Development Cycle of Routing Protocol from Conventional to Harvesting in WSNs

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***Abstract*— Wireless and embedded systems are powered by batteries/supercapacitors. Wireless sensor networks (WSNs) comprise of small sensor nodes work collaboratively using wireless communication. For data transmission, it is essential to find the best path for transmitting data to reduce the energy consumption. Many energy efficient routing protocols have been proposed for improving the WSN life. For analysis the improving of WNS life terms of stability, throughput, alive nodes and packet delivery ratio are used. This paper provide an insight for step forward development process of energy efficient routing protocols for increasing the lifespan of network. This paper, explains the routing protocols concept that increasing the stability periods. All developed protocols after conventional protocol are based on clustering that used probability function to selects a cluster heads for transmission the data from source to destination. By improving the cluster heads election function stability period and lifespan of the network can be increased. Many of routing scheme works on improving the cluster heads hence enhances the network stability period and lifespan.**

Keywords— Wireless sensor networks; Energy homogeneity; Energy heterogeneity; Routing protocol; Energy harvesting; Node placement.

I. INTRODUCTION

A powerful advancement over traditional sensors represents by WSNs and advancements are set up as [1]:

1) In these network, broad sensors are used that uses few complicated approach to differentiate the object against environmental noise are needed.
2) Deploy a lot of sensors with the intention of function sensing only. These sensors collect data from the particular area for passing the information for sink/destination used before that information is fused for the deduction of repetitions of information.

These sensors are capable to monitor the pressure, lighting conditions, humidity and temperature conditions [2].

Nature of the Wireless Sensor Networks (WSNs) topology is distributed and dynamic. This nature of network originate requirement in direction-finding procedures and for better lifetime of network this requirement needs to be fulfilled by network. Network energy utilization and make longer the life span are very essential requirement in order to well-organized routing procedure for WSNs. Many routing protocol have been anticipated for improving the energy utilization and WSNs lifetime. Clustering technique and radio model is important for improvement of WSNs [3-8].

The remainder of this paper is arranged as follows: Section II explains literature on routing protocol in WSNs. Section III explains conventional routing protocol. Section IV homogeneous energy based clustering routing protocols. Section V explains hetrogeneous energy based clustering routing protocols. Section VI explains energy harvesting routing protocols. Section VII represents the concept of node placement for protocol for improving the lifespan of network. Section VIII represents the result and conclusion.

II. LITERATURE ON ROUTING SCHEMES IN WSNS

On the basis of network and application architecture, routing protocol can have definite characteristics for making the power efficient of network routing protocol. In WSNs there are many routing protocols and they are categorized into following categories: based on network structure, topology based, transmission based or based on communication model and based on reliability of network.

In [9], techniques for WSNs and design issues have been surveyed by authors. All layer of protocol stack, their related proposed protocol and sensor nodes physical constraints are discussed.

In [10], present a surveyed on network routing scheme. Network structure based routing protocol or scheme is categories into three classes. These protocol classes are: flat routing, hierarchical routing and routing based on location. Protocol based on their operation is categorized as: routing based on query, routing based on QoS, multipath routing and routing based on negotiation.

It represents 27 routing protocols and it also represents the design issues and routing challenges that have to be considered using WSNs. Emphasize on design issues that point out the energy and communication operating cost tradeoffs in routing scheme and also discuss pros and cons of every scheme of routing.

In [11], it present a routing scheme surveyed. Total 24 routing scheme was discussed here for WSNs and they are classified into three classes: data centric, grouping based or hierarchical and routing based on location.

In [12], many routing scheme are presented in arranged manner. Algorithms have been classifying as Minimum Energy Multicast/Broadcast (MEM/MEB) and Maximum

Lifetime Multicast/Broadcast (MLM/MLB) using wireless Ad- hoc networks.

In [13], top-down method that is used by many applications on the base of this authors review on different aspects of WSNs routing schemes. These aspects are classified into three classes: communication protocol stack, internal platform and fundamental operating system and network services provisioning and deployment.

In [14], a survey has been presented focusing on energy expenditure. A sensor node is made by hardware components and these components are: sensing unit for data acquisition, for local processing a processing is used with memory for storage, power supply unit and radio unit for wireless transmission of data. To decrease energy consumption in WSNs power breakdown and the architecture has been presented as the way out. They offer the main guidelines to energy management in WSNs.

In [15], the classification and design issues of WSNs routing protocols are offered. Routing scheme is classified according to method that they employ for make longer life span of network and uniqueness of routing scheme is also discussed.

In [16], Medium Access Control (MAC) routing scheme design challenges represented to make power efficient schemes. Total 12 schemes of MAC routing are discussed and highlighting strong point and limitations of every scheme.

In [17], offered routing schemes for wireless multimedia sensor networks were discussed. Problem in performances is also highlighted for every approach. Chasing the restriction of existing method considered in data communication for non multimedia networks author summarize about challenges in design of WMSNs routing schemes. Moreover, current WMSNs routing schemes categorization presented here.

Here we presented a development process from conventional to harvesting routing protocol in WSNs.

III. CONVENTIONAL ROUTING PROTOCOLS

Conventional protocol is not suitable for optimal transmission and conventional protocols are direct transmission and efficient minimum-cost routing. Various network analysis and conception based graph theoretic routing algorithms i.e. strongly linked with dynamic programming in data communication systems together with minimum span, shortest-route, and maximal flow problems are covered in conventional routing.

In each routing algorithm/scheme, common approach is transmitting the data through route that having minimal cost from source to base station. Concept of this approach, consider the regularity in data that produce by nodes and having controlled bandwidth then send data through low cost path. Routing schemes have a concept of considering the bandwidth constraint on channel.

There are two routing scheme that exists for finding the shortest path. An algorithm for finding the path with minimum hop by Bellman Ford and another one is considering the concept of polynomial complexity given by Dijkstra. Some routing scheme having minimum cost discuses here:

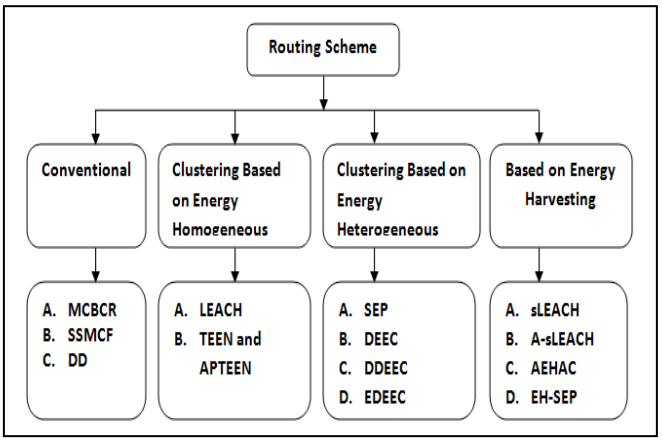

Fig. 1 Various Routing Scheme for WSNs

Fig. 1 list all wireless sensor network routing protocols that is described in this paper.

A. *MCBCR ROUTING SCHEME*

"Efficient Minimum-Cost Bandwidth-Constrained Routing" (EMCBCR), is efficient, scalable and simple clarification to the minimum cost routing problem [18].

EMCBCR routing protocol discovers the most suitable path, using this path data is conveying from source to sink. It decreases whole cost of paying for routing. MCBCR achieves long network life span and has good presentation.

B. *SSMCF ROUTING SCHEME*

SSMCF is stand for "Scalable Solution to Minimum-Cost Forwarding in Large Sensor Networks". In [19], dilemma of smallest cost messages delivery through minimum cost route from know location to desirable base station in wide network. When network area is recognized, information having dynamic cost or message sends through route that are having minimum cost in network area is discussed. Any other node promote message simply when they are having an optimal route considering the dynamic cost.

Designing goals of this algorithm are:

Simplicity: Minimal the operations and stages that retained at every node contributing for transmission of data.

Optimality: To accomplish the least cost in data transmission is considered.

Scalability: The key that scale the network to great network size.

This approach requires space complexities.

C. *DD ROUTING SCHEME*

This scheme of routing is called as "Direct Diffusion" (DD) and it is an application aware routing scheme. This protocol firstly picks experimental better routes; apply data

processing and caching method in network for achieving the minimal of power utilization. The DD consists of some basics [20]: Naming, reinforcement, data propagation and interests and gradients. The direct diffusion method is stable.

IV. HOMOGENEOUS ENERGY BASED CLUSTERING ROUTING PROTOCOL

A. *LEACH ROUTING SCHEME*

LEACH stands for "Low-energy adaptive clustering hierarchy" [21, 22]. In this protocol, all nodes are communicated with head of cluster. There are two phases of this scheme:

The Establishing phase: Grouping the nodes and election for head of group. Cluster head tasks are: aggregation of data, data compress and forwarding data.

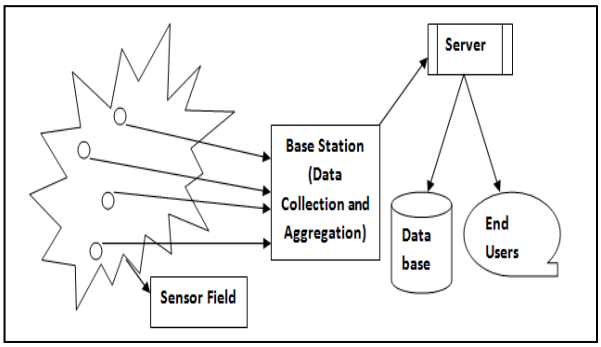

Fig. 2 Wireless Communication Process in WSNs

The Steady phase: In this phase, the data is transmitting to the sink. Fig. 2 described the generalized wireless communication process of wireless sensor network.

The major pro of LEACH is that it is better than traditional transmission protocols, in the conditions of system life span/quality of the network, simplicity of configuration, and power utilization [23]. Single-hop routing is used in LEACH protocol. Thus, it is not suggested for networks that are deployed in great areas.

B. *TEEN and APTEEN ROUTING SCHEME*

TEEN "Threshold-Sensitive Energy Efficient Sensor Networks Protocol"[24] and APTEEN " Adaptive Periodic TEEN"[25] are homogeneous routing protocols. Both protocols are used in time-critical applications. Sensor nodes continuously sense the object in TEEN and this protocol work with soft and hard threshold value for data transmission. Soft threshold is small value change in sensed object and hard threshold value is used to set the interest range of data transmission. TEEN is used to reduce the transmission energy. APTEEN is hybrid concept of protocols and is implemented with the concept of modified Time Division Multiple Access (TDMA).

V. HETEROGENEOUS ENERGY BASED CLUSTERING ROUTING PROTOCOLS

A. *SEP ROUTING SCHEME*

SEP is "Stable Election Protocol" [26] for energy heterogonous clustering protocol. This protocol gives the concept of energy heterogeneity for clustering to enhance the network lifespan. In this protocol randomly distribute all nodes and nodes are divided into two type's normal nodes and advanced nodes. For selecting the cluster heads election probability function is used. In this protocol higher energy value nodes gives higher stability period and prolong the life of network.

B. *DEEC ROUTING SCHEME*

DEEC [27] is "Distributed energy efficient clustering algorithm" for decrease the consumption of energy by using clustering techniques. DEEC selects the cluster heads based on probability function that is set by ratio of residual energy of each node and whole network energy. This protocol provides better scalability and lifespan of network.

C. *DDEEC ROUTING SCHEME*

DDEEC [28] is "Developed DEEC" also used techniques of clustering provides better stability period by changing the cluster heads election procedure effectively and dynamically. This protocol is better than SEP and DEEC.

D. *E-DEEC ROUTING SCHEME*

E-DEEC [29] "Enhanced DEEC" is developed with three types of nodes concept. There are three types of nodes such as normal nodes, advanced nodes and super nodes are used that concept provides better results in terms of stability period.

VI. ENERGY HARVESTING ROUTING PROTOCOLS

A. *sLEACH ROUTING SCHEME*

sLEACH [30] is "solar-aware clustering" protocol energy in protocol plays important role for enhances the lifespan of network. Previous all protocols are based on battery. When battery drains out then communication links will break down this is a drawback of battery driven protocol. For enhancing the lifespan and continuous communication within network using environmental energy such as solar power is used. Fig. 3 depicts the generalized energy harvesting sensor architecture for WSNs. In this protocol battery is used as secondary supply and all nodes are solar powered. It provides better stability better than LEACH.

B. *A-sLEACH ROUTING SCHEME*

It is a "Advanced solar aware LEACH" protocol [31]. This protocol rotate the cluster heads, working on improving the radio model , aggregate data by FIFO scheme and decrease the collision by CSMA.

C. AEHAC ROUTING SCHEME

"Adaptive Energy Harvesting Aware Clustering" [32] protocol of routing. For election of cluster heads its combines the residual energy of nodes and harvesting rate for making better lifespan of network. Throughput and alive available node in network increased.

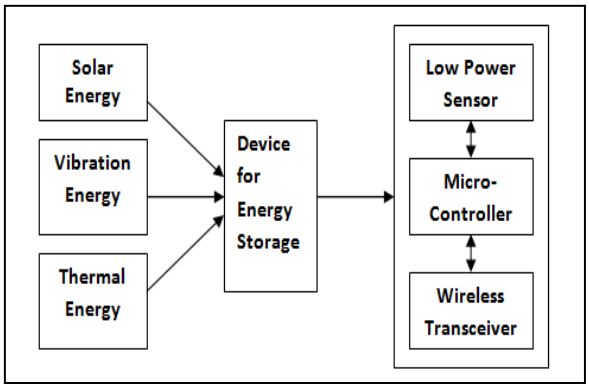

Fig. 3 Energy Harvesting Sensor Architecture for WSNs

D. EH-SEP ROUTING SCHEME

EH-SEP is the "Energy Harvesting version of SEP" routing protocol [33]. This protocol used energy of harvesting nodes and residual energy for election of cluster head by probability function. For transmission of data multiple hop transmission is used. This protocol provides better stability period than SEP.

EWMA [34] is a harvesting model "Exponential weighted moving Average" used for prediction of energy. Many routing protocol used this protocol like ECO-LEACH [35], DC-LEACH [36] are used for forecasting energy.

VII. IMPORTANCE OF NODE PLACEMENT IN PROTOCOLS

Node placement in protocols provides better stability period and useful for getting the desirable objects. Placement of nodes can be done statically and dynamically. Static placement of nodes is suitable at cost point of view. If nodes are mobile then dynamic placement of nodes is suitable for covering interest and connectivity problem. Many node placement techniques are described in [37].

VIII. RESULTS AND CONCLUSION

Combination of sensor nodes and wireless communication called wireless sensor network. In this paper, we concentrate on all types of protocol and classify them as conventional protocols, battery-driven protocols as homogenous and heterogeneous clustering schemes are shows the enhancements in stability period and scalability with new features of new developed protocols. After these protocols, energy harvesting routing protocol comes and concept of node placement is also useful for increasing the lifespan of network.

This paper provides insight on developed protocol for showing the developed cycle of routing schemes for increasing the stability, scalability and lifespan of network.

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