Wireless Sensor networks: Routing protocols, Challenges, Solutions

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Abstract—the most important evolution of the modern era is Wireless Sensors networks. Recent advancements in WSNs also led to the implementation of several new protocols which are to be implemented for proper functioning of the network. This paper reviews thedifferent type of routing techniques used and the different type of routing protocols used also the routing protocols problems .We have also provided the necessary security solutions regarding the routing problems and also the different types of sensors used based on properties.

Keywords—WSN, routing protocols, security solutions, types.

I. INTRODUCTION

The rapid growth in the technology has led to different ways which led to the creation of different type of networks for several purposes. The factors like collection of data, interpret and act on real time data gains increasing interest. However, for the collection of data wired sensor networks have a lot of factors which do not ease the process of doing so.

This led to the fast development and increasing use of Wireless sensor networks (WSN).This are one kind of communication network that provides redundant and less fault tolerant wireless connection between sensors, actuators and collectors. The WSNs are generally a huge combination of several sensor nodes which are used to form secure and flexible networks by combining the sensor radio and the CPU. The WSNs works more effectively and also are low power consumption networks. In any type of networks energy is the primary resource, as the networks are operated to exhibit certain kind of properties there is a definite need of optimization of the network architecture in order to reduce the resource consumed. The limitations make the sensor networks architecture and also their routing protocols more challenging and divergent. The WSNs are a combination of different routing, power management and data distribution protocols and these are designed by considering the work of sensor and also the applications in which it is used. The protocols used here needs to support different constraints which are helpful in maintaining and proper functioning of the WSNs.The different type of constraints or factors to be considered are memory, power consumption, scalability, adaptivity, latency, tolerance also the size of the sensor include in it.

The implementation of these protocols helps in proper working of the WSNs as these were perfectly done sensor networks are having number of applications in various fields. The different type of applications are military sensing, physical security, air traffic control, traffic surveillance, video surveillance, industrial and manufacturing automation, distributed robotics, environment monitoring, and building and structures monitoring, Medical applications, atmospheric observance, home intelligence etc.,

II. ROUTING CHALLENGES IN WSNS

The vast advancement in the sensor network has led to its use in wide range of applications. Also it is constrained to several restrictions like limited power supply, limited computing power also limited amount of bandwidth as the device can connect to the sensors. Many factors affect the proper design of the routing protocols. Some of the factors that affect the routing protocols are:

1.Node deployment: Node deployment in WSNs is application dependent and affects the performance of the routing protocol. The deployment can be either deterministic or randomized. If the resultant distribution of nodes is not uniform, optimal clusteringbecomes necessary to allow connectivity and enable energy efficient network operation.

2. Energy consumption: One of the main factors that affect the sensor networks is the low power availability. The energy available for the sensor is based upon the battery life time. For the transmission of the signal multi hop routing will be of more significance as it consumes less power than direct communication.

3. Network designing: As the sensors are connected through a wireless connection it is necessary to identify the proper routing and the network topology to be used. Also the message traffic is also to be considered at each node as it may lead to the instability of the system if more traffic is present at similar node.

4. Data transfer: The main objective in the WSNs is the proper transfer of data from the sensors to the connected device. This can be done only when a proper routing is applied amongst the network. The data transferring and receiving needs to be properly carried out without much wastage of energy and it should also maintain route stability.

5. Tolerance and scalability: If any sensor or node gets failure due to loss in power or any other external factors it should not affect the entire network as this may lead to total malfunction. Also irrespective of the no. of sensor in the network the routing scheme must be scalable to respond to the events.

In addition to the above defined challenges many others are to be considered like the production cost: total cost estimate; Quality of service provided by the sensor network and its life time; Data latency and overhead; and also the network operating environment also needed to be considered.

III.ROUTING and TOPOLOGY

Distributednetworkhasmany nodesandservicesmany messages,andeachnodeis a shared resource, it must bea lot ofdecisionsto bemade. There may bemultiple pathsfromsource to destination. Theroutingof messagesis an importantinfluence on theperformance. These are mainly influenced byroutingschemebandwidth (the amount of services provided), and the averagepacket delay(Quality ofService).

The routingmethods canbefixed (i.e.,pre-planned), flexible, centralized, distributed, transmitted,etc. Fixed routing schemes often use Routing Tables that dictate the next node to be routed to, given the current message location and the destination node. Routing tables can be very large for large networks, and cannot take into account real-time effects such as failed links, nodes with backed up queues, or congested links.

Adaptive routing schemesdepend on the current network status and can take into account various performance measures, including cost of transmission over a given link, congestion of a given link, reliability of a path, and time of transmission. They can also account for link or node failures.

The routing is closely associated with the optimal control problem, dynamic programming, and feedback control. The shortest path routing scheme is to find the shortest path from the specified node to the destination node. Instead, the cost of the link length, each link is connected to the case; these algorithms can calculate the least-cost path. These algorithms (or distributed) on all the nodes in the shortest path search for the specified node is the shortest path from the centre of the specified node to all other nodes (search).

There are different types of network topologies which are in use they are: star, ring, bus, tree, mesh. These act as both as open and closed type. The different topologies can be used based upon the need and also the availability of proper routing.

IV.ROUTING PROTOCOLS

The main structure of the wireless sensor networks comprises of the routing protocols. Used for different types of routing protocols, these can be classified into different types. Typically, they are mainly divided into three kinds, they can Flat-based routing based on routing layer-based routing and location Also, these protocols can be divided into multipath based routing, querybased routing, Qos based routing; negotiate based routing based on the protocol operation.

Flat based routing protocols:

In flat networks, each nodetypically plays the same role and sensor nodes collaborate together to perform the sensing task. Because these nodes, it is not possible to assign a global identifier to each node. You must specify the properties of the data because the data being requested through queries, attribute-based naming. For example, a data-centric routing,, SPIN director for the spread initial work has been shown to save energy through negotiation and remove duplicate data

Data. These two protocols motivated the design of many other protocols which follow a similar concept.

SPIN (Sensor Protocols for Information via Negotiation) is a family of adaptive protocols for WSNs.

SPIN is designed based on two basic ideas; (1) to operate efficiently and to conserve energy by sending meta-data and (2) nodes in a network must be aware of changes in their own energy resources and adapt to these changes to extend the operating lifetime of the system.

SPIN has three types of messages, namely, ADV, REQ, andDATA.

ADV: when a node has data to send, it advertises viabroadcasting this message containing meta-data (i.e., descriptor) to all nodes in the network.

REQ: an interested node sends this message when it wishesto receive some data.

DATA: With realsensor data, including meta-data header anddatamessage. SPIN is based on data-centricrouting where the sensor nodes send ADV message via broadcastingfor the data they have and wait for REQ messagesfrom interested sinks or nodes. The semantics of SPIN'smeta-data format is application dependent and not supportedby SPIN. In another words; SPIN uses applicationspecific meta-data to name the sensed data.

Directed diffusion is another data dissemination andaggregation protocol. It is a data-centric and applicationaware routing protocol for WSNs. It aims at naming alldata generated by sensor nodes by attribute-value pairs.Directed diffusion consists of several elements; first of all,naming; where task descriptors, sent out by the sink, arenamed by assigning attribute-value pairs. Secondly, interestsand gradients; the named task description constitutesan interest that contains timestamp field and several gradientfields. Each node stores the interest in its interest cache.As the interests propagate throughout the network, the gradientsfrom the source back to the sink are set up. Thirdly,data propagation, when the source has data for the interest, it sends out the data to

the interest (i.e., sink) along theinterest's gradient path. Fourthly, after the interest (sink)starts receiving low rate data events, it reinforce one particularneighbor to draw down higher quality (higher datarate) events. This feature of directed diffusion is achievedby data-driven local rules. Directed diffusion assists in savingsensors' energy by selecting good paths by caching andprocessing data in-network since each node has the abilityfor performing data aggregation and caching.

LEACH (Low Energy Adaptive Clustering Hierarchy) is a self-organizing, adaptive clustering-based protocol thatuses randomized rotation of cluster-heads to evenly distributethe energy load among the sensor nodes in the network.
LEACH based on two basic assumptions: (a) basestation is fixed and located far away from the sensors, and(b) all nodes in the network are homogeneous and energyconstrained.The idea behind LEACH is to form clusters ofthe sensor nodes depending on the received signal strengthand use local cluster heads as routers to route data to thebase station.
The key features of LEACH are:
1. Localized coordination and control for cluster set-up andoperation.
2. Randomized rotation of the cluster "base stations" or"cluster-heads" and the corresponding clusters.
3. Local compression to reduce global communication.

PEGASIS (Power Efficient GatheringinSensorInformation
Systems) is a greedy chain-based power efficient algorithm
The key features of PEGASIS are:
1.The BS is fixed at a far distance from the sensor nodes.
2. The sensor nodes are homogeneous and energy constrainedwith uniform energy.
3.No mobility of sensor nodes.
PEGASIS is based on two ideas; Chaining, and Data Fusion.
In PEGASIS, each node can take turn of being a leader of
the chain, where the chain can be constructed using greedy
algorithms that are deployed by the sensor nodes.

GEAR (Geographical and Energy Aware Routing) a recursive data dissemination protocol WSNs. It uses energyaware and geographically informed neighbor selectionheuristics to rout a packet to the targeted region. Withinthat region, it uses a recursive a geographic informed mechanismto disseminate the packet.

In addition to these there are several other routing techniques like flooding, Gossiping, Rumor routing, Gradient based routing, CADR, COUGAR, ACQUIRE which are some of the data centric protocols. The hierarchical protocols like self organizing protocols, Energy aware routing. Location based protocols like MECN and SMECN, GAF and GEAR and also the Network flow and Qos aware protocols.

V.SECURITY SOLUTIONS

1) Flexible routing and aggregator election: The configured
WSN must be flexible enough to cope with gradually orabruptly disappearing nodes. The overall scheme must support routing and multiple levels of in-network processing.

2) Concealed data aggregation: It is a concern within WSNs
to both reduce the energy consumption at the sensor nodes
and the effect of physical attacks on the nodes. Concealed Data Aggregation provides a good balancebetween energy-efficiency and security while still allowingdata to be processed at the sensor nodes.

3)Provably secure routing: Routing is one of the most basic networking functions in multi-hop sensor networks. Thepresence of malicious nodes must be considered and precautions taken. Routing has two main functions: finding routesto the sink nodes, and forwarding data packets via these
Routes. Security approaches for routing protocols have mainly
been analyzed by informal means only. What is needed isa mathematical framework in which security can be precisely
defined.

4)Enhanced key pre-distribution: It is not possible for the
Manufacturer to configure all the sensitive information, before the WSN is rolled-out. Some sensitive informationcan only be determined and stored with knowledge ofthe final position of the nodes within the network topology. Also, the traffic pattern, i.e. how data is expected to flow inthe network, is another parameter to consider when distributingkeys.

VII.TYPES OF SENSORS

Sensor networks are the key to gathering the information needed by smart environments, whether in buildings, utilities, industrial, home, shipboard, transportation systems automation, or elsewhere.A sensor network is required that is fast and easy to install and maintain. The following are the different type of sensors available:
1) IEEE 1451 and smart sensors: These are the sensors manufactured by the IEEE and these have their own characteristic feature to behave like smart sensors.A

smart sensor is a sensor that provides extra functions beyond those necessary for generating a correct representation of the sensed quantity.
2) Mechanical sensors: These rely on direct physical contact.
It makes use of different type of mechanical effects.The Piezoresistive Effect, the Piezoelectric Effect,Tunneling sensing are some of the principles used in these sensors.
3) Capacitive and Inductive sensors are also available.
4)Magnetic and Electromagnetic Sensorsdo not require direct physical contact and are useful for detecting proximity effects.
These type of sensors make use of the Hall effect, Magneto resistive effect.
5)Magnetic Field Sensorscan be used to detect the remote presence of metallic objects.
Eddy-Current Sensorsuse magnetic probe coils to detect defects in metallic structures such as pipes.
6)Thermal Sensorsare a family of sensors used to measure temperature or heat flux. Some of the principles utilised in the thermal sensors are Thermo-Mechanical Transduction,Thermo-resistive Effects;and Thermocouples and resonant temperature sensors.
7)Optical Transducersconvert light to various quantities that can be detected. These use several mechanisms to operate. They mainly use the photoelectric effect.Photoconductive sensors,junction-based photo sensors,Thermopiles are some of them which work on this principle.
8) Chemical and Biological Transducers
9) Chemiresistors
10) Metal oxide Gas sensors
11) Electrochemical transducers
12) Bio sensors
13) Acoustic sensors
14) Acoustic wave sensors

Here are some of the commercially available wireless sensor systems
1) Crossbow Berkeley Motes
2)Micro strain's X-Link Measurement System

VIII. Conclusion

The recent advancements in the sensor networks have led to the increase of routing protocols.In this paper we have discussed several protocol and design issues in the wireless sensor networks. We have several no. of routing protocols and these were used based upon the type of network and its application. The above are some types of routing protocols in the WSNs which are in use and there me be scope for much development in these fields as the research increases and also the need to do so.

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Biography

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