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REVIEW PAPER ON ENERGY EFFICIENT WELL ORGANIZED ROUTING FOR WSNS

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ABSTRACT

The wireless sensor networks are rapidly growing and are being used in several applications such as military, weather, activity monitoring, forest fire detection, etc. The sensor networks lacks in the various cases in the case of handling the routing responsibilities. In the proposed model, we have proposed the energy balanced routing with the localization module. The proposed model is based upon the tree-based routing with the localization module. The proposed model has been designed for the better connectivity, low energy routing, low transmission delay and lost node recovery by using the proposed design. The proposed model will be implemented and tested in the simulation.

Keywords: Self-organized routing, Well-organized routing, tree-routing, localization.

I. INTRODUCTION

Over the last half a century, computers have exponentially increased in processing power and at the same time decreased in both size and price. These rapid advancements led to a very fast market in which computers would participate in more and more of our society's daily activities. In recent years, one such revolution has been taking place, where computers are becoming so small and so cheap, that single-purpose computers with embedded sensors are almost practical from both economical and theoretical points of view. Wireless sensor networks are beginning to become a reality, and therefore some of the long overlooked limitations have become an important area of research [1, 3, 4, 5].

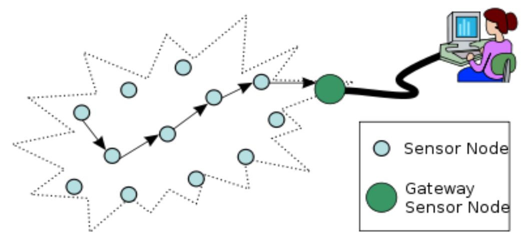

Figure 1: Wireless Sensor Network Architecture

Today in the market of rapid growth of computers the processing power are increased unexpectedly but the price and size of computers have greatly reduced which encourages the use of computers very much. The latest technologies have made vast advancements in computers era and also enhance the use of computers in our daily activities. In recent years, from the economic point of view, the single-purpose desktop computers having sensors embedded in them are highly used due to cheapness in prices and reduction in size of computers.

Wireless Sensor Networks have been receiving a great amount of attention recently due to their substantial applicability to improve our lives. They aid us by extending our ability to accurately monitor, study, and control objects and environments of various scales and conditions such as human bodies, geological surveys, habitats, and security surveillance. Large no. of sensor nodes in a field connected with a sink node to transmit information about events to satellite associated is shown in Figure 1.

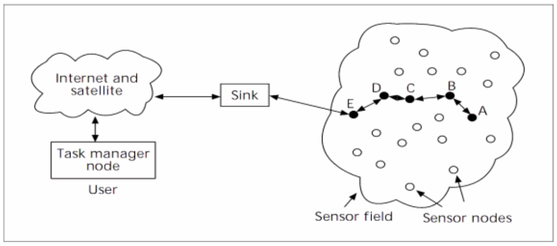

Figure 2 Sensor nodes scattered in a sensor field

This figure 2 shows sensed data is delivered to the user. Suppose data is sensed by the sensor node *A* inside the sensor field. Since the transmission range of radio for each sensor is short, *A*, at first, passes sensed data to the neighbor node *B*. In this example, this data may be routed by the path *A-B-C-D-E-Sink*. Since sink is already connected to the Internet, it can deliver sensed data to the user directly from sink. Sensor nodes in WSNs can also autonomously process and cooperatively analyze sensed data inside networks so that they can prune the redundant data observed inside a network and deliver only necessary data to the user through sinks. Furthermore, WSNs can dynamically adapt its topology. After the deployment of sensor nodes in a sensor field, they autonomously find the neighbor nodes and start communicating with each other in various ways, normally using multi-hop communications.

In wireless communication and embedded micro-sensing technologies, the advancements encourage the use of WSNs today in many environments to detect and monitoring sensitive information. Such environments include border protection, disaster areas, health-related areas, and intelligent house control and many more. WSNs are here to detect and track the tanks on a battlefield, tracking the personnel in a building, measure the traffic percentage on a road, monitor environmental pollutants, detect fire and rain. Sensors contribute to electricity production, and also used in collecting the solar energy where WSN tracks the sun rays to detect the power.

Now, whether the WSNs are starting to become a reality in this world, but there are some limitations such as change in topology randomly, restrictions in power, limited computational resources like power, error-prone medium, energy-efficiency. The energy consumption is an important limitation of WSN which demands researcher's skills to get a way in reducing the energy consumptions by sensor nodes used in WSN.

In latest research on WSN, the researchers attempt to find out and overcome limitations of the wireless sensor networks such as: limited energy resources, varying energy consumption based on location, high cost of transmission, and limited processing capabilities.[5] All of these characteristics of wireless sensor networks are complete opposites of their wired network counterparts, in which energy consumption is not an issue, transmission cost is relatively cheap, and the network nodes have plenty of processing capabilities.[8] Routing approaches that have worked so well in traditional networks for over twenty years will not suffice for this new generation of networks.

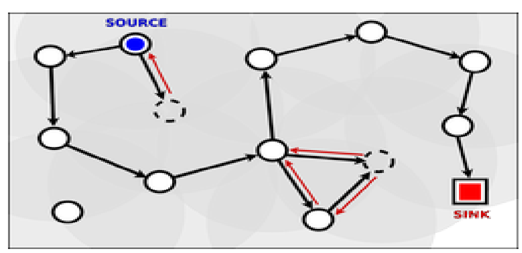

Figure 3: Representation of a network in which a node goes down due out of battery and a different path is chosen with a Single-path algorithm

Besides maximizing the lifetime of the sensor nodes, it is preferable to distribute the energy dissipated throughout the wireless sensor network in order to minimize maintenance and maximize overall system performance.[1] Any communication protocol that involves synchronization between peer nodes incurs some overhead of setting up the communication. WSN routing or clustering protocols determine whether the benefits of more complex routing algorithms overshadow the extra control messages each node needs to communicate.[1-2] Each node could make the most informed decision regarding its communication options if they had complete knowledge of the entire network topology and power levels of all the nodes in the network. This indeed proves to yield the best performance if the synchronization messages are not taken into account. However, since all the nodes would always need to have global knowledge, the cost of the synchronization messages would ultimately be very expensive. For both the diffusion and clustering algorithms, we will analyze both realistic and optimum schemes in order to gain insight in the properties of both approaches [9, 13].

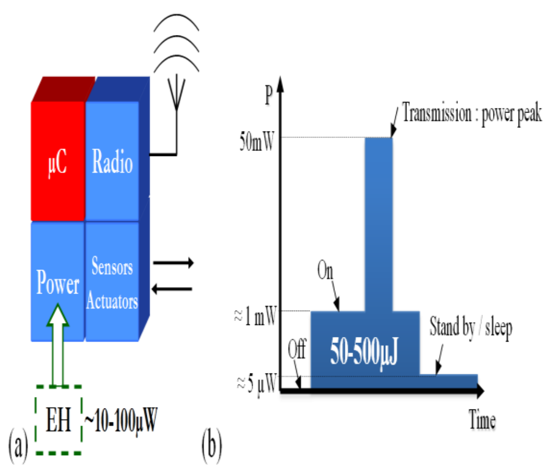

Figure 4: a) Autonomous WSN node and (b) sensor node's power consumption

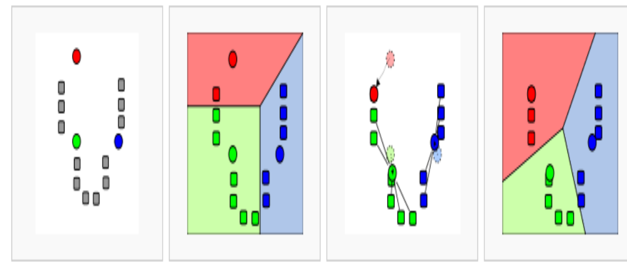

Figure 5: A standard clustering algorithm example

II. APPLICATION AREAS OF WSN

Countless applications in many different fields, including:

➢ **Agriculture:** In agriculture, WSN is used to detect and monitor the condition of crops which favours crop-harvesting very much by decreasing their cost value in cropping crops, also helps in improving crops quality.

➢ **Monitoring and Controlling Traffic:** measure the traffic percentage on a road

➢ **Structural Health Monitoring**

➢ **Solar Energy:** Sensors contribute to electricity production, and also used in collecting the solar energy where WSN tracks the sun rays to detect the power.

➢ **Healthcare and medical research**

➢ **Homeland Security:** WSN are used in tracking the personnel in a building.

➢ **Military applications:** In military, WSN is used to detect and track the boundary areas for any kind of event. WSNs are here to detect and track the tanks on a battlefield.

➢ **Detection of chemical/biological agents**

➢ **Fire Detection in forest:** Using WSN to detect fires in a forest is another example where sensors are used to sense such events of fire occurring. Sensor nodes after sensing, reports to BS about the location where the fire event has occurred and BS then in response do some physical actions like dispatching fire trucks at that location are immediately.

- **New areas keep emerging.**
- **Intruders Detection**
- **Monitoring natural Disaster**

All of these characteristics of WSNs are completely opposite from wired networks because in wired networks the energy consumption is not an issue. In contrast to various applicability of WSNs, the

The usual topology of wireless sensor networks involves having many network nodes dispersed throughout a specific physical area [3]. There is usually no specific architecture or hierarchy in place and therefore, the wireless sensor networks are considered to be ad hoc networks. An ad hoc wireless sensor network may operate in a standalone fashion, or it may be connected to other networks, such as the larger Internet through a base station [2]. Base stations are usually more complex than mere network nodes and usually have an unlimited power supply. Regarding the limited power supply of wireless sensor nodes, spatial reuse of wireless bandwidth, and the nature of radio communication cost which is a function of the distance transmitted squared, it is ideal to send information in several smaller hops rather than one transmission over a long communication distance [12].

The capacity of batteries inside their nodes is highly limited, and it is unrealistic to replenish battery of the nodes in many cases. Therefore, the preservation of such vital energy at each sensor node is significantly important in WSNs.

III. FEATURES OF WSN

- Sensing and data processing
- WSNs have many more nodes which are deployed
- Cheap hardware
- Nodes are more easily fail
- WSNs operate at strict energy constraints
- WSN nodes have static nature
- The communication scheme is many-to-one rather than peer-to-peer

All of these characteristics of WSNs are completely opposite from wired networks where energy is not an issue to worry. The energy is an important characteristic of WSN for increasing the lifetime of sensor nodes to reduce maintenance cost and increase the performance.

IV. LIMITATIONS OF WSN

- Limited Energy (Energy consumption)
- Network Lifetime
- Application Dependency
- Secure Communication
- Cluster formation and CH selection
- Synchronization
- Data Aggregation
- Repair Mechanisms
- Quality of Service (QoS)
- Dynamic topology
- Power restrictions
- Limited computational resources
- Error-prone medium i.e. wireless
- Complexity
- Lower speed as compared with wired network
- Security issues
- Surroundings can effect network

- Distracted easily with other technologies like Bluetooth
- Costly deployment of sensor nodes
- Fault occurrence

V. WSN ROUTING

Routing is the process used by data communication networks to deliver packets from a source device to a destination device.

In WSN, the three main categories of routing are:

- **Flat-based routing:** In this, all nodes have equal roles and perform equal functions.
- **Location-based routing**: In this, all nodes have their roles to route data according to their locations.
- **Hierarchical-based routing**: In this, all nodes have their own roles different from others.

VI. ROUTING PROTOCOLS

As routing is very challenging task in WSN due to contemporary communication feature of this network, the routing protocols plays an very important role in WSN. These protocols are required for sending data between sensor nodes and BS.

Communication protocol is an important part of any network and has a strong impact on the performance of network. Also a protocol affect the factors such as energy dissipation, cost of system, latency and also sometimes security of the network.

If we choose any unsuitable communication protocol which can cause unbalanced energy division among nodes that will result in reduction of network lifetime. Cost involve in setting-up the communication process among sensor nodes will also increase if any wrong communication protocol is chosen.

VII. PHASES OF ROUTING PROTOCOLS

- **Setting-up of communication:** this involves finding all routes and their energy costs
- **Communication phase:** this involves choosing of path for transmission
- **Route maintenance:** this involves flooding so that paths are available always, and also updating of cost of route.

VIII. ROLE OF SENSOR NODES IN WSN

As we know WSNs are used to collect information about areas for event occurring. For this WSNs comprises various sensor nodes that are used for monitoring an area for events and after monitoring these nodes report to the BS (i.e. Base Station) about the location where the event has occurred. When BS receives the event occurring reports then it will response with a prompt physical message. In sense-response applications, sensor nodes are deployed in the coverage area with overlapping sensing regions to avoid holes. Thus more than one sensor nodes (neighbours nodes) detects an event at same time and reports to BS and redundancy occurs. In such situation, the BS deals with this redundancy by replying to only those who are coming in the network area. In such a way, BS avoids any *false positives* i.e. event which has been reported was never occurred. Since problem has been solved but what about the energy which is used by every sensor node in large amount while transmission about detected event to the BS. An another solution would be that all the neighbor sensor nodes reports to one common node i.e. head which transmit an message to BS about an event detection and BS will get the information sensed by every node implicitly.

IX. COMPONENTS OF SENSOR NODE

The components of a typical sensor node in the figure 6:

- **Sensing unit** – which consisting one or more sensor nodes for collecting data
- **Processing unit** – which consisting a memory unit and micro-controller for processing of local data collected by sensing unit
- **Radio unit** – which is used for data communication among various sensor nodes and BS wirelessly
- **Power unit** – which supplies power to sensor nodes.

Various components associated to form a sensor node include sensor, processor, storage and transceiver. Once the sensing unit captures an event, it converts the analog signal in to digital signal and passes it to the processor for possible processing. The data can be stored in the storage and later transmitted to a downstream sensor node. In this figure, extra components are enclosed in dotted lines. For instance, a location finding system such as GPS is not always necessary, and centroid localization calculated from the location of sinks is used instead.

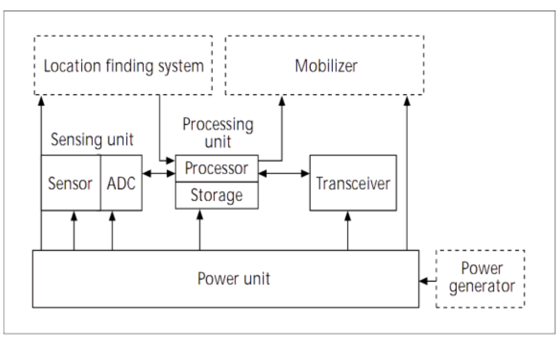

Figure 6: *n* components of sensor node

X. WSN SELF-ORGANIZED ROUTING

The self-organized routing is the routing model based on the controlled parameters, where the whole routing procedure can run automatically and can individually handle the down links, up links, convergence, load balancing, etc.. The self-organized routing includes the balanced and parameter centric routing in all of the possible scenarios. The wireless sensor networks are very complex to be handled manually, which produces the strong need of the self-organized routing for the sensor networks. The proposed model proposes the self-organized routing with the localization support. The well converged and connected network during the localization can be perform better in the terms of failure handling, short path or lowest cost path selection.

XI. TREE BASED ROUTING

The tree routing concept is simple and intuitive. A single (or multiple) data sink acts as a root to the tree. All data in the network is directed towards the root for collection. Each sensor chooses a single neighbor that it will use to forward all data. This chosen neighbor is called the sensor's *parent*. Using a single parent to forward all data reduces the chance of routing loops occurring in the network.

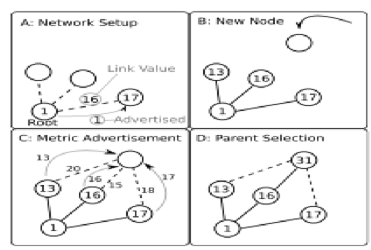

Figure 7: The basic tree routing architecture

The parent is chosen as the neighbor that is in the best position to forward data to the root, or is the root itself. The routing metric used will determine how fit a neighbor is to forward data to the root. Figure 1 illustrates how a sensor chooses a parent by evaluating the neighbor, using arbitrary link estimation metric as a minimum direct routing metric.

There is inherent stability issues present when using the tree structure. The tree sets up a routing environment whereby a sensor's metric value is wholly dependent on each of the links that form the route to the root. A sensor may in turn act as a forwarding sensor for other sensors down the branch. Fluctuations on a single link in the chain can end up affecting the metric value of a large number of sensors in the network. Furthermore, a large change in a single link instigating a change of route can propagate down the branch resulting in many more route changes. Figure 7 illustrates this in a simple network.

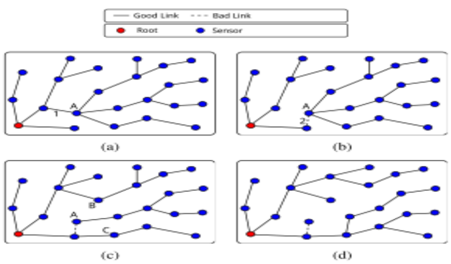

Figure 8: Illustration of a simple tree based WSN architecture

A network forming a tree structure is presented in figure 8. Many sensors in the tree form a route through *A.* Sensor *A* uses link 1 to forward all traffic from sensors down the branch.

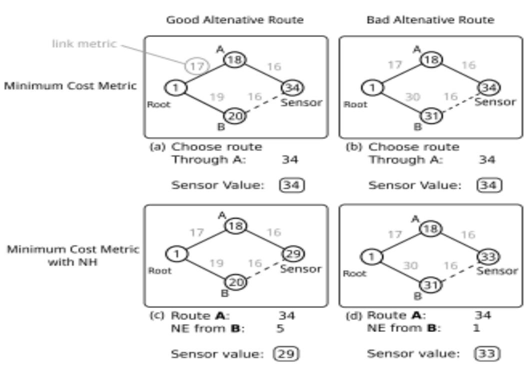

Figure 9: The tree formation of the WSN routing topology

As link 1 becomes unavailable, sensor A must resort to link 2 as its primary link as no other routes are available to it as shown in figure 8. Link 2 is of poor quality and results in a severely degraded metric value for sensor A. The immediate sensors, B and C learn of the degraded link as A updates its metric value, and react accordingly by switching to alternative routes as depicted in 3. Sensors B and C metric values are also adversely affected as a result of the route changes. As their neighbor learns of the updated metrics they re-evaluate routing options. Figure 8(d) shows the resultant network after the changing metric values propagate through the network causing more sensors to change route. This phenomenon is known as a domino effect and is a fundamental issue in tree type routing. Reducing the domino effect is key to achieving increased stability.

Currently, instability is managed by applying thresholds to those metrics used. This dictates that a sensor will only change parent to a competing neighbor, if the competing neighbor advertises a metric that is better than the current parent by a predetermined amount. This amount is carefully chosen as it poses a trade-off between stability and dynamism in the network; two aspects we wish to maintain in the network. This solution is easy to implement but relies solely on a single threshold and therefore does not constitute a complete solution. NHs is unique as it aims to increase stability by asserting proactive damage control by routing through sensors offering good failover options. Route changes are inevitable, but if a used link goes down unexpectedly, another similar route is more likely to be available to carry traffic minimizing the knock-on effect of the change preserving stability.

XII. CONCLUSION

The proposed model has been designed to solve the existing problems of the wireless sensor networks. The proposed model is the tree-based routing design, which works in the hierarchical manner and well suited for the sensor networks deployed using the hierarchical topology. The proposed model has been prepared with the support of localization algorithm for the purpose of better connectivity during the initial connection setup phase. The proposed model has been expected to produce the results on the basis of balanced network parameters and best route selection. The proposed model is expected to produce the minimum transmission delay, higher throughput and higher packet delivery ratio.

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