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Enhancing quality of service using sencar in wireless sensor network

Venkatesan C.* and Jagadeesan S.**

ABSTRACT

In this paper, a three-layer framework is planned for mobile information assortment in wireless detector network, which has three layer (sensor layer, cluster head layer, and mobile collector (called SenCar) layer). The framework employs distributed load balanced clustering and twin information uploading, that is brought up as LBC-DDU. the target is to attain smart measures ability, long networklifetime and low information assortment latency. At the detector layer, a distributed load balanced cluster (LBC) algorithmic program is planned for sensors to self-organize themselves into clusters. In distinction to existing cluster ways, our theme generates multiple cluster heads in every cluster to balance the work load and facilitate twin information uploading. At the cluster head layer, the inter-cluster transmission vary is fastidiously chosen to ensure the property among the clusters. Multiple cluster heads among cluster cooperate with one another to perform energy-saving inter-cluster communication. Through inter cluster transmissions, cluster head information is forwarded to SenCar for its moving mechanical phenomenon coming up with. At the mobile collector layer, SenCar is provided with 2 antennas, that permits 2 cluster heads to at the same time transfer information to SenCar in on every occasion by utilizing multi-user multiple-input andmultiple-output (MU-MIMO) technique. The mechanical phenomenon coming up with for SenCar is optimized to completely utilize twin information uploading capability byproperly choosing polling points in every cluster

Keywords:

1. INTRODUCTION

THE proliferation of implementation for cheap, low-power, multifunctional sensors has created wireless sensor network (WSN) a distinguished information assortment paradigm for extracting native measures of interests [1], [2]. In such applications, sensors area unit typically densely deployed and indiscriminately scattered over a sensing field and left attended after being deployed, that makes it tough to recharge or replace their batteries. when sensors type into autonomous organization, those sensors close to the info sink typically run through their batteries abundant quicker than others due to a lot of relaying traffic. once sensors round the information sink deplete their energy, network property and coverage may not be warranted. as a result of these constraints, it’s crucial to design associate energy-efficient information assortment theme that consumes energy uniformly across the sensing field to achieve long network life [3]. moreover, as sensing data in some applications area unit time-sensitive, information assortment may be needed to be performed among a nominative time frame. Therefore, associate economical, large-scale information assortment theme ought to aim at sensible measures ability, long network life and low information latency.

The main contributions of this work is summarized follows. First, we have a tendency to propose a distributed algorithmic rule to organize sensors into clusters, wherever every cluster has multiple cluster heads. In distinction to clump techniques projected in previous works [10], [11], [12], [13], our algorithmic rule balances the load of intra-cluster aggregation and permits dual knowledge uploading between multiple cluster heads and the mobile collector. Second, multiple cluster heads insidea cluster will collaborate with

* M.Tech (final year), *Email: venkatchandru22@gmail.com*

** Assistant Professor SRM University, *Email: Jagadeesan81@gmail.co*

one another to perform energy efficient inter-cluster transmissions. totally different from alternative hierarchical schemes [17], [18], in our algorithmic rule, cluste rheads don't relay knowledge packets from alternative clusters, which effectively alleviates the burden of every cluster head.

Instead, forwarding ways among clusters ar solely accustomedroute small-sized identification (ID) data of cluster heads to the mobile collector for optimizing the info assortmenttour. Third, we have a tendency to deploy a mobile collector with 2antennas (called SenCar during this paper) to permit simultaneous uploading from 2 cluster heads by victimisation MU-MIMO communication. The SenCar collects knowledge from the clusterheads by visiting every cluster. It chooses the stop locationsinside every cluster and determines the sequence to go to them, specified knowledge assortment is tired minimum time. Our work chiefly distinguishes from alternative mobile collection schemes [20], [21] within the utilization of MUMIMO technique, that permits twin knowledge uploading to shorten knowledge transmission latency. we have a tendency to coordinate the mobility of SenCar to completely relish the advantages of twin knowledge uploading, that ultimately ends up in an information assortment tour with each short moving mechanical phenomenon and short knowledge uploading time.

1.1. MU-MIMO in WSNs

The practicableness of using MIMO techniques in wire lesssensor networks is pictured in [27], [28], [29]. owing to difficulties to mount multiple antennas on one device node, MIMO is adopted in WSNs to hunt cooperations from multiplenodes to attain diversity and cut back bit error rate. Anoverview of MIMO-based programing algorithms to coordinatetransmissions was mentioned in [26]. Another challenge in MIMO is that the energy consumption in circuits maybe on top of a conventional Single-Input-Single-Output(SISO) approach. In [27], it absolutely was incontestible that MIMOcan outdo SISO once the transmission distance is larger than sure thresholds (e.g., 25 m). In [28], it was shown that with correct styles of system parameters, important energy saving will be achieved with MIMO techniques.

1.2. Sensor Layer: Load Balanced agglomeration

In this section, we have a tendency to gift the distributed load balanced clustering algorithmic program at the detector layer. The essential operation of agglomeration is that the choice of cluster heads. To prolongnet

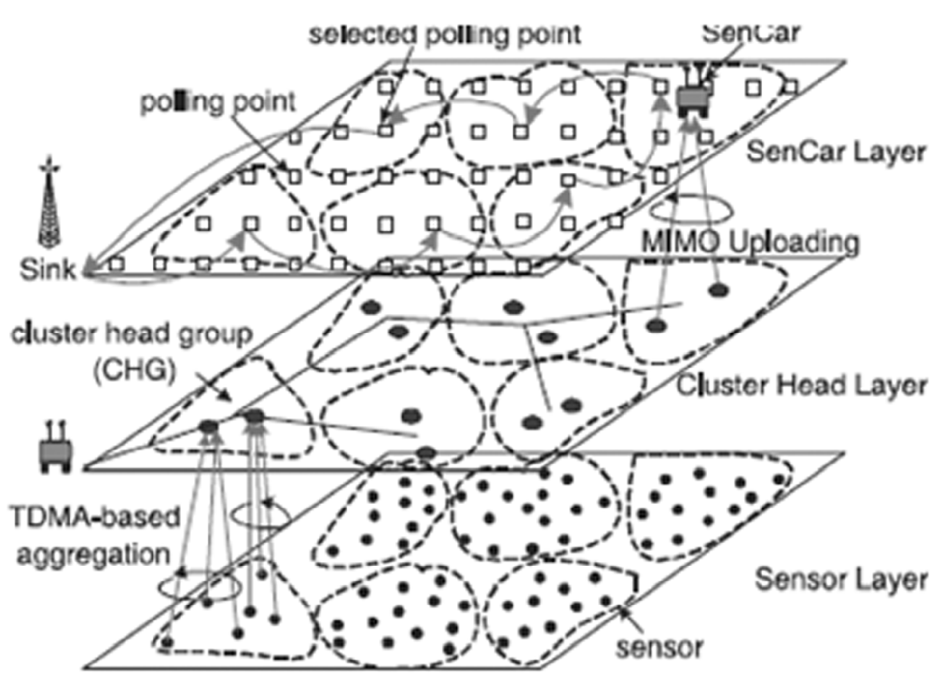


Figure 1: Illustration of the LBC-DDU framework.

work time period, we have a tendency to naturally expect the chosencluster heads square measure those with higher residual energy. Hence, we have a tendency to use the share of residual energy of everysensor because the initial agglomeration priority. Assume that a groupof sensors, denoted by S ¼ fs1; s2; . . . ; sng, square measure consistentand each of them severally makes the choiceon its standing supported native info. when running theLBC algorithmic program, every cluster can have at the most M (1) clusterheads, which implies that the dimensions of CHG of every clusteris no quite M. every detector is roofed by a minimum ofone cluster head within a cluster. The LBC algorithmic program iscomprised of 4 phases: (1) Initialization; (2) standing claim;(3) Cluster forming and (4) Cluster head synchronization.

Next, we have a tendency to describe the operation through associate example inFig. 3, wherever a complete of ten sensors (plotted as numbered circles in square measure labeled with their initial prioritiesand the property among them is shown by the linksbetween neighboring nodes.

1.3. Initialization part

In the format part, every device acquaints itself withall the neighbors in its proximity. If a device is Associate in Nursing isolatednode (i.e., no neighbor exists), it claims itself to be a cluster head and also the cluster solely contains itself. Otherwise, a sensor, say, si, 1st sets its standing as “tentative” and its initialpriority by the share of residual energy.

1.4. Initialization half

In the format half, each device acquaints itself withall the neighbors in its proximity. If a tool is Associate in Nursing isolatednode (i.e., no neighbor exists), it claims itself to be a clusterhead and additionally the cluster exclusively contains itself. Otherwise, a sensor,say, si, first sets its standing as “tentative” and its initialpriority by the share of residual energy.clusters, wherever every cluster has 2 cluster heads andsensors area unit related to with completely different cluster heads within thetwo clusters.

1.5. Cluster forming

```
if My.status ¼ clusterhead then
    My.clusterhead My.id;
else
recvpkt ();
My:BFnlNðMy:BÞ;
if My.B 6¼ F then
My.statusclustermember;
My.clusterheadRandoneðMy:BÞ.id;
sendpkt (3, My.id, My.clusterhead,
    clustermember, My.initprio);
else
My.statusclusterhead;
My.clusterhead My.id;
sendpkt (2, My.id, IDListðMy:AÞ,
    clusterhead, My.prio);
```

1.6. Examples of LBC rule

Next, we offer Associate in Nursing example to point out the impact of someparameters on the clump lead to Fig. 4. Fig. 4a shows arandom arrangement of eighty sensors on a one hundred one hundred space. Theconnectivity among sensors is known by the linksbetween any 2 neighboring nodes. Fig. 4b displays theresult of LBC with M set to a pair of. Since the priority of a detectoris the add of its initial priority and people of its M one candidatepeers, the 2 thresholds, th and tm, ar proportionatelyset to M 0:9 and M 0:3, severally. In Fig. 4b, sensorsare self-organized into half dozen clusters, every having 2 clusterheads shown in blue. The links between every cluster headand its members, that ar shown in gray, indicate the ultimateassociation pattern of the sensors. and therefore the links shown inblue, represent the property between the 2 clusterheads in an exceedingly CHG. Fig. 4c shows the initial priority of everysensor and people of the chosen cluster heads arhighlighted in blue. it's ascertained that the ultimate clusterheads ar those with higher initial priorities in its proximity,which validates the need that the sensors inpossession of upper residual energy ar preferentially chosento be cluster heads.

2. CLUSTER HEAD LAYER: PROPERTY AMONG CHGS

We currently take into account the cluster head layer. As same,the multiple cluster heads in a very CHG coordinate among clustermembers and collaborate to speak with alternativeCHGs. Hence, the inter-cluster communication in LBCDDUis essentially the communication among CHGs. Byemploying the mobile collector, cluster heads in a very CHGneed not to forward knowledge packets from alternative clusters.Instead, the inter-cluster transmissions ar solely accustomed forwardthe information of every CHG to SenCar. The CHGinformation are accustomed optimize the moving flightof SenCar, which is able to be mentioned within the next section. ForCHG data forwarding, the most issue at the clusterhead layer is that the inter-cluster organization to confirm theconnectivity among CHGs.

2.1. Connectivity among CHGs

The inter-cluster organization is set by the connection between the inter-cluster transmission vary Rt and the detector transmission vary Rs. Clearly, Rt is much larger than Rs. It implies that during a ancient single-head cluster, every cluster head should greatly enhance its outpu tpower to achieve different cluster heads. However, in LBC-DDU the multiple cluster heads of a CHG will mitigate this rigiddemand since they'll

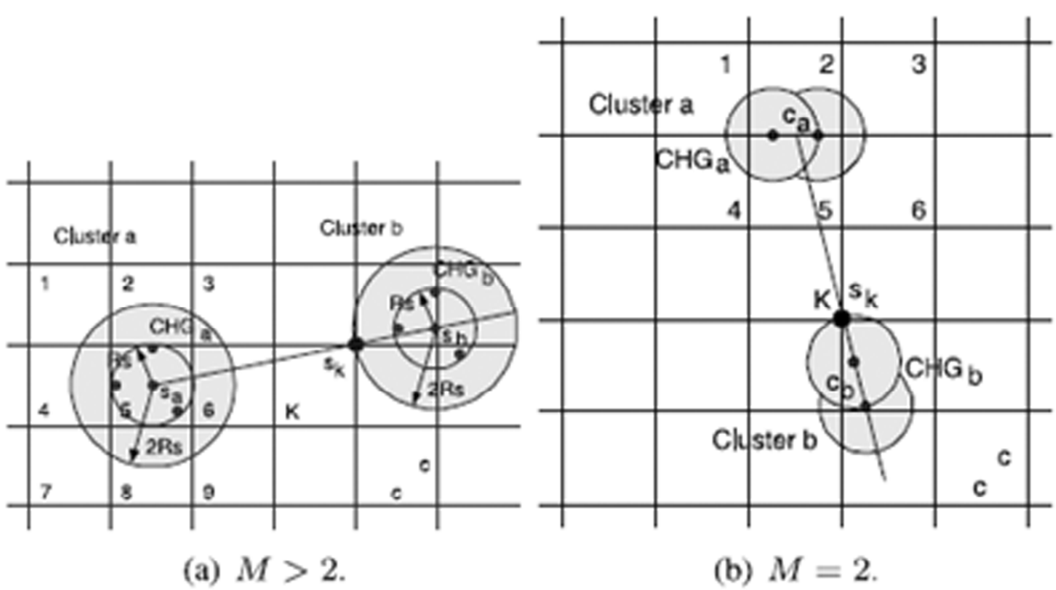


Figure 2: Maximum distance between two neighboring clusters when both of them have *M* cluster heads.

get together for inter-cluster transmission and relax the necessity on the individual output power. within the following, we have a tendency to initial notice the condition on Rtthat ensures inter-cluster property, and so discuss how the cooperation during a CHG achieves energy saving in output power.We assume that associate l l detector field is split intosquare cells, every of that is of size c c and c ¼ 2Rs.Based on the end in [33], Ye et al. [34] showed that once nsensors area unit uniformly distributed and c2n ¼ kl2 ln l forsome k & gt; zero, every cell contains a minimum of one detector. When Rt & gt; 2ðffiffiffiffip5 þ 1ÞRs, the inter-cluster property may beguaranteed with single-head clump. during a similar approach,the following property provides the condition to ensure the inter-cluster affiliation in LBC-DDU.

2.2. Inter-Cluster Communications

Next, we have a tendency to discuss however cluster heads during a CHG collaboratefor energy-efficient inter-cluster communication. We treatcluster heads during a CHG as multiple antennas each within thetransmitting and receiving sides such a similar MIMO system are often made [27]. The self-driven clusterhead during a CHG will either coordinate the native datasharing at the sending facet or act because the destinationfor the cooperative reception at the receiving facet. every cooperativecluster head because the transmitter encodes the transmissionsequence in step with a given reference system blockcode (STBC) [36] to realize abstraction diversity. Compared tothe single-input single-output system, it's been shown in[37] that a MIMO system with abstraction diversity ends up inhigher dependableness given a similar power budget. analternateview is that for a similar receive sensitivity, MIMO systemsrequire less transmission energy than SISO systems forthe same transmission distance

2.3. Properties of Polling Points

We contemplate the case that SenCar is provided with 2antennas, because it isn't tough to mount 2 antennas on SenCar, whereas it possible become tough and even unworkable tomount additional antennas owing to the constraint on the distancesbetween antennas to confirm freelance attenuation. Note thateach cluster head has just one antenna. The multiple antennasof SenCar, that act because the receiving antennas in informationuploading, build it potential for multiple cluster heads during aCHG to transmit distinct information at the same time to ensure successful cryptography once SenCar receives the mixedstreams, we want to limit the amount of coinciding informationstreams to no quite the amount of receiving antennas.In alternative words, since SenCar is provided with 2 receivingantennas, at the most 2 cluster heads during a

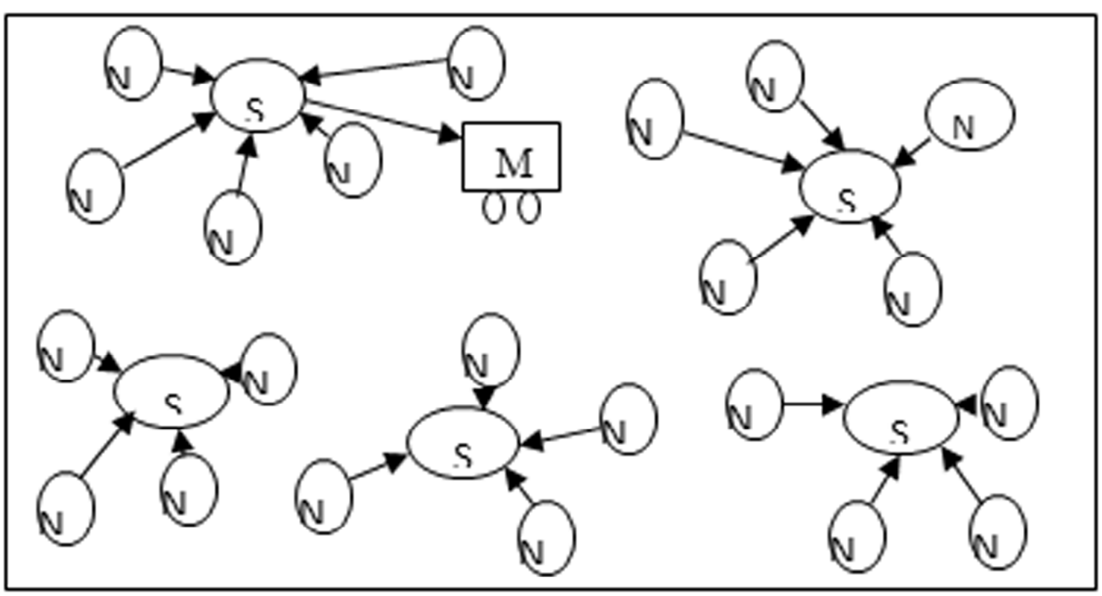


Figure 3: Network Architecture of Mobile SensCar based WSN

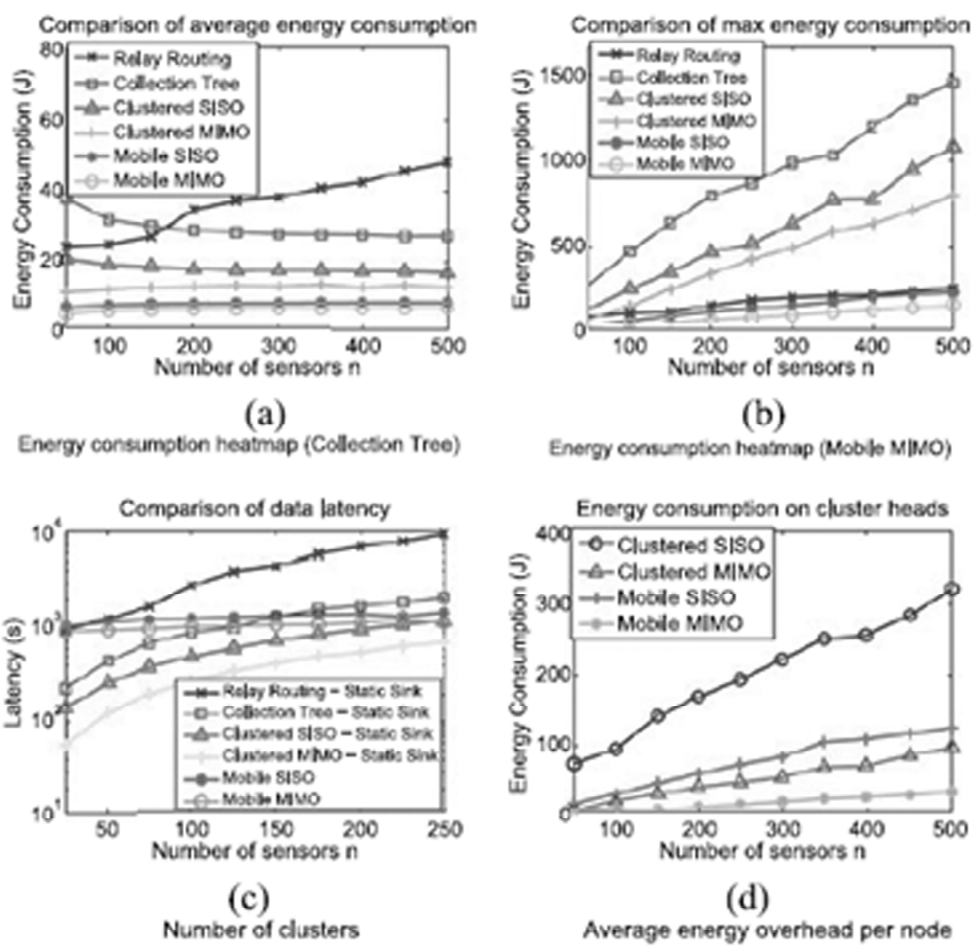
CHG will at the same timesend information to SenCar during a time interval. Hence, identical2 a pair of MIMO system for AN transmission transmission is formed, that achieves abstraction multiplexing gain for higher data rate. With such occurring transmissions, information uploadingtime may be greatly reduced. If there ar invariably 2cluster heads that at the same time transfer their information to Sen-Car in anytime slot, information uploading time may be turn over half within the ideal case.

3. SENCAR LAYER

In this section, we have a tendency to specialise in a way to optimize the mechanical phenomenon ofSenCar for data} assortment tour with the CHG information,which is spoken because the quality management at the SenCar layer. As mentioned in Section three, SenCar would stop atsome chosen polling points among every cluster to gatherdata from multiple cluster heads via single-hop transmissions.Thus, finding the optimum mechanical phenomenon for SenCar are oftenreduced to finding chosen polling points for every clusterand decisive the sequence to go to them.

4. PERFORMANCE EVALUATIONS

In this section, we have a tendency to measure the performance of our framework and compare it with alternative scheme. Since the most focus of this paper is to explore completely different selections of knowledge ecollection scheme, for truthful comparison, we have a tendency to assume all the schemes square measure enforced beneath an equivalent duty-cycling MAC strategy. the primary theme for comparison is to relay messages to a static knowledge sink in multi-hops and that we decision it Relay Routing. Since nodes with higher battery energy give a lot of hardiness and error immunity, sensorsselect following hop neighbor with the best residual energy whereas forwarding messages to the sink. Once some nodes on a



routing path consume an excessive amount of energy, an alternative route are going to be chosen to bypass these nodes. during this means, the relay routing technique will give load balance among nodes on the routing path. The second theme to match is predicated on assortment Tree Protocol, [6]. In CTP, the expected variety of transmission (ETX) is employed as a routing metric and also the route with a lower ETX takes precedence over routes with higher ETX. For simplicity, we have a tendency to assume ETX is proportional to transmission distances between nodes

4.1. Comparison of Energy Consumptions and Latency

First, we have a tendency to compare the typical energy consumption for every sensor and therefore the most energy consumption within the network. We set l ¼ 250 m, np ¼ 400, and M ¼ a pair of (at most 2cluster heads for every cluster) and vary n from fifty to five hundred. Note that once n ¼ fifty, network property can not be guaranteed all the time for multi-hop transmission with astatic sink. The results here ar solely the typical of the connected networks within the experiments. However, the mobile schemes will work well not solely in connected networks however also in disconnected networks, since the mobile collectoracts as virtual links to attach the separated subnetworks. Fig. seven a compares the typical energy consumption per node.we are able to see that our mobile MIMO theme ends up in the least energy consumption on device nodes, whereas the methods that transmit messages through multi-hop relay to the static knowledge sink end in a minimum of double additional energy on each node. Fig. 7b more presents the most energy consumption within the network. The network lifespan sometimes lasts till the primary node depletes its energy. it's intuitive that schemes with lower most energy consumption would have longer network lifespan.

4.2. Number of Clusters and Energy Overhead

The amount of clusters generated by mobileSISO and MIMO. we are able to see that the mobile MIMO generally yields fewer clusters than mobile SISO. Note that the average energy consumptions of mobile SISO and MIMO become indistinguishable as n will increase. this is often as a result of that though fewer clusters area unit discovered with mobileMIMO, a lot of cluster heads area unit generated for every cluster.Thus, the entire range of cluster heads within the 2 schemesturns to be comparable, that is truly a dominant issuedetermining energy consumptions. Finally, we tend to compare the energy overhead with mobile SISO and MIMO, and illustrate the energy consumption by MIMO uploading itself in Fig. 7h. For the mobile approaches, overhead is principally comprised of standing and synchronization messages in agglomeration, messages notifying SenCar of cluster locations logic gate energy consumption if MIMO uploading is adopted. First, the amount of standing messages exchanged is tried to be higher finite by 2n in Property 4 in Section five, wherever n is that the range of nodes, and synchbetween cluster heads area unit solely propagated within every cluster.

4.3. Impact of most variety of Cluster Heads in Each Cluster

In this section, we tend to value the impact of the utmost number of cluster heads in every cluster, M, on energy consumptions, latency and variety of clusters in Fig. 8. We plot the performance of mobile MIMO with totally different M once l varies from fifty to four hundred m and n ¼ two hundred. We fix the interval distance t between a polling purpose and its adjacent neighbor in horizontal and vertical direction sat about 20 m, which means that np varies from 16 to 441 with different settings of l. Fig. 8a shows that the average energy consumption declines as l increases in all cases. This is because that more clusters would be formed when sensors become sparsely distributed as indicated in Fig. 8d. It is also noticed that a larger M leads to less energy consumptions. For example, when l ¼ 200 m, energy consumption with M ¼ 4 is 35 percent less than the case of M ¼ 2. This result is intuitive since cluster heads perform more transmissions than other nodes. When M increases, there are more cluster heads in a cluster to share the

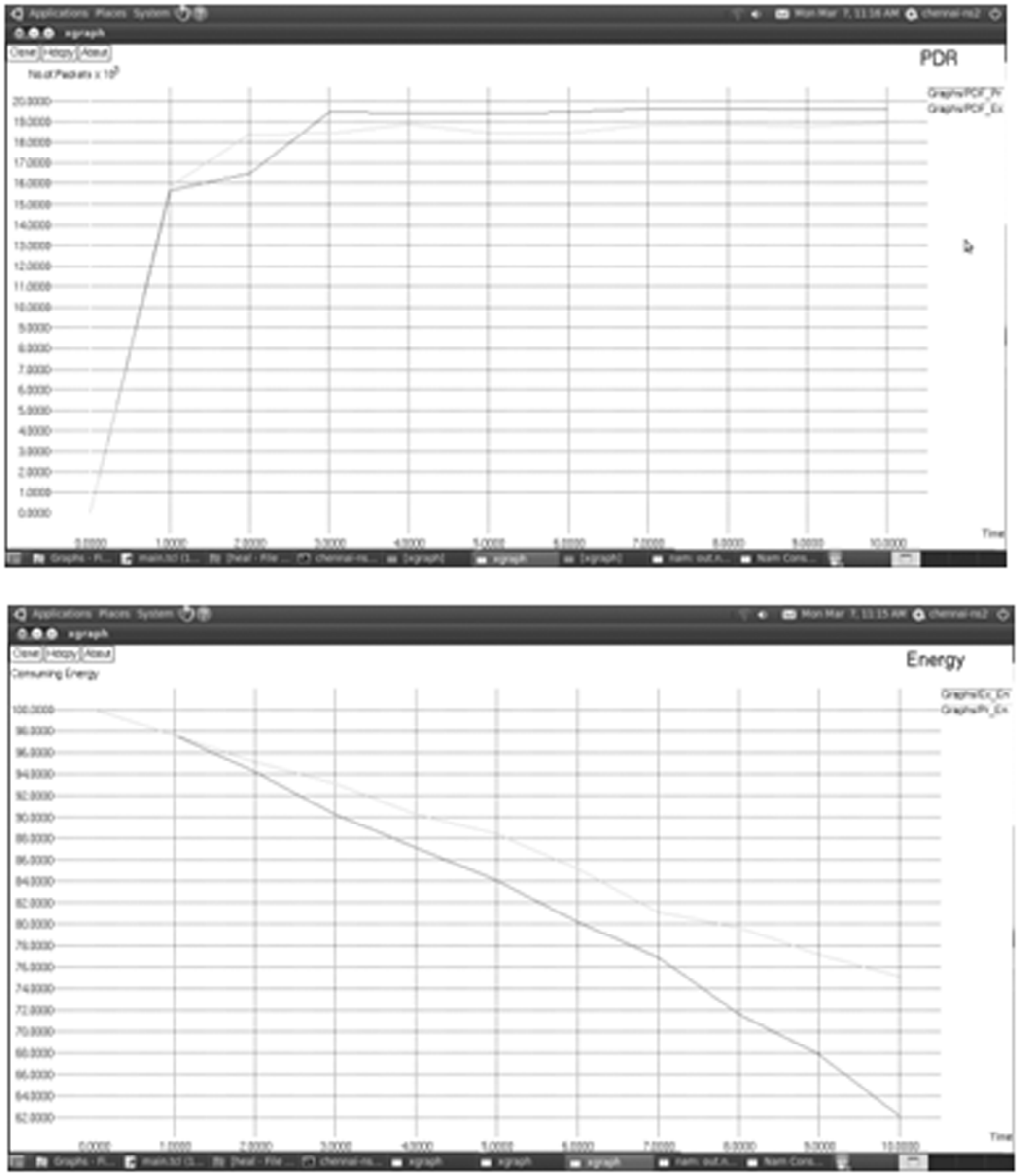


Figure 5: Pdf and energy comparison

workload. Fig. 8b shows the maximum energy consumption in the network. Since more cluster heads can directly upload their data to SenCar without any relay, the case with have larger M result in a slightly less energy consumption.

4.4. Data assortment with Time Constraints

In this section, we have a tendency to demonstrate our projected framework when information messages have time constraints be delivered. The percentage of information messages that miss their deadlines and the impact of your time constraints on the traveling value of SenCar are shown in Fig. 9. to look at the effectiveness of the projected algorithm in Section half dozen.3, we have a tendency to set the message point to be uniformly every which way distributed over [0,X] and alter X from sixty to a hundred and eighty minutes. Therefore, the mean of point is from thirty to ninety minutes. the quantity of nodes n is about to two hundred and the facet length of sensing field l varies from a hundred to three hundred with an increment of fifty. In Fig. 9a we are able to see that given a brief average point and an oversized field (l ¼ 300m, mean point equals thirty mins), and the majority the messages would miss their deadlines. this is often as a result of that the moving time of Sen- Car to traverse all the polling points exceeds most of the deadlines. Once we have a tendency to relax the point constraints (mean deadline equals 40-90 mins), the share of missing deadlines drops fast. We also observe that when l is between 100 to 200 m, the algorithm is able to maintain the percentage of missing deadlines within 20 percent for most cases.

5. CONCLUSIONS AND FUTURE WORKS

In this paper, we've planned the LBC-DDU framework for mobile knowledge assortment in an exceedingly WSN. It consists of detector layer, cluster head layer and SenCar layer. It employs distributed load balanced bunch for detector organization, adopt cooperative inter-cluster communication for energy-efficient transmissions among CHGS, uses dual data uploading for quick knowledge assortment, and optimizes SenCar's quality to completely relish the advantages of MU-MIMO. Our performance study demonstrates the effectiveness of the planned framework. The results show that LBC-DDU can greatly scale back energy consumptions by assuaging routing burdens on nodes and equalisation work among cluster heads, that achieves twenty % less knowledge assortment time compared to SISO mobile knowledge gathering and over sixty % energy saving on cluster heads. We have also even the energy overhead and explored the results with totally different numbers of cluster heads within at the framework.

Finally, we have prefer to illustrate that there area unit some interesting issues which will be studied in our future work. The first drawback is the way to notice polling points and compatible pairs for every cluster. A discretion theme ought to be developed to partition the continual house to find the optimal polling purpose for every cluster. Then finding the compatible pairs becomes an identical drawback to attain optimum overall spacial diversity. The second drawback is the way to schedule MIMO uploading from multiple clusters. AN formula that adapts to this MIMO-based transmission scheduling algorithms ought to be studied in the future.

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