Evolution of Fault Detection WSN and MANET

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***Abstract-* Wireless sensor networks have been established, at an early stage in their development, to be a useful dimension technology for environmental monitoring applications. Wireless sensor nodes may experience two types of faults that would lead to the degradation of performance. One type is function fault, which normally results in the crash of individual nodes, packet failure, routing failure or network separation. In this paper , the problem of adaptive Distributed diagnosis in WSN using clustering is measured.. In fact, fault-diagnosis becomes an important building block to establish dependability in WSN. An important problem in WSN is the distributed system-level diagnosis problem whose purpose is to have each fault-free sensor node to determine the state of all the sensor nodes in the structure. The parameters such as diagnostic latency and message complexity are used for evaluating the performance of proposed diagnosis algorithm. After the complete diagnosis global diagnostic information is provided to have a consistent diagnosis view of the network .The threshold value tells how much percentage of nodes are faulty or fault-free. Diagnosis algorithm should be efficient enough to find the status (either faulty or fault free) of each sensor node in the network.**

***Index Terms*—WSN, Fault Model, Hi-ADFD Algorithm, Cluster**

I.INTRODUCTION

From the last thirty years many network Researchers are studying networks based on new communication techniques, in Wireless Communications [1][12]. Like traditional wired networks, wireless networks are created by routers and hosts. In a wireless network, the routers are capable for forwarding packets in the network and hosts are sources or sinks of data flows. People can deploy a wireless network very easily and speedily .The basic difference between wired and wireless networks is the way in which network components communicate with each other. A wired network depends on physical cables to move data. As it is understood that in a wireless network, the communication among different network components can be either wired or wireless. As wireless message does not have the constraint of material cables, it allows explicit freedom for the hosts and routers to travel in the wireless network. The main advantage of a wireless network [2] is that it presents the productivity, convenience, and cost advantages over the wired networks [13].

- Mobility: Wireless LAN systems can provide LAN users with access to real-time information anywhere in their organization. Mobility supports efficiency as well as service opportunities which are not possible with wired networks. There are now thousands of hotels, universities and public places with public wireless connection.
- Reduced Cost-of-Ownership: Though the initial investment required for wireless LAN hardware can be higher than the cost of wired LAN hardware, but overall mechanism expenses and life-cycle costs can be considerably lower. Long-term cost benefits are more in dynamic environments requiring frequent moves and changes.
- Installation Speed and Simplicity: It is very easy and quick process to install a wireless LAN system and thus allows to get rid of the need to pull cable through walls and ceilings.

Scalability: Wireless LAN systems can be configured in many different types of topologies to fulfil the needs of particular applications and installations. Configurations can be naturally changed and ranges from peer-to-peer

In a wireless network the network components communicate with each other by the use of wireless channels. Dissimilar radio frequency (RF) spectrum ranges are used in wireless networks, for example a 2.5-2.7 GHz for the Multipoint Multichannel Distribution System, 27.5-29.5, correspondingly. The strength of the signal in a wireless medium decreases when the signal travels [10].

When the signal travels beyond some distance, the strength gets reduced to the point where reception is not possible. The distance that a signal travels when it reaches to that point is called the radio range for the given signal. To simplify the transmission model regarding this property, people think that the wireless signal is strong enough for the receivers to receive the signal if the receivers are inside of the radio range [2].

FAILURES IN WIRELESS SENSOR NETWORKS

To comprehend fault tolerance mechanisms, it is significant to point out the difference between faults, errors, and failures. Different definitions of these terms have been used [9].

- .A fault is any kind of defect that leads to an error.
- An error corresponds to an incorrect (undefined) system state. Such a state may direct to a failure

A failure is the (observable) manifestation of a fault, which occurs when the system deviate from its specification and cannot deliver its intended functionality. Figure1 below illustrates the difference between fault, inaccuracy (error), and failure. A sensor service successively on node A is expected to periodically send the measurements of its sensors to an aggregation service running on node B. However, node A suffers a crash that causes a loose connection with one of its sensors. However the code that execute node A's services is not designed to detect and overcome such location, a wrong state is reached when the sensor check tries to acquire data from the sensor. Due to this state, the service does not send sensor data to the aggregation service within the specified time interval. This results in a break down or omission failure of node A observed by node B.

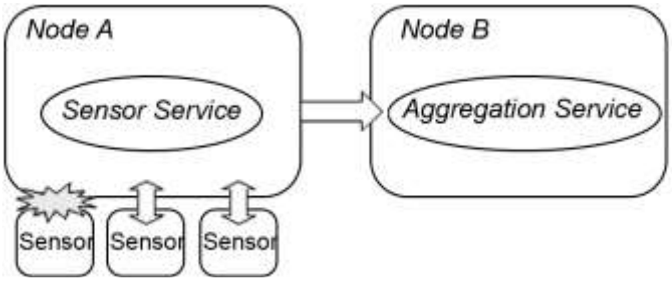

Fig 1. Description of fault, error and failure

In the scenario explained above, the fault is the loose connection of the sensor. The error is the state of the service after trying to read the sensor data and the failure occurs when the application does not send the sensor data within the specified time interval. To provide flexibility in faulty situations two main actions must be performed:

Fault detection. To provide any counter measures, the first step a system must carry out is to detect that a specific functionality is faulty.

Fault Recovery. After the system has detected a fault, the next step is to check or recover from it. The main technique to achieve this goal is to replicate the components of the system that are vital for its correct operation.

RELATED WORK

Failures are unavoidable in Wireless Sensor Networks due to the lack of monitoring and incoprative nodes. There are many issues related to energy, memory and computational ability of a sensor node. The occurrences of faults are mostly due the presence of faulty sensor nodes .To identify a fault node and to replace it, manytechniques are proposed.

2015 Jie Wu, et al wireless sensor networks [8], named clustered agreement time synchronization (CCTS). This algorithm is developed on the basis of the distributed consensus time synchronization (DCTS) algorithm. However, to obtain faster meeting in the clock synchronization of node and better energy efficiency, the clustering technique is included into the algorithm. The CCTS includes two parts: 1) intracluster time synchronization and 2) intercluster time synchronization. In the intracluster time synchronization, the better DCTS is applied. The cluster head is responsible for exchanging messages within the cluster. The standard value of skew costs parameters of intracluster virtual clock and the average value of intracluster virtual clocks are used to update the skew compensation parameter and offset compensation parameter, respectively. In the intercluster time synchronization, cluster head replace messages via gateway nodes. To modernize the clock compensation parameters of the network virtual clocks, clock costs parameters of intracluster virtual clocks of every cluster head are assigned with corresponding weights based on the size of each cluster. The simulation results shows that the future algorithm reduces the communication traffic compared with the DCTS algorithm, and improve the convergence rate suitable for the combination of clustering topologies.

2014 Ravindra Navanath Duche et al [11] proposed the method of fault detection which was based on RTD time size of RTPs. RTD times of discrete RTPs are compared with threshold time to determine failed or malfunctioning sensor node. Initially this method was tested and verified on six wireless sensor nodes, implemented by with microcontroller and Zigbee. In order to confirm the scalability of this concept, WSNs with huge numbers of sensor nodes were implemented and simulated in open source software NS2. Generalized model to establish the fault detection analysis time for WSNs by using discrete RTPs was suggested. Different experiments were performed in hardware and software based on RTD time measurements. Analysis time in every cases of fault detection is determined with the help of generalized model. Result scrutiny in hardware and software indicates that RTD time measurement results in both cases were quite the same, validating the real time applicability of the method.

2013 Hong-Chi Shih et al proposed a fault node recovery (FNR) algorithm[10] to enhance the lifetime of a wireless sensor network (WSN) when some of the sensor nodes were shut down, either they no longer have battery energy or they have reached their operational threshold. The FNR algorithm can result in smaller number of replacements of sensor nodes and more reused routing paths. Thus, the algorithm not only enhances the WSN lifetime but also reduces the cost of replacing the sensor nodes. The conventional approaches to sensor network routing include the directed diffusion (DD) algorithm and the grade diffusion (GD) algorithm. The proposed algorithm is based on the GD algorithm, with the objective of replacing several sensor nodes that are inoperative or have depleted batteries, and of reusing the greatest number of routing paths. These optimizations will ultimately augment the WSN lifetime and reduce sensor node replacement cost.

2006 C. Husin and M. Liu [14] presented the self monitoring approach for monitoring a class of wireless sensor networks. In many applications for security reasons it is very important to monitor the health of network of sensors. In this mechanism they used a two phase self monitoring scheme. First, some level of active monitoring is necessary simply because it is the only way of detecting communication-disabling attacks. However, because of the high volume of traffic it incurs, active monitoring should be done in a localized, distributed fashion. Secondly, the more decision a sensor can make, the less decision the control center has to make, and therefore less information needs to be delivered to the control center. Arguably, there are scenarios where the control center is at a better position to make a decision with global knowledge, but whenever possible local decisions should be utilized to reduce traffic.

2006 W. L. Lee et al [15] [16] presented the wireless sensor network management system and used the concept of central manager to monitor the whole system. The central manager has the global view of the network and it continuously analyze the system and takes corrective and preventive actions according to policies defined by human mangers. To detect faults and link qualities the central manger analyses the topology map and energy map information. This approach is used in many applications but it is not scalable and cannot be used for large networks. And due to centralized mechanism whole traffic is directed to and from a central point.

Iv Purposed Algorithm

Hi-ADFD groups nodes to which are set of nodes and uses a divide and conquer testing approach to allow nodes to autonomously achieve consistent diagnosis. The number of nodes in a cluster, its size, is always a power of 2^n and system itself is a cluster of N nodes. a hierarchical approach to test cluster is shown. In the first testing interval, each node perform tests on node of a cluster that has one node. In the second testing period, on nodes of cluster that has two nodes, in the third testing period, on nodes of cluster that has four nodes and so the cluster of $2^{\log N-1}$ or N/2 nodes is tested. After that, again the cluster of size one is tested and the process is repeated until all the nodes are tested by every other node in the network. For Figure: 4.1, for all p and k, $C_{p,k}$ is listed in Table 4.1

The formula used for generating clusters of varying sizes is shown below:

$C_{p,k} = \{ n_z \mid z= (P \bmod 2^k+2^{k-1}+q) \bmod 2^{k-1+x}+(p \text{ div } 2^k)*2^k+y*2^{k-1} ;q=0,1\ldots\ldots 2^{k-1}-1\}$

Where

x={ if P mod $2^k<2^{k-1}$,0 otherwise}

y={1 if x=1 AND (P mod2^k+2^{k-1}+q)mod2^{k-1+x}+(P div 2^k)*2^k<P,0 otherwise}

where,

$C_{p,k}$:is a list of ordered nodes that are tested by node x in a cluster having size 2^{k-1}.in a given testing round.

K	$C_{0,k}$	$C_{1,k}$	$C_{2,k}$	$C_{3,k}$	$C_{4,k}$	$C_{5,k}$	$C_{6,k}$	$C_{7,k}$
1	1	0	3	2	5	4	7	6
2	2,3	3,2	0,1	1,0	6,7	7,6	4,5	5,4
3	4,5,6,7	5,6,7,4	6,7,5,4	7,4,5,6	0,1,2,3	1,2,3,0	2,3,0,1	3,0,1,2

Table4.1: $C_{p,k}$ for the system

v. Performance of Purposed Algorithm

Simulation of the Hi-ADFD algorithm was carried out using MATLAB language (matrix laboratory) which is a numerical computing environment developed by Math Works. MATLAB allows matrix multiplication, showing graphs of functions and data, implementation of algorithms. The experiments were conducted for the network of different sizes of 8, 16, 32, 64,128 nodes. Tests were scheduled for each node at each 30 ± б units of time, where σ is a random number in the range of 0 to 3. During each test, the status of nodes are checked and if the node is fault free, diagnosis information concerning the cluster is copied to testing node.. Network is clustered using the algorithm described above.

Sl. No	**Parameter**	**Value (units)**
1	Diagnosis task execution time	0.01 to 0.05
2	Send initiation time	0.002
3	Request heartbeat/ Response heartbeat delay	0.008 to 0.08
4	Local diagnostic message /Global diagnostic message delay	0.012 to 0.12

Table 5.1: Values of Different Parameters Used in the Simulation

In proposed diagnosis algorithm, an initiation heartbeat message goes from each initiator node simultaneously to a node of a cluster of size $C_{p,k}$ of one and waits for a time out period of Tout. If the node in this cluster is fault free, the initiator node will receive a response heartbeat message from this fault free node and collects the diagnosis information about the entire network as of this node. If the node in the cluster is faulty, the initiator node whichever will not receive a response heartbeat message or it may receive an erroneous message. The initiator will detect this fault most within Tout. The initiator then sends another initiation heartbeat message to another node in the cluster of size 2 and repeats same process. In the worst case, an initiator node has to send an initiation heartbeat message to all the nodes of all the clusters of size $C_{p,k}$ comprising of only faulty nodes.

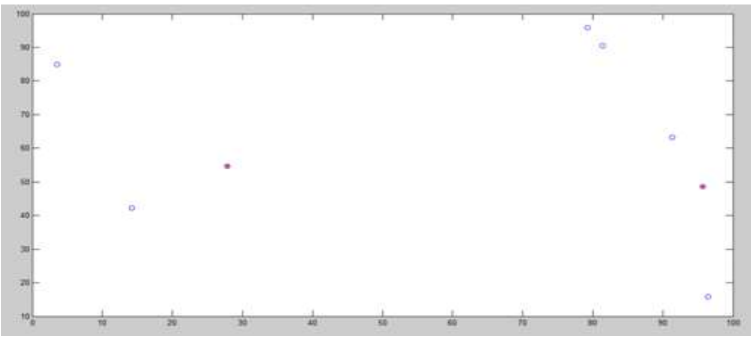

Figure5.1: Faulty and Fault free nodes.

1. **Diagnostic Latency:**

The diagnostic latency for the proposed algorithm using clustering is shown in figure. As the network size increases, the diagnostic latency using clustering increases but in general there is a significant reduction in diagnostic latency by using clustering as compared to the diagnostic latency without using clustering. This shows that the proposed algorithm is suitable for large WSN deployed in hostile and harsh environments.

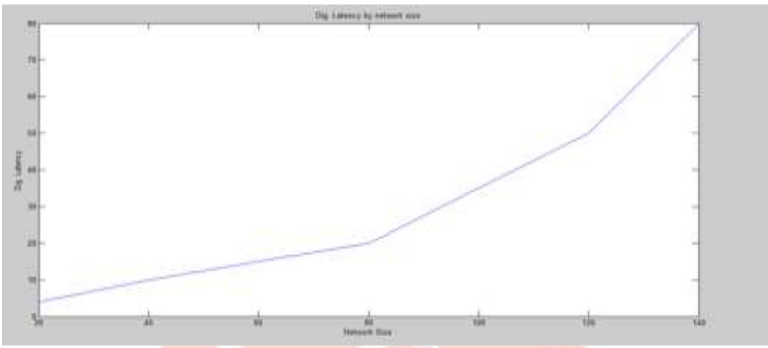

Figure5.2: Diagnostic Latency Graph

The diagnostic latency of our algorithm depends on number of messages such as initiation heartbeat message, response heartbeat message, local diagnostic message, global diagnostic message and message size. Sensor node running our proposed algorithm gets messages with diagnostic information concerning about the nodes in each cluster being tested. Since the number of messages and message size is directly proportional to diagnostic latency, the diagnostic latency of our algorithm comes out to be less.

2).Message Complexity

Figure shows the number of messages versus number of nodes. Message complexity i.e. total number of messages exchanged increases linearly with the number of nodes and found to be O(N.Cm,k).This shows the proposed diagnosis algorithm is linearly scalable.

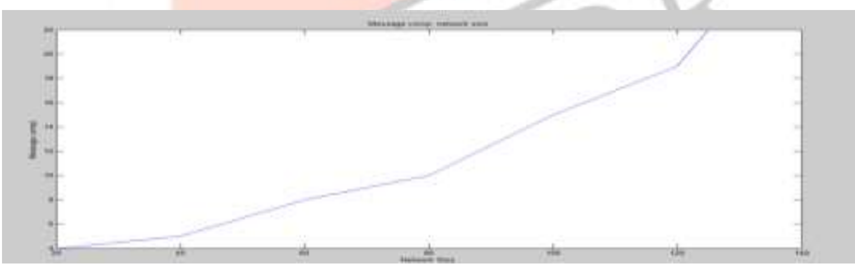

Figure5.3 :Message Complexity Graph

3).Hop-count

The number of hop counts for the proposed diagnosis algorithm to complete fault diagnosis for network of different sizes is shown in figure. Hop count on an average is being calculated as the ratio of the Euclidian distance between the source and destination node in the simulation and the number of nodes in between the source and destination node.

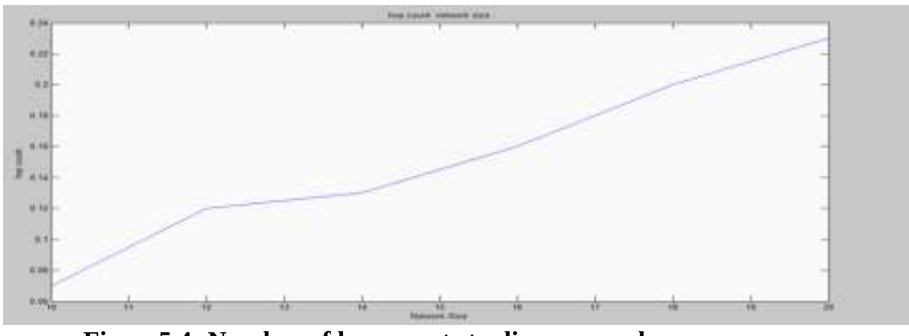

Figure5.4: Number of hop counts to diagnose nodes.

VI. CONCLUSION

In this paper we provided a detailed study of the faults that occurred in real WSN deployments. This concise study provides a valuable knowledge input for future application to prevent the same kind of issues from happening. . We have presented a promising framework for fault detection using FIND to model faults and monitor the data to detect the occurrence of these faults. It is worth emphasizing that fault detection is not the end goal in Wireless sensor networks. The primary goal is to obtain clean data which can be analyzed to achieve the scientific objectives. Fault detection methods are used to make this goal possible With the presence of faulty readings, the accuracy of query results in wireless sensor networks may be greatly affected.

vii.FUTURE WORK

Make a trusted network or central network, by making the central network the burden of splitting the information to the number of nodes is reduced . the complete information is stored in this trusted network so that every cluster takes the information from this trusted network and access the information, not store the information of all their own nodes in separate table. The complete information is stored at one place, all the nodes of the clusters access the information from this central network and reduce the burden of nodes.

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