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Interim Election Protocol for Selecting Cluster Head to Mitigate Network Partitioning in NDN WSN

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***Abstract*—** Immediately Advent of new technologies, such as content centric networking, IoT, smart grids, vehicular networks, machine to machine communication and smart application encourages the researchers to build autonomous, intelligent and self-organizing wireless sensor networks to preserve efficiency and maximize network lifetime. Clustering is considered as one of the most effective method for energy preservation and increasing network up time and it also come with challenges i.e.; selecting optimal nodes to be part of a cluster, fault tolerance and selecting cluster head for every cluster. To make self-organizing WSN, it is necessary to dynamically choose cluster head (CH) in case of accidental or natural death of CH also for preserving energy and mitigating network partitioning. This paper presents a short survey on various lifetime maximizing techniques, self-organization models and also proposed an protocol named IE protocol for selecting cluster head node initially also at the time of node failure to maximize network lifespan and palliate the network partitioning issue in WSN. We have evaluated performance of proposed protocol with previously proposed protocol like LEACH for WSN and NDN-WSN.

***Keywords*—**Clustering, Energy consumption, Sensor nodes, LEACH, IE protocol, Wireless sensor networks, Name data Networking

I. INTRODUCTION

Wireless sensor network is network consists of specialized transducer with communication capabilities installed in an area for monitoring and keeping record physical and environmental situation. Transducers (which are also knows as sensor nodes and they are autonomous devices) are connected together via wireless communication network. WSN systems also have gateways which provide connectivity to wired world (where further processing of sensed data can be done). All of the sensor nodes are able to collect (sensing), process and communicate data simultaneously. Sensor nodes in WSN are also knows as motes and they have three main modules: A sensing module (which consists of one or more types sensors), a processing module for local processing and storage of data and a communication module, which is responsible for data transmission. Motes also consist of a power source (battery in most cases) which provides energy for various tasks performed by mote [1]. As motes works on batters to it is limited and have to be used efficiently and carefully because in some environments it is not possible to change or recharge battery.

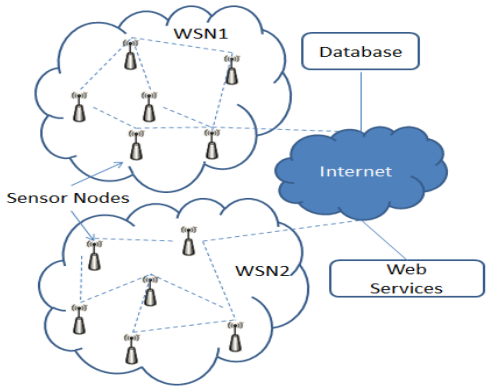

Fig. 1 Wireless Sensor Network [2]

Wireless sensor networks have wide variety of application areas like Environmental monitoring, Security and emergencies, smart world, transportation, medical and health, entertainment, military applications, industrial automotive controls and so on. As sometimes sensor nodes are deployed in hostile areas and may be die (stop working) due accidents or natural death (battery discharged), it may lead to network partitioning. Self-organization is considered as best way to fight network partitioning. In self-organization, network organizes itself for maximizing network uptime. Name data networking is a data centric approach in which data is of

primary importance rather than hosts. As IP based internet used to route data on the basis of IP addresses which makes it peer to peer network but it does not fit in current usage pattern as same information is needed to various user regardless of its origin. In NDN there is no IP address and data is transferred using interfaces. In sensor networks we do not have IP addresses and it uses device ids to identify a particular node. NDN can be a very good contender to use in WSN. NDN can leads to fast data retrieval in sensor networks. NDN inherently supports broadcast communication which is also a characteristic of sensor network. NDN reduces auto configuration complexity so it make more useful for self-organization in WSN. The contributions of this paper are summarized as follows.

1) Broad overview of Self organization definition.
2) Provides a brief survey on various techniques proposed so for maximizing network uptime and self-organization.
3) A proposed a method (Interim Election protocol) for maximizing network uptime.
4) Presented comparative results of LEACH, CLEACH, VLEACH and IE Protocol.

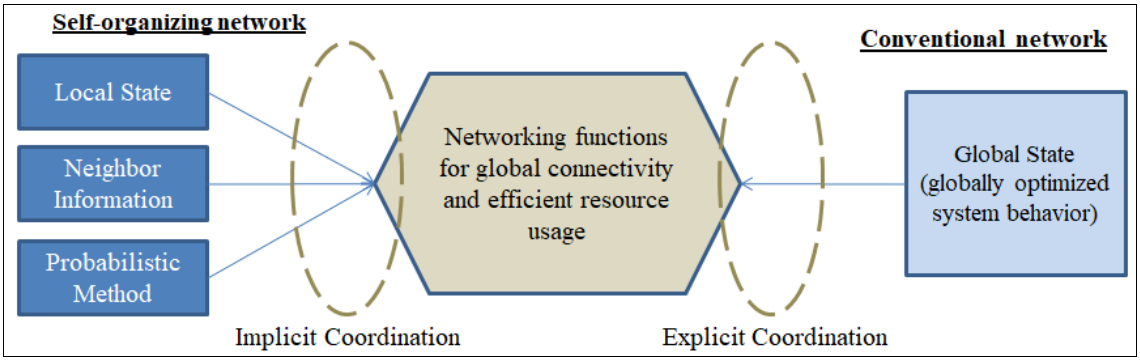

Fig.2. Principle and properties in self-organizing vs conventional WSN

A. Network Lifetime and Self Organization

Network life time can be defined as amount of time a network can function with its full functionality. For maximizing network life time it is necessary to organize motes in a manner that none of the node dies much before other. Well defined, battery management, routing protocol, architectures are necessary for maximizing life time. WSN are deployed in hostile environment and there are possibilities of physical damages or hardware failure, In such situation there is need of a strategy by which a network is able to perform well in case of death of sensor node, it is also known as self-organization. Following are certain designed constraints that's have to be considered while designing schemes for self-organization and maximizing network life time.

i. Resource Limits: Sensor nodes have very limited resources when it comes to battery and computation power and it will widely affects design of sensor networks.

ii. QoS Requirement: For better quality of service (latency, energy dissipation, data redundancy and time synchronization) better part of band is required (which will consume more power), more number of nodes are required and will increase overall cost.

iii. Mobility and Deployment: Nodes can be deployed in mobile environment like vehicle to vehicle communication etc. that have to be considered while designing.

iv. Communication Medium: choice of communication medium is widely affects network lifetime and fault tolerance. As radio spectral band require different power to transmit data and capable of different distance.

v. Coverage and Connectivity: For maximizing connective large density of sensor nodes are needed as well as for covering large area large number of sensor nodes are requires, this criteria is also needed to be considered for lifetime maximization and fault tolerance.

a) Techniques used for maximizing network lifetime-

The network is considered up till a node (nodes) is able to send last report to the base station or sink. There are various strategies were proposed to maximizing the network lifetime and they can be broadly classified in following five categories:

i. Based on Routing or Clustering: Routing decision have noteworthy role in networking lifetime maximizations. Dynamic routing protocols can be designed in a way that the sensor nodes with very less residual battery power is avoided to transmit data to long distances. Optimal energy aware route can be find to NL maximization. Dynamic routing decision can leads to avoiding same path every time for similar data transmission. Several approaches are proposed based on dynamic routing as well as combination of dynamic routing and sleep-awake algorithms. A similar algorithm was proposed by Liu et al.[3] by taking dynamic routing decisions and sleep mode algorithm in order to balancing load in entire network. They have used geometric programming algorithm which is based on sigmoidal programming. The proposed strategy is able to get near optimal solutions. Similarly Hsu et al.[4] proposed a strategy based on asynchronous sleep mode scheduling as well on

routing optimization. Another approach to maximize NL is to use hierarchal communication routing which is also known as clustering. Clustering protocols divide the whole networks into some groups of nodes (known as clusters). There is a node known as cluster head; to whom all other sensor nodes of a particular cluster send data and cluster head forward that data(collected data) to sink(base station). Cluster head can be chosen dynamically to reduce the burden on one node and prevent it from dyeing. Heinzelman et al.[5] proposed a pioneer clustering algorithm LEACH which dramatically increased network life time, there are certain other protocols were proposed as improvement of LEACH i.e. V-LEACH[6], LEACH-CCH[7], C-LEACH[8] which further improved the efficiency of clustering and increased network lifetime.

ii. Based on Optimal deployment: Sensor nodes should be deployed in a way they provide full coverage and connectivity with efficient battery utilization. Nodes near to the sink are prone to large battery drain as they get large amount of data from other nodes and they need to transmit that data to the sink. The nodes near to the sink can create bottle neck is not optimally placed. Several strategies are proposed for optimal deployments, In Natalizio et al.[9] analyzed optimal placement of sensor nodes which can increase network lifetime. Liu et al.[3] focused on identifying bottlenecks crate at the sensor nodes near to the sink. Wang et al. proposed a robust scale free topology to balance load. Magno et al.[10] also proposed a strategy for node deployment for ultra-low power networks. Mini et al.[11] Proposed a scheduling algorithm as well as scheme for optimal deployment of sensor nodes. Liu et al.[12] proposed a scheme where nodes are able to adjust transmission range for best and energy efficient topological way.

iii. Based on Transmission Schemes and Schedule: After gathering data from fields, the next step is to send it to the sink. Now it is the task of transmission scheme to find out which nodes are used to relay data, which is better channel for energy conservation. Matamoros et al.[13] proposed a scheme which optimally allocate transmission power and select optimal node to be cluster head, for parameter estimation, so that particular sensor node can send data using a favorable channel. Chen and Zhao[14] proposed an efficient MAC layer protocol, which is based on the channel state and knowledge of MAC. Another scheme based on prevalent channel state as proposed by Phan et al.[15], which claims to be energy efficient transmission scheme to maximize network lifetime. Kim et al.[16] proposed an optimal sleep and wake strategy which can increase network lifetime. Wu et al.[17] prosed a scheme based on game theory to choose best possible transmission scheme. Hsu et al.[18] posed a scheme based on optimal sensor node organization and sleep-wake schedule. Sichitiu et al.[19] also posed an optimized sleep and wake schedule, in which nodes only awake when necessary.

iv. Based on Beamforming: Beamforming is a technique used for directional signal transmission. A node using beamforming techniques uses multiple antennas to send same signal and determine best path to reach a sink using feedback given by sink. So node need to transmit signal in all direction instead it can transfer signal in best direction which saves energy. Bejar-Haro *et al*.[20] proposed an energy efficient scheme based on collaborative beamforming for transmitting data from sensor nodes to sink in order to maximize network lifetime without compromising the QoS. Han *et al*.[21] also proposed a scheme based on collaborative beamforming, which used closely located sensor to reduce traffic load and prevent transmission of data from a sensor node having low battery charge. Exploiting beamforming technique can increase the network lifetime from 10% to 90 percent based on topology.

v. Resource Allocation Depending on Cross Layer Design: Efficient and optimal resource allocation is one of the widely used techniques for maximization of network lifetime. It is most researched area for NL maximization. Optimal resource allocation is usually based on cross layer constraints like routing, scheduling, power control, throughput maximization, transmission reliability rate adaption, optimal node deployment, optimal transmission strategy and estimation quality. Hoesel *et al*.[22] proposed a strategy based on cross layer optimization which jointly work on routing as well as MAC layer. Known *et al*.[23] considered routing, MAC and physical layer for resource allocation optimizations. Xu *et al*.[24] examined the conflicting design issues like transmission rate, reliability network lifetime using an framework. Madam *et al*.[25]considered designing of optimal transmission rate, link scheduling and power for improving NL maximization. In 2013 Jeon *et al*.[25] considered both sleep control and contention probability of the sensor nodes for network lifetime maximization.

vi. Based on Data Correlation and Data Gathering: Adjacent sensor nodes in WSN may collect some amount of same data and that redundant data need energy for transmission. For maximizing network lifetime that redundant information should be reduced. There are certain approaches are proposed to reduce redundant sensed data. He *et al*. proposed a scheme based on temporal spatial correlation to predict data sensed by particular sensor nodes. Their approach leads to maximize network lifetime. Other schemes based on correlation is proposed by Heo *et al*.[26], which also predict the traffic load and spatial correlation is used to maximize network lifetime. Bhardwaj *et al*.[27] defined various constraints for data gathering and transmission with upper bound in achievable maximum network lifetime. They have considered various parameters like path loss, location of base

and well as sensor node etc. Liang *et al*.[27]also proposed scheme for maximizing NL which is based on efficient data gathering.

b) Techniques used for self-organization in WSN-

WSN can be very large in size and they are prone to accidental or natural damage and techniques used for managing them are very costly, so to make networks efficient and affordable, it is necessary for networks to be self-organized which allow devices to cooperate to their topologies, reconnects to other nodes in case of damage or adapt to various environmental changes without need of human intervention. WSN can use Self-organization for resource sharing, processing, communication, structure formation, maintenance, sensor or server placement, routing and information dissemination. Various models are proposed for self- organization and they can be broadly categorized into following categories:

i. **Biological Models**: Biological processes include self-organization like in multi-cellular embryogenesis. These techniques can be used in computer science. In 1989 Kohonen[28] proposed self organization maps that transform a multidimensional space of input into a lower dimensional lattice of neuron in such a way that, topological relationship among the multidimensional input space are reflected into newly constructed neural network. Hofmeyr *et al*.[29] used self-organizing maps to form artificial immune system for intrusion detections that can be used for self-organization.

ii. **Social Models:** Functions such as swarms, ant colony, bee colony, firefly, bat birds, insects exhibits self-organization characteristics to exchange information.

iii. **Economic Models:** Producer and consumer model as if consumer is low in market then producer can lower the price of the product or reduce production.

iv. **Miscellaneous Models:** Various models based on physics, gravitation our earth is the best example of self-organizing system as carbon die oxide emits in environment can increase the temperature of earth , earth have its own mechanism of rain which reduce carbon di oxide in environment.

II. RELATED WORK

This study proposed a clustering based protocol for self-organization in WSN-NDN. There are various energy efficient protocols are proposed for self-organization in WSN in case of natural as well as accidental death to maximize network uptime. We have divided the related work in two parts one is background of NDN, NDN WSN and second part is various previously proposed energy efficient self-organization protocol.

A. *NDN-WSN Background*

NDN stands for Name Data Networking and it is a NSF sponsored project and FIA (Future internet architectures). It is also based on content centric networking where content is of primary interest irrespective of its producer or location. NDN project described only two types of packs: Interest packet(*I_Packet*) and Data packet(*D_Packet*). NDN works on pull mechanism and data is pulled (requested) from the network using Interest packet and Data is reverted back to the user using data packet. Interest packet contain name of data (naming using specific mechanism) and interface from which data is requested. *I_Packet* is forwarded to next NDN router, which contains three kinds of data structures i.e. Content Store, PIT (Pending Interest Table) and FIB (Forwarding Information Base). Content Store (CS) is used to cache data previously transferred through this router, PIT contains interest that yet to be fulfilled and FIB consists for forwarding information. As Interest packet reaches NDN router, router first check whether requested data presented in CS or not if yes then router revert requested data to the incoming interface, otherwise NDN router check PIT for previous interest for same data is presented in PIT or not if yes then it add interface of incoming *I_packet* to it otherwise new entry is created in PIT and *I_Packet* is forwarded to FIB.

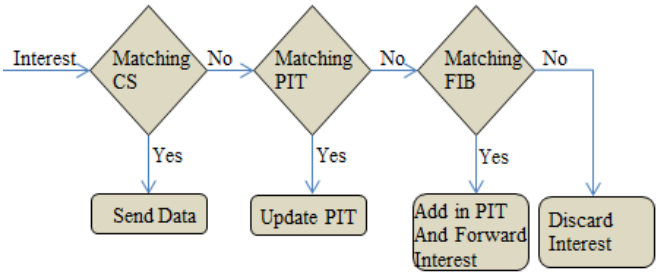

Fig.3 Interest forwarding process in NDN

In NDN Interests are forwarded to all interfaces except to which the Interest arrives. But IF we want to use NDN in WSN then broadcasting Interest can leads to heavy traffic in the network. To solve this issue Amadeo et al.[30] proposed a protocol called Direct Diffusion. They have used blind forwarding technique, which was based on deferrer timer to identify path for a certain nodes (or producer) that can be used for fulfilling future interests. dd-NDN is not considered as scalable and energy efficient due to blind forwarding. The author have also proposed a scheme SIMD (Single Interest Multiple Data). The SIMD includes several mechanisms to ensure reliability but it is applicable to one hope networks only. In 2014 Wang et al. proposed a framework called NETWRAP. It consists of comprehensive set of protocols to access dynamic information about energy levels and data gathering, delivery (based on NDN concepts). Dual Mode Interest Forwarding (DMIF) scheme for NDN-WSN forwarding was proposed by Gao *et al*.[31] with the use of two modes i.e. flooding mode and directive mode. Flooding

mode is use to find out various producers and directive mode is use to guide Interest forwarding.

B. Energy efficient self organization protocols

Following are previous work done in this field using clustering technique. Legendry Time division multiple accessing (TDMA) based media accessed control (MAC) protocol with integration of clustering was proposed by Heinzelman *et al*.[5] known as LEACH. The goal of LEACH was to reduce battery consumption by making clusters and only CH is allowed to forward data to sink. Other sensor nodes (non CH nodes) send collected data to CH only. The challenges were to define appropriate cluster, choose cluster head and self- organization in case of accidental or natural death. The improvement of LEACH was proposed by Tian *et al*.[5] in the form of LEACH-C which uses a centralize clustering method for cluster formation. LEACH-C initially assumes that each node has information about its remaining energy level and they exchange messages for localization. Cluster head is selected by BS (base station) randomly from deployed sensor nodes, which more than half average remaining energy.

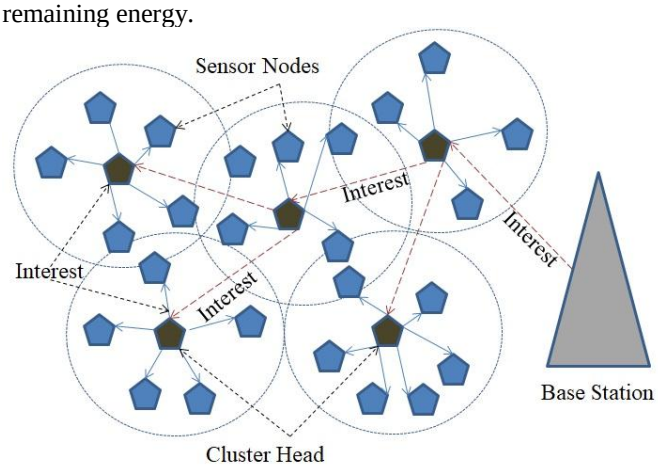

Fig.4. Interest Packet forwarding in NDN WSN

Each node sends its location (GPS info.) to CH and quadratic some is calculated to find optimal cluster. In 2009, M. Bani Yassein *et al* [32] proposed a new variant of LEACH protocol known as V-LEACH. The aim of V-Leach designing was to reduce energy consumption. V-LEACH also divides the network into several clusters and each cluster contains a cluster head. Only cluster head is allowed to send data to base stations. This protocol also chose a Vice-CH node whose responsibility is to forward data to the BS (sink) in case cluster head dies due to energy drain or accident damage. Non-CH nodes are for gathering data from environment and send it to the CH. Azim *et al*.[33] proposed a relay node based scheme to preserve some energy in choosing cluster head dynamically. H-Leach is designed in a way that if network can operate with or without relay node. Nodes working in H-Leach are able to send data to BS even in case only one node left and have energy to send data. It increased network uptime. H-LEACH also works with control cluster size to make it more efficient. Lu Tao *et al*.[34] also proposed a protocol base din LEACH which is able to work well on small as well as big size clusters. The main motive of proposed protocol was to improve energy distribution, manage uneven cluster and variable size clusters. Another attempt was made by Liu *et al*[35] in the form of LEACH-GA, which is based on genetic algorithms. LEACH-GA selects cluster head on the basis of genetic algorithms in preparation phase as well as subsequent phases. To maximize network life time farooq *et al*.[36] also proposed a protocol MR-LEACH based on LEACH. MR-LEACH divides the WSN into two layers of clusters. Only cluster head in each layer is allowed to interact with other layers cluster head. They have used two types of nodes i.e. transmitting nodes and normal nodes which collect data from field and send it to cluster head. Transmitting nodes are managed by base station. For conserving energy it uses multi-hoping routing algorithm. Another approach for clustering in WSN was proposed by Mittal et al. with the help of Self organizing feature map neural network. The recent for lifetime maximization in WSN are proposed in Alexender Titaev[37] they have considered nodes with two level transmission power, which is then used for creating a minimum spanning route tree.

III. THE PROPOSED SCHEME

The Goal of proposed scheme is to develop a mechanism for creating appropriate clusters, choosing appropriate cluster head in normal as well as in case of coordinator node failure to prevent network partitioning and enhance NDN-WSN up time.

The whole mechanism is divided into several rounds and there are two phases in each round.

1. Set-up Phase
2. Steady- state Phase

Set-up Phase:

a. **Selection of Cluster Head:** This phase is all about selection CH for a particular cluster. Each node in the cluster sends its location (it is assumed that each node know its location) and remaining energy to sink. Base station use the data sent by nodes to computes average energy level of nodes in particular cluster. Nodes which have higher remaining energy are considered as candidate for cluster head. Base station broadcasts selected cluster head ID. All nodes match their ID with the broadcasted ID and if match found, then that node work as cluster head otherwise node go to sleep until its next scheduled TDMA slot.

b. **Formation of Clusters:** After selection of cluster head it is time to form cluster. Non CH nodes join (inform) cluster head on the basis of energy-Cost ratio i.e.; cost of transmitting data (Minimum Distance).

i. If there are N numbers of nodes presents in network and K numbers of nodes are selected as candidates from CH for a particular round then only k number of clusters will be formed for current round.
ii. N/K number of nodes will be presented in each cluster including CH for particular round.

IV. STEADY- STATE PHASE

a. **Data gathering:** AS NDN is pull network and communication should be started by receiver only. So BS sends an interest packet and it is forwarded using dd-NDN. After receiving interest nodes seed data to the cluster head with remaining energy level. The operations in steady state are splited into frames. Every node collects data from the field and need to send it to cluster head. Sensor nodes can send data in their TDMA slot only. Sensor nodes only awake when he have to send data and other time it becomes dormant or goes into sleep mode to preserve energy. Cluster Head need to remain active to collect data from other nodes.

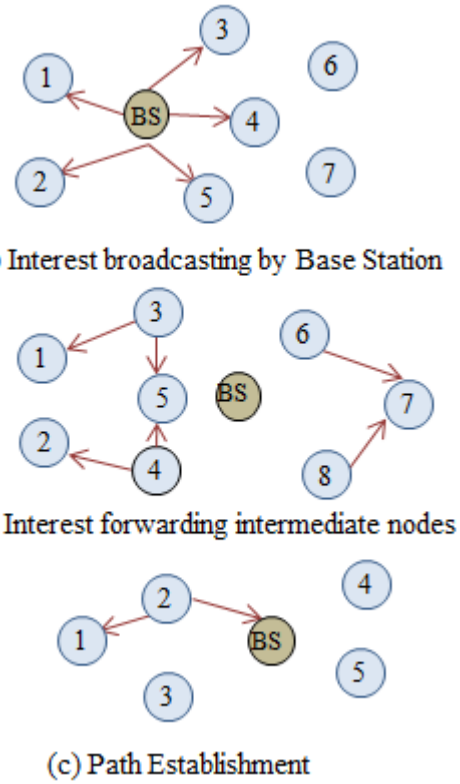

Fig.5. Path Establishment in dd-NDN

b. **Data aggregation:** It is very likely that the data related to particular sink have some redundancy and in order to save energy, it is necessary to remove redundancy that leads to reduced number of transmissions. This can be achieved by data aggregation. There are three general types of suboptimal aggregation techniques namely shortest path tree, greedy increment tree and centre at nearest source. In our proposed mechanism we have used centre at nearest source technique, In CNS the node near to the base station is ac as aggregation point.

c. **Fault tolerance:** After performing data aggregation by cluster head, cluster head transmits collected data to base through relying cluster head nodes. If cluster head's energy level is less than predefined threshold level than an immediate re-election for another cluster head requires for mitigating network partioning.

A. INTERIM ELECTION Protocol

Steps to be followed in proposed protocol

Set-up Phase I: Network set-up

i. In first round cluster generation and CH node selections are done via LEACH-C.

ii. In each cluster, cluster head nodes function as root while non-cluster head nodes are organized with root nodes in tree topology.

Cluster Head selection
If
Re (Remaining energy) > Me (mean energy level) of all sensor nodes
Then,
node is eligible for being CH
else
Not eligible
Begin Process

Phase 2: Steady- state
i. Data gathering
a. After getting I_*Packet*, no non-CH node sends data to CH of the cluster in given TDMA slot.
b. Leaf nodes send remaining energy level data to their parent node including their node id.
c. Parent (immediate parent) node collects data (about remaining energy and node id) from child node and compares that energy level with its own remaining energy.
d. After comparing the information about node with highest level energy is forwarded to its upper level.
e. The processes are repeated by all higher level nodes till data (information about highest energy level node) reached to the CH node.
f. CH node is also bound to perform same comparisons.
g. Same process of data gathering is carried out in all clusters.
ii. Data aggregation (within single cluster):
a. Cluster head sends collected data (*Node_ID* + *Re*) and additional information about the node having maximum remaining energy in entire cluster to the base station.
b. These same data aggregation processes are carried out by all clusters (in entire network).
iii. Fault tolerance:
Consider four cases are as follows.

Case 1) Energy of cluster head is not enough for transmission of data(remaining energy < threshold) out of all the nodes in the clusters, the node having higher energy level act as the cluster head for current(ongoing) round and sends collected data to BS.
Case 2) Cluster head dies because of natural death (remaining energy =0).
a. Death of cluster head leads to failure of collected data transmission (ongoing transmission)
b. Base station broadcasts a *FaultMessage+NewClusterID+ PreviousCH* ID to the cluster.
c. Children of dead cluster head node receive the fault message and send acknowledgement to the sink containing node ID and energy level.
d. After receiving acknowledgement containing *Node_ID+Energy* level, sink compares and choose new cluster head and broadcast its ID.
e. Nodes in the cluster records new cluster head ID and forward subsequent data to it.
f. All sensor nodes within the cluster receive message about new CH id and initiate data transmission to new CH.
Case 3) Intermediate sensor node dies (because of natural death)
a. Nodes in the higher level cannot receive information in given TDMA.
b. Higher level nodes broadcasts FaultMesssage_NewCluster ID+PreviousCH ID to the cluster.
c. Nodes in the cluster receiveall these messages and find own PnodeID in the table.

If
P_ID(Parent node ID) does not match with dead node ID
Then
No RequestParent message
Else
Send RequestParent message to Higher level node
Begin Process

d. If higher level nodes receive the *RequestParent* message then it sends the *ReadyMessage* to all subordinates.
e. After receiving ready message, all children send data to immediate upper level.
Case 4) Any leaf node dies (because of natural death).
a. If leaf node dies, immediate parent are unable to get data (sensed data) in given TDMA slot.
b. Immediate parent node of dead node broadcasts *ChangeId+ FaultMessage*
c. After receiving this message, all nodes in the cluster begin the process.
Message types
i. FaultMessage: to cluster containing ID of dead CH node and sink address.
ii. ChangeIdMessage:To neighbours for updating IDs in neighbour tables. It changes its ID if any neighbour is found a child for this node. This process goes on till ID of all affected nodes are modified.
iii. ReplyMessage: Containing the node IDs and remaining energy levels.
iv. Acknowledgement message: to clusters containing the IDs of CH node.
v. RequestParent message: containing ID of node which requested for parent and higher level node ID.
vi. Ready message: for association with parent.

Notations
i. N is the number of all alive nodes (alive nodes are nodes who are capable of transmitting data).
ii. P is no. of cluster heads per round = 5 percent of all alive nodes.
iii. C[] is set of CH Candidates.
iv. E is prevailing energy of any particular node.
v. D[ ] depicts the distance between sensor nodes.
vi. CH[ ] containing node selected as CH.

B. *Design Details*
Network model

In Proposed approach, following are properties of considered sensor network model.

i. The Sink is distantly located and it is static and fixed.
ii. As the characteristic of WSN, nodes run on battery and energy constrained and has uniform initial charge.
iii. Sensor nodes have capability to control power. It can be used to variable power according to the need. As for larger distance larger power is needed and for smaller distance less power is needed.
iv. After collecting data from field, each sensor nodes sends it to CH which forwards data to BS after aggregation.
v. For this particular scheme we have only considered immobile sensor nodes.
vi. All sensor nodes are equipped with Data processor, power supply, transmitting and receiving antenna and amplifier.
vii. Microsensor senses environment information, data processor does all the data operation and antenna is responsible for data transmission. The energy consume in the sensor network can be defined as the energy consumed for data transmission to CH which is energy communication factor.
viii. Calculation of energy dissipation for data communication to CH is as follows.

$$E_{dx} = E_{amplification} + E_{processing}$$

Where, $E_{processing}$, is defined as energy consumed in processing data.
ix. $E_{amplify}$ energy consumed in amplifying signals.

C. *Assumptions*

i. The number of cluster formed will be equal to K if there are N numbers of nodes in whole network and K numbers of sensor nodes are selected as CH for ongoing round.
ii. Numbers of sensor nodes in particular cluster including CH are N/k for prevailing round.
iii. Initially all sensor nodes are equipped with equal level of energy.
iv. All sensor nodes are full function devices.
v. All nodes in the cluster construct a logical tree. We have used a new addressing scheme proposed by Momami et al.[9] for the construction of tree, which is used to assign addresses to the cluster nodes. It is mandatory for a node to keep information of neighbour nodes, their energy levels, and their addresses.
vi. An energy threshold value is predefined for forwarding data.
vii. Node is considered under failure condition is its energy level goes below predefined threshold.
viii. Any node which is in failure condition is require to broadcasts its ID in an InformMessage to its children, parent, neighbour about its breaking down inorder to make them take appropriate action and prepare themselves to reconstruct logical tree.

The study shows that, In IE-NDN protocol more number of nodes alive over time in comparison to LEACH. It can be infer from the study that, uptime of IEN(Interim election NDN) protocol is more than LEACH protocol, due to(re-election) interim election process at the time of sensor node failure and using NDN-WSN approach[8].

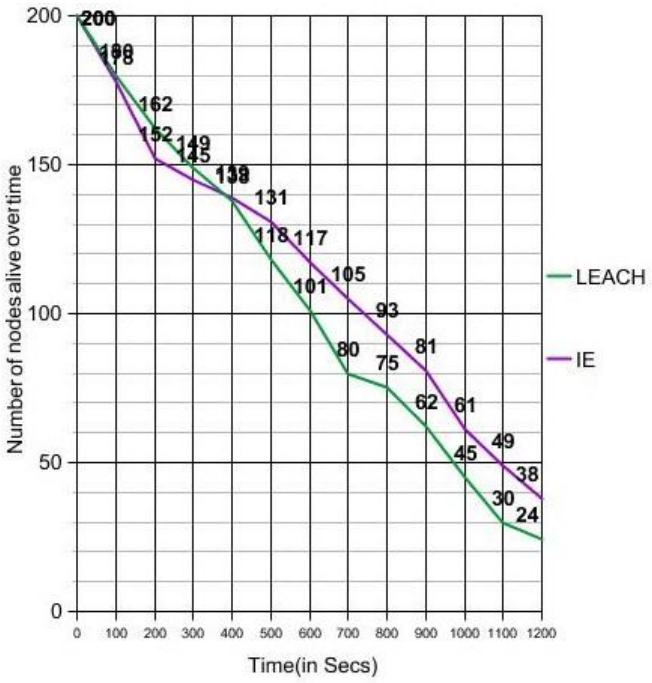

Fig. 6 Comparison of network lifetime LEACH vs IE-NDN

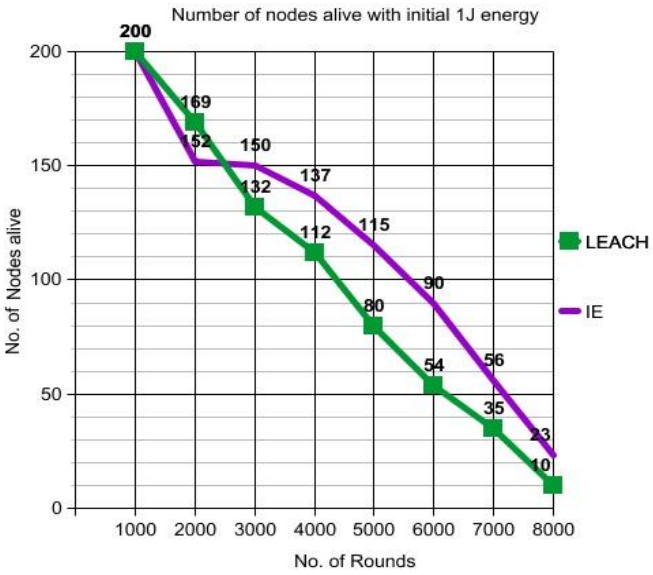

Fig.7. Comparison of LEACH vs IE NDN Protocol

V. CONCLUSION

We have studied various protocols proposed for self-organization, energy conservation and maximizing network lifetime and found number of issues i.e. N fault tolerance, cluster head selection at the time of node failure and compatibility on NDN with WSN. Our proposed protocol addresses these points in terms of individual node availability. We have proposed a protocol for self-organization in NDN-WSN. Similar to classical WSN, NDN based WSN networks are also prone to accidental or natural death of nodes and network need to self-organize in order to continue working. We have also proposed a clustering algorithm for selecting dynamic cluster heads to save energy and maximize network uptime. We have simulated results on NS3 and compared results with LEACH protocol.

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