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Comparative Study of Flat-Based/Data Centric WSN-Specific Routing Protocols

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Abstract: - The present research paper contribution is organized in two folds. First focus is on the basics of data-centric approach for WSN. As well as the first fold focuses on the most popular existing flat-based/data centric WSN-specific. Finally the second fold presents an analytical comparison table of some existing flat-based/data centric WSN-specific routing protocols.

Keywords: - Wireless Sensor Network, Protocols, Data Centric, Energy Efficiency.

I. INTRODUCTION

The main objective of data-centric approaches is to perform data aggregation in more energy efficient way inside region of interest. Data centric approach performs a routing scheme in a network which is totally different than the traditional end-to-end routing schemes resulting in communication with efficiently more high data rate. Data centric technology differ from traditional address centric approach by the pattern it follows for the dissemination of data that are coming from several different data sources and bring them together to a single destination(sink), resulting in redundancy prevention as well as the number of transmission required is also lessened which in turn saves the energy. This pattern can also be termed as the converge cast tree. Thus, we can say that, through data centric approach we can increases the lifetime if a network increases in compare to end-to-end/address centric routing.

In data centric routing, the data is routing, the data is routed in a network depending on the actual content of the data and not on the destination where the data is to be disseminated. It applies the rules and principles to the data content for deciding/verifying the receiver of the data, and for this reason, data centric technique is also known as content-based routing.

Data-centric routing is used in situation whose it appears to be impractical assigning unique IDs to each and every node of the network i.e., when the number of nodes in a wireless sensor network is comparatively large then data to perform efficiently network operations.

II. PROBLEM FORMATION

WSN-specific routing (network layer) protocols were/are very attractive area for research, so huge works are available on it with a number of classifications exists under this layer. Based on research results available on that time, authors of a highly cited research contribution [1], compares 28 different routing techniques according to these metrics: Classification, Mobility, Position Awareness, Power Usage, negotiation based, Data aggregation, Localization, QoS, State Complexity, Scalability, Multipath, and Query based. After evaluating a number of highly cited research contribution it has been observed that there is a need in detail analysis, evaluation, and performance comparison on Data-centric or Flat based routing protocols that fit for a WSN application.

III. FLAT BASED OR DATA CENTRIC WSN-ROUTING PROTOCOLS: A REVIEW

Directed Diffusion [2]

In directed diffusion protocol all nodes are application-aware; this feature enables diffusion to achieve energy savings by selecting empirically good paths and by caching and processing data in-network.

MCFA (Minimum Cost Forwarding Algorithm) [3]

An energy efficient protocol, which makes the utilization of the information about the direction of routing. MCFA gets relieve from the unique ID assignment and the routing table, as an alternative each node in this protocol maintains the least cost estimate, from the node itself to the base station.

TEEN (Threshold sensitive Energy Efficient sensor Network protocol) [4]

As the LEACH [5], the renowned TDMA-based energy efficient MAC protocol for WSN, having drawback of TDMA scheduling which assumes that nodes always have some data to send. TEEN was proposed to overcome this drawback for reactive networks by sensing and gathering information about the network environment continuously, but it transmits data only when a assured starting point is sensed. This protocol is appropriate for time decisive purpose and also is energy efficient as the transmission is done comparatively less frequently. Despite of overcoming the drawbacks encountered in LEACH protocols. TEEN also has a disadvantage that the nodes will not at all be communicating to each other if in case the thresholds are not attained, and the user will not be getting any data from the network and will not be able to sense if any or all the nodes expire in the network.

APTEEN (Adaptive Periodic Threshold sensitive Energy Efficient sensor Network protocol) [6]

A hybrid routing protocol that permits for wide-ranging information retrieval. In WSNs the nodes does not react only to time-critical conditions, but it also gives an overall representation of the network in an extremely energy efficient manner, at specific period of time intervals. Such a network provides historical form of data and this feature gives the facility to the user for making request to the past, present and future data from the historical data of the network at one time and queries having persistent nature.

EAD (Energy Aware Data) Centric Routing Protocol [7]

EAD is a flat based routing protocol that gives better performance in compare to the other existing routing protocols such as LEACH. However, EAD encounters an innate difficulty that allows only closed nodes to be chosen as gateways to the sink which will ultimately lead into isolating the respite of the nodes in the network even despite the fact that they still have sufficient energy to communicate with the destination (sink node).

RUMOR Routing [8]

A variant of the most popular data centric protocol directed diffusion. This protocol is primarily designed for being used in applications where geographic routing is not reasonable. In contrast to directed diffusion, the use of flooding is not necessary here, as only a small amount of data is requested from the nodes many times. If a large number of queries are present and the amount of events is comparatively limited then, an another approach is used in which events are being flooded and routes the queries only to the nodes that have observed a particular event instead of flooding the whole network for retrieving the information regarding the occurring events. This algorithm, make use of long-lived packets that are called as agents, which travel through the network for broadcasting information about local events to remote nodes. The overall cost of the communication is reduced, as well as only a single path is retained between the source node and the destination node.

SPIN [9]

It is a family of protocols which is more energy-efficient than popular existing approaches like flooding or gossiping while distributing data at the same rate or faster than either of these protocols allowing dissemination of information efficiently in a wireless sensor network. It uses data negotiation and resource-adaptive algorithms to overcome the shortcomings encountered in traditional approaches. In this approach before any data is transmitted, nodes assign a name to their data, called meta-data, that represents a high-level name and perform meta-data negotiations ensuring non-redundant data to be sent all over the network. It also has the feature of adapting the protocol based on how the fact that how much energy is left by accessing the current energy level of the node. It has two secure building blocks: SNEP and μTESLA providing data confidentiality and authenticated broadcast for strictly resource-constrained atmosphere respectively.

CADR (Constrained Anisotropic Diffusion Routing) [10]

A general form of Directed Diffusion is proposed known as CADR (constrained anisotropic diffusion routing). This routing protocol provides a feature for maximizing the information gain and minimizing the latency and bandwidth. Routes for data dissemination are adjusted dynamically by activating the nodes that are close to a specific event. The fact that differentiates it from Directed Diffusion is the motive of getting information with along with a concern of communication cost. In CADR, data dissemination is done depending on the local information/cost gradient and according to the requirements of end-user. As observed from simulation results it has been found that more CADR is more energy efficient than Directed Diffusion as it delivers data by reaching the nearest neighbors first in an isotropic manner.

COUGAR [11]

A data-centric protocol which treats the network as a vast distributed database system. The working principle of this protocol is utilizing the declarative queries from the network layer functions for processing. For obtaining more energy savings COUGAR uses local data aggregation. An additional query layer between the network and application layers is used that provides the abstraction feature. In this approach a leader node is selected to perform aggregation for transmitting the data to the base station, and the base station generates a query plan specifying the required information regarding the data flow as well as tells how a leader should be selected for the query, providing methods independent of network-layer for querying data. The additional layer on each sensor node consumes extra energy and memory storage.

SER (Stream Enabled Routing) [12]

A new routing protocol called SER is proposed that depends on the sensor nodes specified by sinks for performing the tasks. In the absence of global positioning system (GPS), a location awareness protocol is used to locate their positions. SER is based on instructions or tasks that enables it to be incorporated very easily within the application layer. An identifier value is defined from a predefined instruction rather than assigning attributes to a task in order to conserve memory.

EAR (Energy Aware Routing Protocol) [13]

In the field of Wireless sensor Networks (WSNs) EAR has helped to expand a variety of applications deployment with satisfying the main goal of conserving the energy of network lifetime. It is an energy-efficient routing protocol in which communication path is selected depending on the overall energy observation of the network. The path is selected through an energy-weight function by estimating the energy weight of different nodes along the particular path and the communication path and maximizing the network life.

ACQUIRE [14]

ACQUIRE is an energy efficient protocol for obtaining information in wireless sensor networks, which determines the query by forwarding an active query through the network. A response is sent directly back to the node which requested for the query after resolving the query completely.

TTCRP (Two Tier Cluster Based Routing Protocol) [15]

TTCRP is a new architecture for data dissemination for reliable and energy efficient data delivery in WSNs. It uses a rich resource cluster heads with dual channels providing the power control algorithm for connecting the isolated low power nodes for achieving the network robustness. It has been observed that TTCRP is efficient in both uniform as well as non-uniform sensor nodes deployment.

SPEED [16]

It operates on the geographic location for making restricted routing decisions. It provides real-time communication services, that are real-time unicast, real-time area-multicast and real-time area-any cast. It is adapted as a stateless algorithm and gives relief from the overhead of control management and where the resources of each and every node are inadequate , it is a found to be highly efficient and scalable protocol in WSNs. SPEED is specifically designed for handling congestion.

GBR (Gradient Based Protocol) [17]

Gradient-based routing protocols use no pre-setting of routes for sending data to the sink. While disseminating data from the source node to the sink node, by acquiring the minimum hop count and energy left at each node.

IV. COMPARATIVE STUDY

The following table given below shows the comparison of some well known data centric protocols:

Table I: Comparison Table of different Data Centric Protocols

Protocols	**Negotiation based**	**Data Aggregation.**	**Mobility**	**Localization**	**QoS**	**QoS Scalability**	**Multi path**	**Position Awarenaess**	**Querybased**	**Network Lifetime**
Direct Diffusion [2]	Yes	Yes	Limited	Yes	No	Limited	Yes	No	Yes	Good
MCFA [3]	No	No	No	No	No	Good	No	No	No	-

TEEN [4]	No	Yes	Fixed BS	Yes	No	Good	No	No	No	Very Good
APTEEN [6]	No	Yes	Fixed BS	Yes	No	Good	No	No	No	Very Good
EAD [7]	-	Yes	-	-	-	-	-	-	-	Good
Rumor Routing [8]	No	No	Very Limited	No	No	Good	No	No	Yes	Very Good
SPIN [9]	Yes	Yes	Possible	No	No	Limited	Yes	No	Yes	Good
CADR [10]	No	Yes	No	No	No	Limited	No	-	No	Good
COUGAR [11]	No	Yes	No	No	No	Limited	No	No	Yes	Good
SER [12]	Yes	Yes	-	Yes	Yes	-	Yes	Yes	Yes	Very Good
EAR [13]	No	No	Limited		No	Limited	No	No	Yes	Good
ACQUIRE [14]	No	Yes	Limited	No	No	Limited	No	No	Yes	Good
TTCRP [15]	-	Yes	No	Yes	-	-	-	No	-	Good
SPEED [16]	No	No	No	No	Yes	Limited	No	No	Yes	Good
GBR [17]	No	Yes	Limited	No	No	Limited	No	No	Yes	Good

V. CONCLUSION

In the recent years data centric routing protocols in sensor networks has attracted a lot of attention and introduced unique challenges compared to traditional data routing protocols such as address centric routing protocols. In this paper, based on recent research results on data routing in sensor networks through data centric approach has been summarized, including that whether the protocol is utilizing data aggregation or not. Since data aggregation is an important concern for data centric routing protocols in context of energy saving and traffic optimization.

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