensor Networks", UKSim-AMSS 18th IEEE International Conference on Computer Modelling and Simulation, pp. 435 – 440, Sep. 2016.

[14] F. Farouk, R. Rizk, and F.W. Zaki, "Multilevel Stable and Energy Efficient Clustering Protocol in Heterogeneous Wireless Sensor networks," IET Wireless Sensor Systems, vol. 4, no. 4, pp. 159-169, Oct. 2014.

[15] N. Mittal, U. Singh, and B.S. Sohi, "A Stable Energy Efficient Clustering Protocol for Wireless Sensor Network,"International Journal of Wireless Networks, vol. 23, no. 6, pp. 1809-1821, Mar. 2016.

[16] C. Lu, B.M. Blum, T.F. Abdelzaher, J.A. Stankovic, and T. He, "RAP: a real-time communication architecture for large-scale wireless sensor networks," IEEE Real-Time Embedded Technology Applications Symposium, pp. 55–66, 2002.

[17] K. Mizanian, R. Hajisheykhi, M. Baharloo, and A.H. Jahangir, "RACE: a Real-Time Scheduling Policy and Communication Architecture for Large Scale Wireless Sensor Networks," Communication Networks Services Research Conference, pp. 458–460, 2009.

[18] M. Yu, S.J. Xiahou, and X.Y. Li, "A Survey of Studying on Task Scheduling Mechanism for TinyOS,"International Conference on Wireless Communication, Network and Mobile Computing, pp. 1–4, 2008.

[19] Y. Zhao, Q. Wang, W. Wang, D. Jiang, and Y. Liu, "Research on the Priority-Based Soft Real-Time Task Scheduling in TinyOS," International Conference on Information Technology and Computer Science, vol. 1, pp. 562–565, 2009.

[20] E.M. Lee, A. Kashif, D.H. Lee, I.T. Kim, and M.S. Park, "Location Based Multi-Queue Scheduler in Wireless Sensor Network," International Conference on Advanced Communication Technology, vol. 1, pp. 551–555, 2010.

[21] E. Karimi and B. Akbari, "Improving Video Delivery Over Wireless Multimedia Sensor Networks Based On Queue Priority Scheduling," International Conference on Wireless Communication, Network and Mobile Computing, pp. 1–4, 2011.

[22] N. Nidal, L. Karim, and T. Taleb, "Dynamic Multilevel Priority Packet Scheduling Scheme for Wireless Sensor Networks," IEEE Transactions on Wireless Communications, vol. 12, no. 4, pp. 1448-1459, April 2013.

A. Kashaf, N. Javaid, Z. Khan, and I. Khan, "TSEP: Threshold-Sensitive Stable Election Protocol for WSNs," IEEE International Conference on Frontiers of Information Technology (FIT 12), December 2012.

[23] D. Kumar, T. Aseri, and R. Patel, "EEHC: Energy Efficient Heterogeneous Clustered Scheme for Wireless Sensor Networks," Computer Communications, vol. 32, pp. 662–667, 2009.

[24] G. Arya, D. Chauhan, "Modified Stable Election Protocol (M-SEP) for Hierarchical WSN," International Journal of Computer Applications, vol. 79, no. 16, pp. 35–39, 2013.

[25] D. Yuana , S.S. Kanhere , and M. Hollick, "Instrumenting Wireless Sensor Networks—A Survey On The Metrics That Matter,"International Journal on Pervasive and Mobile Computing, vol. 37, pp. 45-62, June 2016.