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A Survey & Study on Improvements in Efficiency and Effectiveness of Multipath Routing Protocols in Wireless Sensor Networks

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Abstract: In the recent decade, several technology trends have influenced the field of WSN in significant ways. The first trend is the more readily available technology of ubiquitous wireless sensor networks as well as wireless communication networks and progress in the development of low-power sensor nodes, efficient working sensor networks, multithreading, communication between nodes, joint routing and scheduling, path availability, less energy consumption on nodes etc. WSNs have the potentiality to connect the physical world with the virtual world by forming a network of sensor nodes. Here, sensor nodes are usually battery-operated devices, and hence energy saving of sensor nodes is a major design issue. To prolong the network's lifetime, energy consumption should be reduced in the sensor nodes. The minimization of computing and storage platforms as well as the development of novel micro sensors and sensor materials with high reliability force encourages technology in research on WSN. All the trends have changed the type of dynamic environmental phenomena that can be detected, monitored and reacted to. Another important aspect is the real-time data delivery of novel platforms today. In this paper, we will survey the field of multipath routing in wireless sensor networks, and mainly focus on the technology of QoS of WSNs. Furthermore, our objective is to investigate how this technology can be embedded in the current scenario of intelligent sensor platforms in the WSNs and identify its place and purpose using various communication techniques.

Keywords: WSN, multithreading, communication between nodes, joint routing and scheduling, path availability, less energy consumption on node.

I. INTRODUCTION

Multipath routing is one of the promising schemes to improve availability. Recent advances in wireless communication technologies and the manufacture of inexpensive wireless devices have led to the introduction of low-power wireless sensor networks. The Internet takes an increasingly central role in our communication infrastructure. Traditional application data were delivered in a manner of best efforts. However, the demands of delay-sensitive applications, such as voice over IP (VoIP), video streaming, and gaming, have been increasing. These applications require more continuous availability compared to data applications. Availability is not only related to failure recovery, but also to QoS such as end-to-end delay or available bandwidth. Due to their ease of deployment and the multifunctionality of the sensor nodes, WSNs have been utilized for a variety of applications such as health care, target tracking, and environment monitoring. It is composed of a large number of sensor nodes that are randomly and densely deployed in an area for the purpose of monitoring certain phenomenon of interest.

The nodes sense information, process the sensed data and transmit the processed data to the base station over a wireless channel. The advancement in sensor technology has made it possible to have extremely small, low powered sensing devices equipped with programmable computing, multiple parameter sensing and wireless communication capability. Also, the low cost makes it possible to have a network of hundreds or thousands of these sensors, thereby enhancing the reliability and accuracy of data and the area coverage. Most of the existing routing protocols in WSNs are designed based on the single-path routing strategy without considering the effects of various traffic load intensities and energy efficiency of the sensor nodes. Due to the resource constraints of sensor nodes and the unreliability of wireless links, single-path routing approaches cannot be considered effective techniques to meet the performance demands of various applications. In order to cope with the limitations of single-path routing techniques, another type of routing strategy, which is called the multipath routing approach has become as a promising technique in wireless sensor as well as ad hoc networks.

Dense deployment of the sensor nodes enables a multipath routing approach to construct several paths from individual sensor nodes towards the destination. Discovered paths can be utilized concurrently to provide adequate network resources in intensive traffic conditions. There are many limitations of wireless sensor networks in practical implementation of large networks because maintenance in big network infrastructures is very high. Although WSNs have huge advantages over wired ones, in any critical scenarios like disaster, military attacks, flood and cyclone, earthquake etc, the sensor network infrastructure may breaks down. To overcome these limitations researchers are working on ad-hoc and WSNs.

Energy of Sensor nodes is an important parameter in WSNs; many routing strategies are applied in WSNs to overcome the Energy issue.

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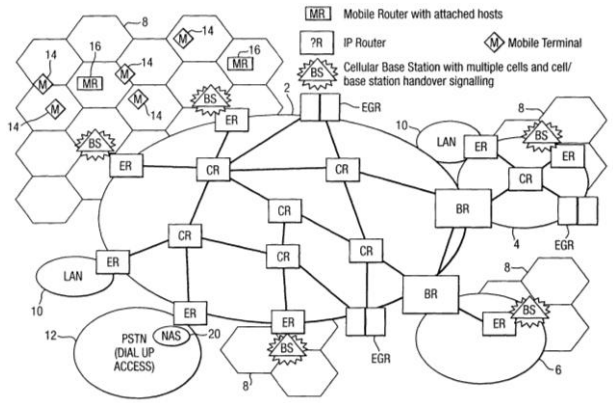

Fig. 1.1 Multipath routing distribution cell structure

Many routing protocols for WSNs are already tested in different simulators. But still it has some limitations due to its complexity. To realize the importance of qualities of multipath routing protocols of ad-hoc routing in WSN, in this paper we are focusing especially on energy efficiency, path selection, low power nodes, joint disjoints, algorithms etc. of multipath routing protocols, ad-hoc routing protocols in WSNs. One of them is use of the static addressing so they are not scalable to networks with more than 100 nodes. As the network grows to more than 100 nodes, in static addressing routing becomes very complex. Dynamic Hash Table (DHT) based protocols were proposed in [2][7] to solve the Energy and Scalability problem. DHT based multipath routing protocols requires a lot of work to be done in WSNs.

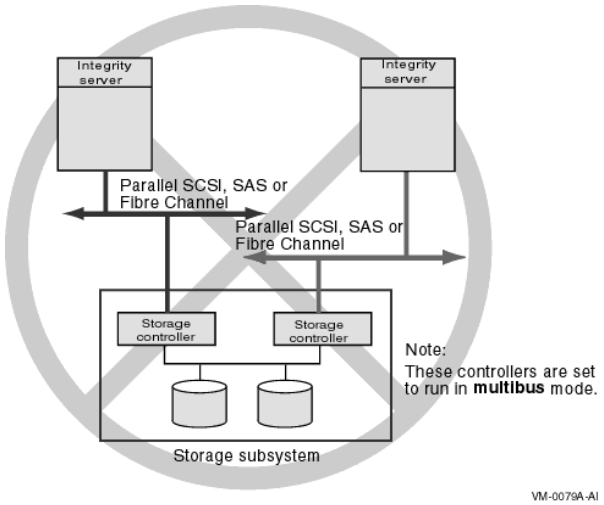

Fig. 1.2 Packet storage phenomena in protocol

II. TECHNIQUES & ALGORITHMS BRIEFING

A wireless sensor network (WSN) deployed for detection applications has the distinguishing feature that the sensors cooperate to perform the detection task. Therefore, the decoupled and maximum throughput design approaches typically used to design communication networks do not lead to the desired optimal detection performance. Recent work on decentralized detection has addressed the design of media access control (MAC) and routing protocols for detection applications by considering independently the quality of information (QoI), channel state information (CSI), and residual energy information (REI) for each sensor. However, little attention has been given to integrate the three quality measures (QoI, CSI, and REI) in the system design. In this work, they present a cross-layer approach to design a QoI, CSI, and REI-aware transmission control policy (XCP) that coordinates communication between local sensors and the fusion centre, in order to maximize the detection performance. They formulated and solved a constrained non-linear optimization problem to find the optimal XCP design variables, for both ALOHA and time-division multiple access (TDMA) sensor networks. They shown the detection performance gain compared to the typical decoupled and maximum throughput design approaches, without utilizing additional network resources. Also they compared ALOHA and TDMA MAC schemes and shown the conditions under which each transmission scheme outperforms. In this paper, they pursued a cross-layer, model-based approach to design a single-hop ALOHA and TDMA WSNs deployed for detection applications. They developed an integrated model for the detection system that includes the communication network, sensing, and energy models. They considered the QoI, CSI, and REI quality measures in the design process. They designed a complete transmission control policy that includes the transmission probabilities, communication rate, and energy allocation for each sensor. They have shown in their results that a significant performance increase over the decoupled and maximum throughput design approaches with equal energy allocation scheme, for both ALOHA and TDMA networks [3].

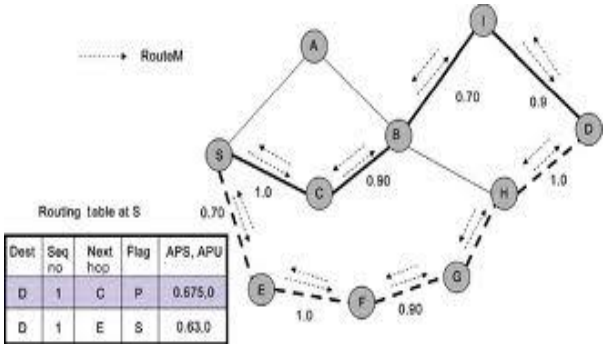

Fig. 2.1 Routing table marking node table & time consumption with shortest path selection

Routing techniques involved in WSN that considers both static and mobile sensor nodes. They have thrown light not only on routing protocols which might vary based on the implementation and network architecture, but also on future directions of research on development of routing protocols for WSN. They explained in their research that WSN Protocol suggested which can be classified as Non-architecture based and Architecture based. Routing protocols without a specific architecture (DSR, PEGASIS) are more suitable for WSNs with small deployment areas since a Multi-hop routing mechanism is simply used to transmit data from sensor nodes to the sink. The architecture of clusters is one of the most well-known architectures which have been so far proved to be best in terms of

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energy conservation. Various protocols like - A) Low energy adaptive clustering Protocol (LEACH**),** B) LEACH-Centralized (LEACH-C), C) LEACH-H (Hybrid Cluster Head Selection LEACH), D) A Hybrid, Energy-Efficient Distributed Clustering Approach (HEED), E) Threshold sensitive Energy Efficient sensor Network Protocol (TEEN), F) Adaptive Periodic Threshold-sensitive Energy Efficient Sensor Network (APTEEN), G) Dynamic Source Routing (DSR), H) Power Efficient gathering in Sensor Information System (PEGASIS), I) Dynamic Static Clustering (DSC) Protocol, K) Low energy adaptive clustering Protocol- Mobile (LEACH-M), L) Low energy adaptive clustering Protocol - Mobile-Enhanced (LEACH-ME), M) Reliable location-aware routing protocol for mobile wireless sensor network (LFCP-MWSN), N) Cluster Based Routing Protocol for Mobile nodes (CBR-M), O) Mobile sink routing protocol (MSRP), P) Reliable Energy Aware Routing (REAR), Q) Graphical adaptive fidelity (GAF). They have summarized recent research results on routing in sensor networks and classified the approaches into several categories, namely routing with static nodes, routing with mobile nodes and location-based, power usage .etc. Few other protocols followed the traditional network flow and QoS modelling methodology [4].

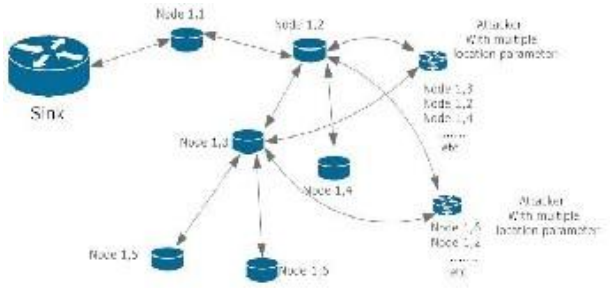

Fig. 2.2 Routing algorithm analysis using routers

Wireless multimedia sensor networks with sensing and processing abilities of multimedia data have recently emerged as one of the most important technologies for high quality monitoring. The routing scheme for multimedia data is an important research issue addressed in wireless multimedia sensor networks. In this paper, a disjointed multipath routing scheme for real-time data transmission in wireless multimedia sensor networks. This scheme uses a hybrid routing protocol based on Bluetooth and Zigbee in order to overcome the limitation of low bandwidth in conventional sensor networks. This scheme also performs disjointed multipath routing based on competition to alleviate the delay of routing path setup and they compare it with the existing scheme through performance evaluation. Their experimental results show that the proposed scheme reduces the end-to-end delay by about 30% and the routing path setup costs by about 22% over the existing scheme and also increases data reception rates by about 690% over the existing scheme on average. Various schemes to transmit data in the conventional sensor networks have been simulated. Representative schemes are tree-topology-based TAG, cluster-topology-based HEED, and greedy-forwarding-based GPSR. Though these schemes are suitable for sending scalar data from the conventional sensor networks and are designed on the basis of the low bandwidth of Zigbee, multimedia data has a large size which is different from conventional sensor networks that handle scalar data. Therefore, they are not suitable for transmitting mass multimedia data such as video and image [5].

III. ALGORITHM APPROACHES

Wireless sensor networks have grown enormously and become progressively attractive in wide variety of applications because of their low cost, low power, small in size, self-organizing behaviour in harsh environments. There are many routing protocols like: location based, multipath, data centric, mobility based, hierarchical routing, hybrid routing etc. Clustering is used to prolong the lifetime of the wireless sensor networks. Clustering is the process where sensing area is divided in groups to balance the energy level of sensor nodes known as clusters. An Optimal Clustering technique can reduce the energy consumption in WSN and increase the lifetime of the network. Energy is the main consideration when they analyze routing protocols for WSN. In this paper they study the different clustering based energy efficient routing protocols of wireless sensor networks and compared them on various parameters.

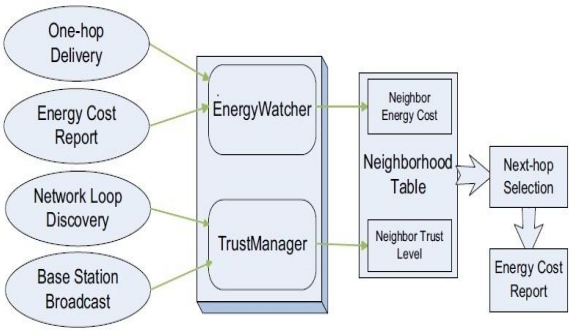

Fig. 3.1 Routing Algorithm flow control mechanism

Homogeneous and Heterogeneous nodes are used in wireless sensor network where a wireless medium is used by the nodes to communicate with each other. A hundred to thousands of nodes can be deployed in the sensing region to sense the environment. These nodes work cooperatively and send sensed information to the sink. Wireless sensor network can be categorized into two types: **1) Unstructured WSN**- The nodes are densely deployed and also the nodes can be deployed in ad-hoc manner in the sensing area or region. **2) Structured WSN** – Sensor node developments of some or all nodes are preplanned. The nodes placement is also planned. So, the maintenance of structured WSN is much easy as compare to Unstructured WSN. Sensor nodes work cooperatively to monitor environment conditions such as temperature, sound, vehicular movement, pressure and pollutants. Energy conservation in wireless sensor networks has become one of the most important research areas The main objective behind the routing protocol design is to keep sensors alive as much as possible, thus prolonging the lifetime of network. For het-

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erogeneous wireless sensor networks, many energy efficient clustering protocols are proposed which are based on residual energy, density etc. they also discussed energy-efficient clustering protocols like: Low energy adaptive clustering hierarchical (LEACH), Threshold-sensitive energy-efficient sensor network protocol (TEEN), Adaptive TEEN, Geographic adaptive fidelity (GAF), Constrained shortest path energy aware routing (CSPEA), Power-efficient gathering in sensor information system (PEGASIS), Stable election protocol (SEP), Hierarchical Geographic Multicast Routing (HGMR), Distributed energy-efficient clustering (DEEC), Distributed Weight-based Energy-efficient Hierarchical Clustering protocol (DWEHC), Improved and balanced LEACH (IBLEACH), Concentric Clustering Scheme (CCS), Energy-efficient cluster head election protocol (EECHE), Hybrid Energy-Efficient Distributed Clustering (HEED), Base-Station Controlled Dynamic Clustering Protocol (BCDCP) [6].

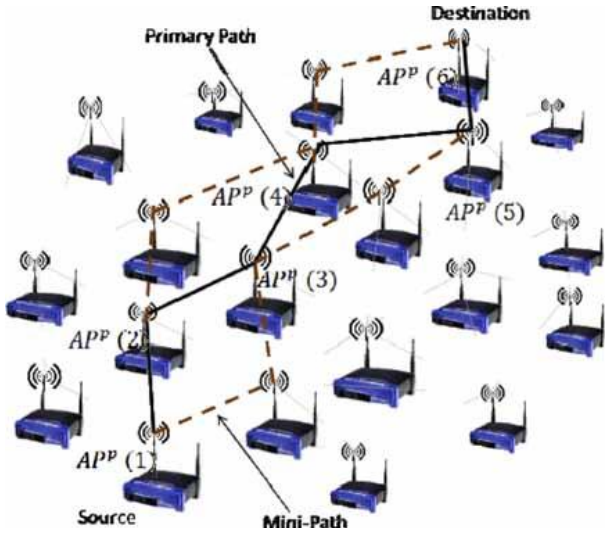

Fig.3.2 Nodes shortest path selection mechanism

Wireless sensor networks are networks having non wired infrastructure and dynamic topology. In OSI model each layer is prone to various attacks, which halts the performance of a network .In this paper several attacks on four layers of OSI model are discussed and security mechanism is described to prevent attack in network layer i.e wormhole attack. In Wormhole attack two or more malicious nodes makes a covert channel which attracts the traffic towards itself by depicting a low latency link and then start dropping and replaying packets in the multi-path route. This paper proposed promiscuous mode method to detect and isolate the malicious node during Wormhole attack by using Ad-hoc on demand distance vector routing protocol (AODV) with omni directional antenna. The methodology implemented notified that the nodes which are not participating in multi-path routing generates an alarm message during delay and then detects and isolate the malicious node from network. In this paper promiscuous mode methodology is implemented which works very efficiently in WSNs during wormhole attack. It not only prevents the degradation of the wireless network also helps in improving performance of wireless sensor networks. This methodology has not been proposed yet based on delay metrics. Analysis has been done through simulation to enhance performance of the proposed model in wireless multi hop network. The simulation results have shown that in the presence of malicious nodes in ad hoc network. The performance of wireless network with AODV provided extensions with promiscuous mode mechanism is better than wireless network with simple AODV routing protocol in terms of throughput and end to end delay. Furthermore, it can help in putting some constraints on the network topology to design a robust network for such attacks, and in the design of new and more powerful attack countermeasures. Comparatively this approach is analytical and systematic than previous theoretical approaches [8].

IV. RESULT TABULATION

Various techniques and algorithms used to make this process effective approach. Some tables and parameters are surveyed as follows:

Parameters	Value
Network Filed	(0,0) ~ (500,500)
Number of nodes	100
Cluster radius R	30 m
Sensing radius r	10 m
Initial energy	10 J
Data packet size	1024 Bytes
$E_{threshold}$	0.01 J
E_{elec}	50 nJ/bit
E_{fs}	10 nJ/bit/m^2
Threshold distance	80 m
MAC layer	IEEE 802.11
Max buffer size	256 K-Bytes
Simulation time	1000 s

Table 4.1: Node Parameter for Clustering

Parameter Name	Comment
CID	UL-MAP IE, section 8.4.5.4, table 287 of IEEE Std. 802.16e-2005.
Serving BSID	Identifier for the serving BS
OFDMA symbol offset	UL-MAP IE, section 8.4.5.4, table 287 of IEEE Std. 802.16e-2005. UIUC, section 8.4.5.4.3 of IEEE Std. 802.16e-2005.
Subchannel offset	
No. OFDMA symbols	
No. subchannels	
Ranging method	
Dedicated ranging indicator	
CDMA_Allocation_IE	UL-MAP IE, section 8.4.5.4, table 287 of IEEE Std. 802.16e-2005. UIUC = 12, section 8.4.5.4.3 of IEEE Std. 802.16e-2005.
Fast_Ranging_IE	UL-MAP IE, UIUC = 15, Section 8.4.5.4.21 of IEEE Std. 802.16e-2005.
Permutation base (UL_PermBase)	Section 11.3.1, Table 353 of IEEE Std. 802.16e-2005.
Action time	Section 6.3.2.3.52, Table 109 of IEEE Std. 802.16e-2005.
Approximate ranging signal transmission time	This parameter may be derived from other parameters such as, but not limited to, approximate clock of the base station, allocation start time, duration of the allocation, etc. Section 10.3.4.1 and table 342 of IEEE Std. 802.16e-2005.

Table 4.2: Clustered & Comm. Based parameters

These parameters are according to location of routers, cells in geographical areas, basic techniques used in routing, IEEE standards details and connection less or connection oriented algorithms requirement.

V. CONCLUSION

In this paper, we surveyed about multipath routing protocol, ad hoc routing in WSN. Here we also see that various algorithms like clustering hierarchical (LEACH), Threshold-sensitive energy-efficient sensor network protocol (TEEN), Adaptive TEEN, Geographic adaptive fidelity (GAF), Constrained shortest path energy aware routing (CSPEA), Power-efficient gathering in sensor information system (PEGASIS), Stable election protocol (SEP), Hierarchical Geographic Multicast Routing (HGMR), Distributed energy-efficient clustering (DEEC), Distributed Weight-based Energy-efficient Hierarchical Clustering protocol (DWEHC), Improved and balanced LEACH (IBLEACH), Concentric Clustering Scheme (CCS), Energy-efficient cluster head election protocol (EECHE), Hybrid Energy-Efficient Distributed Clustering (HEED), Base-Station Controlled Dynamic Clustering Protocol (BCDCP) may use to develop a effective approach for IP versions and efficient content for internet services. Furthermore analysis and study will be on development of multipath routing algorithms and protocols design may design on various tools like NS2, OPNET, OMNET, TINYOS etc.

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BIOGRAPHIES

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