Routing Techniques Mechanism which Reduces Communication Overhead in WSN

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Abstract: It is not necessary to use an existing fixed network infrastructure to create a wireless sensor network. Sensor nodes, relay nodes, and sink nodes make up a WSN's nodes. Communication between nodes is carried out through a wireless media since each one has limited processing power and energy sources. To monitor physical or environmental factors like temperature, sound, vibration, pressure, humidity, motion or pollution in a dispersed network of autonomous sensors and to collaboratively transmit their data to a central point. It is shown in this study that in wireless sensor networks, the number of nodes employed has an impact on communication overhead owing to sink mobility with speed changes. When sink mobility is high, communication costs have been shown to rise dramatically.

Keywords: **Wireless sensor network (WSN), Communication Overhead.**

1. Introduction

It is a wireless sensor network (WSN) that is used to monitor physical or environmental factors in a cooperative manner. First, wireless sensor networks were designed for military purposes. Many wide-ranging applications currently make use of wireless sensor networks. The growing number of uses for wireless sensor networks is one of the reasons for their growing popularity. To conduct dispersed sensing activities, a wireless sensor network like the one being examined here is comprised of a number of sensors, or nodes. Infrared or radio devices may be used to make connections between nodes. Surveillance, environmental sampling, security, and health monitoring will all be carried out via wireless sensor networks. Wired connections are not required, and they may be utilised even in harsh or difficult-to-locate environments, such as those described above. New sensing and computing paradigms may potentially benefit from their deployment as enabling infrastructure.

Wireless sensor networks provide a considerable problem because of their restricted resources. Sensor nodes that gather data and transfer it to a sink often employ WSNs. There is always a source and a destination for all data flows. Because sink nodes are often considered to be stationary, having them move around isn't much of an issue. Using sinks in combination with other mobile devices, such as mobile phones, is expected to lead to sinks that are mobile. These circumstances limit mobility. Because of this, wireless sensor network administration expenses and overheads are being reduced or eliminated. Resource optimization is crucial in dynamic sensor networks, such as those used in environmental monitoring and military surveillance. Secure communication in a sensor network might be problematic due to the restricted resources and the wireless nature of transmission in this case. It is necessary to re-route a channel when the sink moves, which alters the sensor network's design. It is difficult to reduce transmission overhead in broadcast communication systems because the nodes that carry data to the intended destination are critical to network management. When overheads are high, everything from stability and security to energy use and, most importantly, service quality suffers.

Wi-Fi sensor networks are affected by the overhead of various network protocols, such as quality of service (QoS)-based and negotiation-based ones. Using one of these multi-path routing protocols is typical practise. A more energy-efficient and dependable method of multi-path routing is described in [10]. Wireless sensor networks must be stable and have low traffic overheads. In order to maximise the reliability of data, several routes from the source to the sink are necessary. Nodes in a multi-hop communication network have the same configuration if they receive a message from another node. The sink node is both the destination and the receiver of the message.

1.1 Communication Overhead in WSN

Wireless sensor networks (WSN) often need many intermediary nodes to transport data from one or more sources to its final destination. Messages are lost when intermediary nodes are unable to deliver them. In order to improve system dependability, several pathways from source to destination should be provided, and the identical packet should be sent via each of them [12].

Sensors were tested for their ability to work together to collect and analyse data, as well as to coordinate and control the sensing activities. Sensor nodes are often restricted in terms of power and communication bandwidth in most applications. WSNs have their own unique set of challenges when it comes to energy efficiency, which has necessitated the development of new routing, power management, and data dissemination protocols that are all optimised for WSNs. Different applications and network architectures may need different WSN routing techniques. The following elements influence the overhead of wireless sensor networks.

- **Scalability and Reliability:** Reliability and scalability are inextricably linked in wireless networks. In other words, as the number of nodes grows, it becomes more difficult to establish a stable network. This is because of the additional network overhead that comes with increasing network size. Wireless networks do not have a predefined structure or topology. Consequently, to connect with other nodes, each must send out more packets than it can possibly hold in its own data packets. "Control packets" or "network overhead" are common names for these additional packets. There is a lot of overhead in common wireless network routing protocols, such as route discovery packets and route response packets. This means that as the network expands, it will need more control packets to locate and maintain the routing pathways. More control packets are generated and overhead is increased as the network grows, making it more likely that communication connections may be severed.

- **Quick Responsiveness:** The network's responsiveness refers to its capacity to respond swiftly to topological changes. Increasing the number of control packets sent in an ad hoc network to achieve high responsiveness results in an increase in overhead.

- **Mobility:** If there are many mobile nodes in the wireless sensor network, it has to be very responsive to cope with this. Because of this, designing a large-scale and highly mobile wireless sensor network that does not considerably increase overheads is not a simple task.

- **Power Efficiency:** Another critical factor in wireless networks is the ability to use less power. Reduce the duty cycle of each node in your low-power wireless sensor network. The negative is that the wireless sensor node remains in sleep mode for extended periods of time to save power, reducing its ability to interact with its neighbours.

2. Literature Survey

WSN performance review of AOMDV, AODV, DSR, and DSDV is the subject of various articles. End-to-End latency, number of packets received, packet loss percentage, and network energy usage are all examined in study [2]. AOMDV, AODV, and DSR routing protocols are discussed in article [3] for connection type NODE-UDP. When it comes to packet delivery and average latency, DSDV and AODV routing protocols were compared in a work [5] based on packet delivery percentage and the number of sources while adjusting the stop period. They connected via the UDP protocol. The percentage of packets delivered in high-mobility conditions is quite low. In addition, the AODV protocol is best used with a UDP connection.

Three hybrid routing protocols for MANET have been researched by Ibikunle Frank et al [6]. There are three types of adaptive routing protocols: ADV, Zone Routing Protocol (ZRP), and Sharp Hybrid Adaptive Routing Protocol (SHARP). NS2 was used to evaluate this protocol's performance to that of other protocols. ADV exceeds ZRP and SHARP in terms of packet delivery ratio and average end-to-end latency.

Zone routing protocol (ZRP), Core extraction distributed Ad-hoc routing (CEDAR), and Secure Zone routing protocol (SZRP) have been compared by Gaurav Kadyan et al [7]. (SZRP). There are two metrics used to evaluate performance: routing load and acquisition latency. SZRP is the most successful hybrid routing protocol, according to these researchers' findings after analysing several alternatives.

Proactive, reactive, and hybrid routing strategies have all been studied by Nawneet Raj et al [8]. Routing structure, routing technique, routing overhead, latency, scalability, storage needs, and route availability have all been taken into account in the comparison.

3. Categories of Routing Protocols

There are two methods used to transfer data in sensor networks. The first is referred as Flooding, while the second is a kind of gossiping. Using any routing technique or maintaining the network's architecture is not required. When a sensor node receives a data packet, it broadcasts this data packet to all of its neighbours. Once one of the two following criteria is met, the broadcasting operation is terminated, and no further packets will be sent out. The second criterion is that a packet's hop count has been reached to its maximum [13]. Fig. 1 depicts the major types of routing protocols.

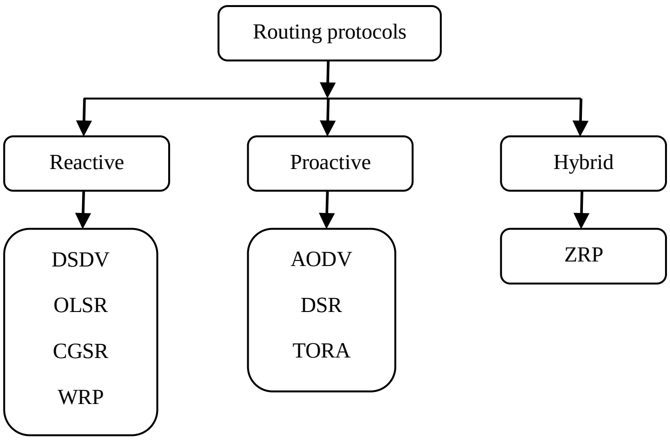

Fig 1: Categories of routing protocol

3.1 Reactive Protocols

A node may activate a reactive routing protocol whenever it wishes to communicate data to another node, rather than maintaining the whole network structure. When a query is made, a new route is automatically generated. The following are the most often used reactive routing protocols:

- In the Ad-hoc on-demand distance vector routing system (AODV), the system responds to a request protocol and routes traffic accordingly. In order to route data packets, the source node establishes a single path, which it maintains for as long as necessary. We name it On-Demand because of this. All three types of routing are supported by AODV: unicast, multicast, and broadcast. AODV is a routing technique for wireless ad-hoc networks that distributes packets across mobile nodes. This protocol allows mobile nodes to route data packets via neighbour nodes that are unable to publicly establish links to the desired destination node. In order to transmit packets, AODV selects the shortest but round free route from the routing table.

- In 1996, Carnegie Mellon University invented "dynamic source routing" for wireless sensor networks (DSR). Source data may be routed dynamically in response to events or on demand. As the name says, source routing replaces routing tables. There are two key aspects of DSR routing: discovery and maintenance. During the route discovery process, RREP messages are sent between the source and destination nodes. Whereas every intermediate node would send a route reply message back to the source, only the final destination in DSR would do so with an RREP message in response to the source's request. Next phase route maintenance, which is used to minimise the number of nodes between the source and destination, will not overburden RREP messages [14,15].
- It is called the Temporally-Ordered Routing Algorithm and was developed by Park and Corson (TORA). There are no loops in this distributed multipath routing approach. Control messages are transmitted to a restricted number of nodes near the topological change, which is an essential design aspect. TORA creates and maintains directed acyclic graphs (DAGs). There are no recursive paths in the directed acyclic graph (DAG). Using this method, partitions may be wrongly identified. It is essential that route control packets be delivered on schedule. Because the algorithm has the ability to provide short-term wrong routes, this is TORA's most significant flaw. TORA has been supplanted by DSR and AODV as the imaging technique of choice.

3.2 Proactive Protocols

The word "periodic" is seldom used to denote preventive practices. The topology of the network is automatically updated on a regular basis. Among the most popular methods is the following:

- The normal Bellman-Ford routing mechanism and the Destination Sequenced Distance Vector Routing protocol are used to create DSDV, a table-driven method (DSDV). All potential destinations, the number of hops necessary to get there, and the sequence number supplied by the destination node are stored in a routing database maintained by mobile stations. The sequence number is used to distinguish between the old and new routes, preventing loops. In the immediate neighbourhood, routing tables are often swapped. The routing table is also sent by a station if there has been a substantial change since the previous update. Because of this, both chronological and event-based information has been updated.
- In the OLSR family, a proactive routing method known as Optimized Link State Routing (OLSR) makes advantage of table-focused practise. OLSR's biggest drawback is its enormous administrative burden. Due of the temporal delay, multi-point relays are employed. Each node has three adjutant nodes acting as MPRs for data transfer. Control information is not required to be consistent since each node presents it in a unique manner [14 ,15].
- Cluster Head Gateway Switch Routing Protocols use a hierarchical network design created by Chiag (CGSR). Each node maintains a routing table and makes use of distributed algorithms to find the next stop on the journey to the destination. Mobile nodes are organised into clusters, and each cluster has its own cluster head to gateway routing strategy for delivering data from a source to a destination.
- As far as wireless routing protocols are concerned, the architecture is flat (WRP). To keep track of how far a destination is and how many different routes there are to get there, a routing node uses this protocol. Avoiding problems with infinity by requiring each node to do consistency checks will assist. On a frequent basis, mobile phones notify their neighbours with the most current information.

3.3 Hybrid Routing Protocols

Proactive and reactive routing systems have their limitations, but hybrid routing solutions combine the best of both worlds.

- As a hybrid protocol, Zone Routing Protocol (ZRP) integrates active and reactive protocols into a single system. Because each node must actively maintain a network connection within a certain range depending on the distances between nodes, a network may be divided into routing zones based on their distances (in hops). A network's internal and external sectors may benefit from the reactive and proactive routing protocols IARP and IERP, respectively. All nodes in the routing zone have immediate access to routing information. ZRP is well-suited for networks with a broad variety of mobility patterns and a large geographic scope. This protocol has the advantage of considerably decreasing communication overhead when compared to pure proactive protocols. It has also reduced the delays associated with reactive-only protocols like DSR by allowing faster route finding.

4. Overall Comparison of Routing Protocols

Features	Reactive	Proactive	Hybrid
Routing Structure	Mostly Flat	Both Flat & Hierarchical	Hierarchical
Topological dissemination	On demand	Periodical	Combination of both
Communication Overhead	Low	High	Medium
Route latency	High due to flooding	Low due to routing tables	Inside Zone
Scalability	Not suitable for large networks	Low	Designed for large networks

Routing Information	Available when required	Always available	Combination of both
Periodic Updates	Not needed	Yes, when the topology of network changes	Yes
Mobility	Route Maintenance	Periodic updates	Combination of both
Storage Requirement	Low	High	Medium
Bandwidth	Low	High	Medium
Power	Low	High	Medium

5. Comparison between Routing Protocols

Parameters	Protocol type	Route metrics	Route approach	Route structure	Route	Route selectio n	Advantages	Disadvantages
DSDV	Destination sequence distance vector	Hop-count	Proactiv e	Flat structure	Single route	Link state	Loop free	High overhead
OLSR	Optimized link state routing protocol	Hop-count	Proactiv e	Flat structure	Multipl e route	Link state	Reduced CO and connection	hop neighbour knowledge required
CSGR	Cluster switch gateway routing	Hop-count	Proactiv e	Hierarchica l structure	Single and multiple route	Shortest path	Loop free	High overhead
WRP	Wireless routing protocol	Hop-count	Proactiv e	Flat structure	Single route	Shortest path	Loop free	High MO
AODV	Adhoc on demand distance vector routing	Hop-count	Reactive	Flat structure	Multipl e route	Shortest and updated path	Multicast routing capabilities; adaptable to highly dynamic topologies	Messages of hello are required. Multiple routes are not supported. Routing information must be stored on intermediate nodes. It may not perform properly when the network grows in size.
DSR	Dynamic source routing	Hop-count	Reactive	Flat structure	Multipl e route	Shortest and updated path	No route information is stored in intermediat e nodes. Possesses the capability of supplying various routes	In large and mobile MANETs, stale caches and relay storms may occur. Source routing adds communication time and cost.

TORA	Temporally ordered routing algorithm	Hop-count	Reactive	Flat structure	Single route	Link reversal	Route upkeep on a smaller scale	Partitions may be mistakenly detected Route control packets must be sent reliably and in the correct sequence. Routing loops over short periods of time.
ZRP	Zone routing protocol	Throughput, end-end delay, packet loss percentage	Hybrid	Flat structure	Multiple route	Link reversal	With properly configured zone radius, outperform both proactive and reactive routing protocol	Memory requirement is greater

6. Conclusion

This article compares the WSN routing protocols. Preventive, reactive, and hybrid treatments are the three main varieties. In a proactive network, each node maintains connectivity and up-to-date routing information for all other nodes. To transport packets to a certain location, a node determines the most direct route. Hybrid routing systems combine proactive and reactive properties by keeping intra-zone information proactive and inter-zone information reactive in a single protocol.

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