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Survey on Data Delivery Schemes in Intermittently Connected Mobile Sensor Networks

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Abstract— Mobile sensor networks are the spatially connected wireless sensors which are mobile. This is used mainly for the health and environment monitoring in hospitals or houses for the elderly. The main issues in mobile sensor network are Delay, Energy efficiency and Network lifetime. In this paper, the data delivery schemes can be compare on the basis of node mobility, fault tolerance and efficient flooding in intermittently connected mobile sensor networks are compared. And the data delivery schemes such as Zebranets, MobiRoute, CCBR, DFT-MSN, GRAB, MDC and ODML etc are comparing to find the best method to reduce the loss and increase the network life time of sensor nodes in mobile sensor networks.

Keywords— Mobile Sensor Networks, Data Delivery.

I. INTRODUCTION

Mobile sensor networks are the spatially scattered sensor nodes which are mobile. Mobile sensor networks are generally the sensor nodes consist of a radio transceiver and a microcontroller which is powered by a battery. One of the greatest challenges is routing data from its source to the destination is no fixed topology in mobile sensor networks. Usually routing protocols are in two fields; that are WSNs and mobile ad hoc networks (MANETs). WSN routing protocols cannot handle the high frequency of topology changes. As MANET routing protocols are can deal with mobility in the sensor network but they are designed for two way communication, which in sensor networks is frequently not required. MANET protocols such as Ad hoc On-Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR) and Greedy Perimeter Stateless Routing (GPSR) are borrowed since there is no standard protocol for WMSNs. The advantage of allowing the sensors to be mobile increases the number of applications beyond those for which static WSNs are used. Mobile sensors are used for the environment monitoring, health monitoring for elderly people and to track animals.

This paper compares the different schemes of data delivery based on node mobility, efficient flooding and fault tolerance. The different schemes of data delivery in mobile sensor networks are Zebranets, MobiRoute, CCBR, DFT-MSN, GRAB, MDC and ODML. The mobile sensor network framework is shown in figure 1.

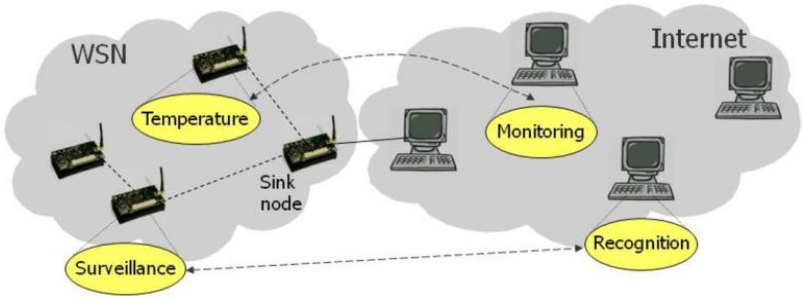

Fig 1 . Mobile sensor network framework

II. DATA DELIVERY SCHEME BASED ON NODE MOBILITY

One of the major challenges in mobile sensor networks is node mobility. Node mobility is classified into sink mobility and network node mobility.

A. *Zebranets*

In network node mobility, zebranet is one of the first applications. The ZebraNet system included custom tracking nodes or collars carried by animals under study across a large, wild area the collars by operate as a peer to peer network to deliver logged data back to researches. Global positioning system (GPS), Flash memory, wireless transceivers, and a small CPU, are included in collars. Each node in the system is a small and wireless computing device. There is no cellular service or broadcast communication to cover the region where animals are studied so ad-hoc and peer to peer routing is needed. Although several ad-hoc protocols exist, extra challenges occur because the researchers themselves are

mobile and thus there is no fixed base station towards which to aim data. Their goal was to use the least energy, storage, and other resources needed to keep a reliable system with a very high 'data homing' success rate. They intended to organize a 30 node Zebranet system at the at the Mpala Research centre in central Kenya.[1]

B. *MobiRoute*

MobiRoute is used for balancing the traffic load and in turn improving network lifetime of a mobile sink. MobiRoute is a routing protocol that efficiently supports sink mobility. Here the sink changes its position when time changes. A routing protocol which transfers data to a sink should perform the following operations that are not required for traditional WSNs. First, report the node when the link with the sink broken down because of mobility. Second, notify the whole network of the topological changes due to mobility. Third, reduce the packet loss throughout the sink moving period. MobiRoute is the extension of MintRoute. MintRoute is a routing protocol intended specially for the all-to-one data transmission way of WSNs. Using the MobiRoute the sink can improve lifetime of network without sacrificing data delivery latency.[2]

III. DATA DELIVERY SCHEME BASED ON EFFICIENT FLOODING

One of the major challenges in mobile sensor networks is efficient flooding.

A. *Context and Content-Based Routing Protocol*

CCBR is a Context and Content-Based Routing protocol which is designed for mobile WSNs having multiple sinks. To efficiently support the data-centric communication paradigm usually adopted by WSN applications, CCBR adopted content-based addressing. The characteristic of the sensors such as context is considered to filter data. To achieve better performance in customized scenario, multiple methods are undertaken by CCBR in multi-sink. The advantage of CCBR is it supports redundant packet delivery for mobile sensor networks. Disadvantage is shaky connectivity and network partitioning is not considered.[3]

B. *Delay/Fault-Tolerant Mobile Sensor Network*

The Delay/Fault-Tolerant Mobile Sensor Network (DFT-MSN) for pervasive information gathering. This is a simple and efficient data delivery scheme. Sensor mobility, loose connectivity, fault tolerability, delay tolerability, and buffer limit are the unique characteristics of DFT-MSN. Direct transmission and flooding are the different approaches. Queuing theory and statistics are used for the performance analysis. In this paper, analytic result shows the tradeoff between data delivery delay/ratio and transmission overhead. To minimize transmission overhead in flooding, an optimized flooding scheme is used. The simple and effective DFT-MSN data delivery scheme consists of two key components for data transmission and queue management. The former makes decision on when and where to transmit data messages based on the delivery probability, which reflects the likelihood that a sensor can deliver data messages to the sink. Fault tolerance indicates the importance of the messages and message transmission decision is based on fault tolerance. In this paper, the proposed DFT-MSN data delivery scheme achieves the highest message delivery ratio with acceptable delay and transmission overhead. Here the protocol support the redundancy and it deal with shaky connectivity. The protocol exchanges neighbor information through handshaking and multicast packets, but handshaking is not efficient under shaky connectivity. [4]

IV. DATA DELIVERY SCHEME BASED ON FAULT TOLERANCE

One of the major challenges in mobile sensor networks is fault tolerance.

A. *Gradient Broadcast*

Fan Ye et.al proposed a GRAdient Broadcast (GRAB) protocol for data delivery of unreliable nodes in sensor node with high robustness. This protocol is used mainly with error-prone wireless channels to forward the data to the sink using unreliable sensor nodes. In this data delivery scheme, stimuli are the events or objects to be monitored. The data delivery using GRAB is done by building and maintaining a cost field by the sink. And each node will have cost to forward the packet from itself to the sink. In GRAB, the receiver is checking its cost field with the sender and then taking the forwarding decision. To improve the delivery of the data delivery the packet is forwarded over multiple links. GRAB is a robust and error prone data delivery scheme in mobile sensor networks to forward the packet from source to sink. The disadvantage of the GRAB is node mobility is not considered well.[5]

B. *Mobile Data Collector (MDC)*

The base station cannot get data easily from the intermittently connected mobile sensor networks to answer the queries from the users. Wei Wu et.al proposed a query driven data collector (MDC) to forward the data in intermittently connected mobile sensor networks. The base station needs to answer the queries from the user, so base station is collecting the data from mobile sensors using MDC .Here a location based protocol is used to forward the data. After collecting the data from the mobile sensors, MDC will move back to the base station.

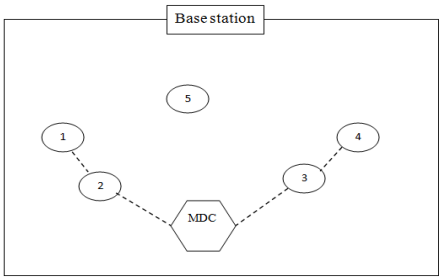

Fig 2. Mobile data collector example

In MDC, there is method called F4C, forwarding for collection to collect query driven data in intermittently connected mobile sensor networks. The example for mobile data collector is shown in figure 2. [6]

C. *On-Demand Minimum Latency (ODML) Routing*

Lu Su et.al proposed an algorithm for routing in intermittently connected mobile sensor networks. This protocol is the solution for the problem of finding routes in intermittently connected mobile sensor networks with minimum latency. if the source and destination are frequently communicating with each other, then the on demand routing algorithm will not work efficiently. Lu Su et.al. Proposed two efficient proactive minimum latency algorithm such as optimal PML and quick PML. ODML can find the path having less latency than the shortest path and possible to minimize the message overhead in routing by using optimal PML. And the route accusation delay is efficiently reduce by using quick PML in intermittently connected mobile sensor networks. And all this schemes can give generic routing functionality for most of the existing schemes.[7]

V. DATA DELIVERY SCHEME FOR INTERMITTENTLY CONNECTED MSNS

Due to the nodal mobility, the connectivity between two nodes in mobile sensor networks is intermittent. Efficient delivery of packets requires reliable connection between the sender and the receiver. Seughun Cha et al. proposed a delivery scheme for intermittent mobile sensor networks with an optimal delaying technique. The connectivity is the probability to get the packet from one node to another. The packet transmission takes place only when the connectivity is above threshold. Otherwise it delays the transmission and then the packet forwarding. Here the threshold is given by the application. This method has efficient packet delivery and less packet delivery cost.[8]

VI. COMPARISON OF DIFFERENT DATA DELIVERY SCHEMES

The different data delivery schemes can be compared based on the characteristics such as node mobility, efficient flooding and fault tolerance. The comparison table is shown below in table 1.

TABLE I
COMPARISON OF DIFFERENT DATA DELIVERY SCHEMES

No.	Method	Advantage	Disadvantage
[1]	Zebranets	Energy Efficient computing for Wildlife Tracking	Network node increases its weight value to meet the sink
[2]	MobiRoute	Sink can improve lifetime of network without sacrificing data delivery latency.	It exploit sink mobility using periodic beacon messages
[3]	CCBR	It minimize traffic	It does not consider shaky connectivity and network partitioning
[4]	DFT-MSN	It achieves the highest message delivery ratio	Handshaking is not efficient under shaky connectivity
[5]	GRAB	Robust data delivery	Not efficient when the sink moves far away
[6]	MDC	Efficient answering of queries	Only for static nodes
[7]	ODML	Minimizes the routing overhead	It is well for static networks and not for MSN
[8]	Data Delivery scheme for intermittently connected MSNs	Efficient and reliable packet delivery scheme	Delay Bound is given by the application

VI. CONCLUSION

This paper is a study of data delivery schemes in intermittently connected mobile sensor networks. The different methods for the data delivery are studied based on the characteristics such as node mobility, efficient flooding and fault tolerance. These techniques are used to improve the efficiency and the performance of the data delivery of intermittently connected mobile sensor networks .The efficient method for data delivery in intermittently connected mobile sensor networks is the optimal delaying technique which gives the efficient and reliable packet delivery.

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