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A COMPARATIVE REVIEW ON PARAMETERS OF ROUTING PROTOCOLS IN WBSN

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Abstract— A wireless body sensor network (WBSN) is a type of network that consists of a collection of miniaturized and wireless-enabled sensors that are placed on or within the human body.[1] These sensors can be used to monitor a variety of physiological parameters such as heart rate, blood pressure, body temperature, and respiration rate.

The sensors are typically connected wirelessly to a central processing unit or gateway, which can then transmit the data collected by the sensors to a remote server or other computing device. This allows for continuous and real-time monitoring of the body's vital signs, which can be useful in a variety of applications such as medical diagnosis, disease management, and sports training.

WBSNs pose several challenges, including limited power and computing resources, as well as the need for secure and reliable communication protocols to protect patient privacy and prevent unauthorized access to sensitive health data. Nonetheless, they have the potential to revolutionize healthcare and enable new applications in fields such as telemedicine and wearable technology.

Index Terms— WSBN, Zigbee, Leach

I. INTRODUCTION

There are several communication protocols that are commonly used in wireless body sensor networks (WBSNs) to ensure reliable and secure communication between the sensors and the central processing unit or gateway. Some of these protocols include:

Bluetooth Low Energy (BLE): This protocol is widely used in WBSNs due to its low power consumption and short-range wireless communication capabilities. It is ideal for transmitting small amounts of data, such as sensor readings, and is commonly used in wearable fitness trackers and other consumer health devices.

ZigBee: This is a low-power, wireless mesh networking protocol that is commonly used in WBSNs due to its ability to support large networks of sensors and provide reliable and secure communication. ZigBee networks can be self-organizing and self-healing, which makes them ideal for use in healthcare settings.

Wi-Fi: This protocol is widely used in WBSNs due to its high bandwidth and long-range wireless communication capabilities. Wi-Fi networks can support a large number of sensors and provide high-speed data transmission, which is useful in applications such as telemedicine and remote patient monitoring.

Near Field Communication (NFC): This protocol is commonly used in WBSNs for secure communication between devices that are in close proximity to each other. NFC is ideal for applications such as access control and secure data transfer, and is commonly used in smart watches and other wearable devices.

Overall, the choice of communication protocol for a WBSN depends on the specific application requirements, such as power consumption, data transmission speed, and security

II .ROUTING PROTOCOLS FOR WBSN

Routing protocols are essential for the proper functioning of wireless body sensor networks (WBSNs). These protocols determine how data packets are transmitted from the sensors to the central processing unit or gateway. Here are some of the commonly used routing protocols for WBSNs:

Directed Diffusion: This is a data-centric routing protocol that uses a gradient-based approach to forward data from the source node to the destination node. The protocol creates a virtual map of the network and sends data in the direction of the steepest gradient, ensuring efficient data transmission.

LEACH: Low-Energy Adaptive Clustering Hierarchy (LEACH) is a cluster-based routing protocol that organizes the network into clusters of sensors. Each cluster has a cluster head, which collects data from the sensors and forwards it to the gateway. The protocol is designed to reduce energy consumption and increase network lifetime.

AODV: Ad Hoc On-Demand Distance Vector (AODV) is a reactive routing protocol that establishes a route on-demand between the source and destination nodes. The protocol is ideal for WBSNs as it reduces the overhead of maintaining routing tables and conserves energy by transmitting data only when needed.

DSDV: Destination-Sequenced Distance Vector (DSDV) is a proactive routing protocol that uses a table-based approach to maintain a consistent and reliable routing path between the source and destination nodes. The protocol is ideal for WBSNs as it ensures low latency and high reliability in data transmission.

The choice of routing protocol depends on the specific application requirements, such as energy consumption, data transmission rate, and network scalability. In addition, a combination of routing protocols can also be used in WBSNs to achieve better performance and reliability.

III.BASIC PARAMETERS IN ROUTING PROTOCOLS OF WBSN

Here's a comparison of some important parameters in the routing protocols commonly used in wireless body sensor networks (WBSNs):

Energy Consumption: The energy consumption is a critical parameter for WBSNs, as the sensors have limited battery life. Directed Diffusion, AODV, and DSDV are proactive routing protocols and are not energy-efficient, as they require continuous communication and periodic updates of routing tables. In contrast, LEACH is a cluster-based protocol that reduces energy consumption by organizing the network into clusters and reducing the amount of data transmitted.

Scalability: Scalability is another important parameter for WBSNs, as the network may need to support a large number of sensors. Directed Diffusion is scalable as it uses a data-centric approach and does not depend on the number of nodes in the network. AODV and DSDV are not scalable as they require the maintenance of routing tables, which can become unwieldy with a large number of nodes. LEACH is scalable as it uses a cluster-based approach and can handle a large number of sensors**.**

Latency: Latency is the time taken for data packets to reach their destination, and is important in applications such as telemedicine, where real-time monitoring is required. AODV and DSDV have low latency as they establish routes before data transmission, while Directed Diffusion has high latency as it uses a data-centric approach. LEACH has medium latency as it uses a cluster-based approach.

Security: Security is an important consideration in WBSNs, as the data transmitted may be sensitive and private. AODV and DSDV do not have built-in security mechanisms, while Directed Diffusion and LEACH provide some level of security by using encryption and authentication.

Overall, the choice of routing protocol for a WBSN depends on the specific application requirements, and a combination of protocols may be used to achieve the desired performance and reliability.

Directed Diffusion is a data-centric routing protocol that uses a gradient-based approach to forward data from the source node to the destination node in wireless body sensor networks (WBSNs).

IV.COMPARISION OF PARAMETERS IN DIFFERENT ROUTING PROTOCOLS USING WSBN

DIRECTED DIFFUSION:

Energy Consumption: The energy consumption in Directed Diffusion for WBSNs depends on several factors, such as the network topology, data transmission rate, and the size of the data packets. The protocol is not energy-efficient, as it requires continuous communication and periodic updates of the routing tables, which consumes significant energy.

Moreover, the gradient-based approach used in Directed Diffusion requires the sensors to continuously sample the environment and transmit data to their neighbors, which further increases the energy consumption.

To reduce the energy consumption in Directed Diffusion for WBSNs, researchers have proposed several techniques such as data aggregation, selective forwarding, and energy-aware routing. Data aggregation involves merging similar data packets from different sensors to reduce the amount of data transmitted. Selective forwarding involves forwarding only the relevant data packets to reduce the amount of data transmitted. Energy-aware routing involves selecting the path with the lowest energy consumption for data transmission.

Scalability: Scalability is a critical parameter for WBSNs, as the network may need to support a large number of sensors. In Directed Diffusion, the scalability depends on the network topology and the number of data consumers.

One of the advantages of Directed Diffusion is its scalability. It is a distributed protocol that does not require centralized control, and it is well-suited for large-scale WBSNs. The protocol uses a data-centric approach, which means that the nodes in the network are not identified by their addresses but by their data attributes. This approach enables Directed Diffusion to support a large number of sensors without requiring the maintenance of routing tables.

Directed Diffusion is adaptable to changes in the network topology, which makes it scalable in dynamic environments. The protocol can adapt to changes in the network by adjusting the gradients and forwarding data packets in a new direction. This adaptability makes Directed Diffusion well-suited for WBSNs, where the network topology may change frequently due to the movement of sensors.

Latency : Directed Diffusion has high latency compared to other routing protocols due to its data-centric approach. In Directed Diffusion, the data is transmitted based on the data attributes and not the destination addresses, and the sensors must continuously sample the environment and transmit data to their neighbors. This results in a delay in the transmission of data packets, which can lead to high latency.

To reduce the latency in Directed Diffusion, researchers have proposed several techniques such as selective forwarding, gradient caching, and event-to-sink routing. Selective forwarding involves forwarding only the relevant data packets to reduce the amount of data transmitted and improve the latency. Gradient caching involves storing the gradient information at the intermediate nodes to reduce the latency in forwarding data packets. Event-to-sink routing involves forwarding data packets directly to the sink node instead of forwarding them to intermediate nodes, which can reduce the number of hops and improve the latency.

SECURITY: The Directed Diffusion usd in WSBN does not provide any inherent security mechanisms. The protocol relies on the underlying security mechanisms provided by the lower layers of the protocol stack, such as encryption and authentication.

To enhance the security of Directed Diffusion in WBSNs, researchers have proposed several techniques such as data encryption, key management, and intrusion detection. Data encryption involves encrypting the data transmitted over the network to prevent unauthorized access. Key management involves securely distributing and managing the keys used for encryption and authentication. Intrusion detection involves detecting and preventing attacks on the network by monitoring the network traffic and identifying abnormal behavior.

LEACH

LEACH (Low Energy Adaptive Clustering Hierarchy) is a popular hierarchical clustering-based routing protocol for wireless body sensor networks (WBSNs).

Energy Efficiency : One of the key features of LEACH is its energy efficiency, which is achieved through the use of randomized clustering and scheduling mechanisms.

The energy consumption in LEACH depends on several factors, such as the network topology, the number of sensors, the data rate, and the transmission range. However, the use of randomized clustering and scheduling mechanisms in LEACH significantly reduces the energy consumption compared to other routing protocols.

The randomized clustering mechanism in LEACH ensures that the cluster heads are distributed evenly across the network, which reduces the distance that data must be transmitted and, therefore, the energy consumption. The scheduling mechanism ensures that the sensors transmit data only during their respective cluster heads' active periods, which further reduces the energy consumption.

Scalability: LEACH is designed to be scalable and can handle a large number of sensors. This achieves scalability by organizing the sensors into clusters and having a cluster head for each cluster. The cluster heads collect data from the sensors in their respective clusters and transmit it to the base station. By dividing the network into clusters, LEACH reduces the communication overhead, which allows the protocol to handle a large number of sensors.

In addition, LEACH uses randomized clustering and scheduling mechanisms, which ensure that the cluster heads are distributed evenly across the network, and the sensors transmit data only during their respective cluster heads' active periods. These mechanisms reduce the energy consumption and improve the network lifetime, making the protocol well-suited for large-scale WBSNs.

Latency : LEACH achieves low latency by using a hierarchical clustering approach, which allows the data to be transmitted to the base station through multiple hops. The cluster heads collect data from the sensors in their respective clusters and transmit it to the base station. Since the cluster heads are closer to the base station than the individual sensors, the data can be transmitted to the base station more quickly.

In addition, LEACH uses randomized clustering and scheduling mechanisms, which ensure that the sensors transmit data only during their respective cluster heads' active periods. These mechanisms reduce the energy consumption and improve the network lifetime, but they can also introduce some latency since the sensors may need to wait for their respective cluster heads' active periods to transmit data. However, this delay is typically small, and LEACH is still able to achieve low latency in WBSNs.

Another factor that affects latency in LEACH is the network topology. The latency can be reduced by optimizing the cluster head selection process and adjusting the transmission power levels. These optimizations can ensure that the data is transmitted through the most efficient path, reducing the latency.

Overall, LEACH is designed to minimize the latency in WBSNs by using a hierarchical clustering approach, randomized clustering and scheduling mechanisms, and optimizations to the network topology. The protocol can handle a large number of sensors while maintaining low latency, making it well-suited for WBSNs.

Security : LEACH includes a key management scheme that generates and distributes cryptographic keys to the nodes in the network. This scheme is used to secure the communication between the sensors and the cluster heads, and between the cluster heads and the base station. The cryptographic keys ensure that only authorized nodes can access the data transmitted in the network, preventing unauthorized access and tampering.

In addition, LEACH includes a data aggregation mechanism, which reduces the amount of data transmitted in the network by aggregating the data collected by the sensors before transmitting it to the base station. This mechanism reduces the risk of data interception and eavesdropping, since the amount of data transmitted is significantly reduced.

LEACH also includes mechanisms to prevent attacks, such as Sybil attacks, in which an attacker creates multiple fake identities in the network. LEACH prevents these attacks by requiring each node to have a unique ID, which is verified by the cluster head during the cluster formation process.

Furthermore, LEACH includes mechanisms for detecting and preventing node compromise and tampering, which are critical in WBSNs since the sensors are vulnerable to physical attacks. These mechanisms include intrusion detection and response mechanisms, which can detect and isolate compromised nodes, preventing them from affecting the rest of the network.

Overall, LEACH includes several security mechanisms to protect the data transmitted in WBSNs. The key management scheme, data aggregation mechanism, and prevention of attacks and node compromise all work together to ensure the security of the network and the data transmitted.

Ad hoc On-Demand Distance Vector (AODV)

Energy Consumption: Ad hoc On-Demand Distance Vector (AODV) is a reactive routing protocol used in wireless body sensor networks (WBSNs) that is designed to minimize energy consumption while ensuring efficient routing of data packets.

AODV achieves low energy consumption by using a reactive approach to routing. The protocol only establishes routes when they are needed, rather than maintaining them continuously, which reduces the number of control packets transmitted in the network and conserves energy. In AODV, the nodes only send route discovery messages when they need to communicate with a destination node that is not within their communication range. The route discovery process involves flooding the network with route request packets, which are used to find a route to the destination node. When a route is found, a route reply packet is sent back to the source node, which can then use the route to transmit data packets.

AODV also includes mechanisms to minimize the number of packets transmitted in the network. For example, the protocol uses sequence numbers to prevent the nodes from using stale or invalid routes. When a node receives a route discovery message, it checks the sequence number of the message and only forwards it if it is newer than the previously received message. This mechanism reduces the number of redundant messages transmitted in the network, reducing the energy consumption.

Furthermore, AODV uses local route repair mechanisms, which can be used to repair broken links in the network without the need for global route updates. This mechanism reduces the number of control packets transmitted in the network, which further reduces the energy consumption.

Overall, AODV is designed to minimize the energy consumption in WBSNs by using a reactive approach to routing, minimizing the number of control packets transmitted in the network, and using local route repair mechanisms. These mechanisms ensure efficient routing of data packets while conserving energy, making AODV a popular choice for WBSNs.

Scalability : Scalability is an important consideration in wireless body sensor networks (WBSNs), as the number of sensors in the network can be very large, and the network topology can change frequently due to the mobility of the sensors. AODV (Ad hoc On-Demand Distance Vector) is a reactive routing protocol commonly used in WBSNs that has some features to address scalability.

One of the main features that makes AODV scalable is its on-demand nature. In AODV, routes are only established when they are needed, and the protocol does not maintain a constant overhead of control traffic in the network. This reduces the amount of traffic in the network, which can improve the scalability of the protocol.

Another feature that improves the scalability of AODV is the use of sequence numbers in the protocol. Sequence numbers are used to avoid loops and stale routes, which can occur in a dynamic network such as a WBSN. This improves the reliability and efficiency of the protocol, which can lead to better scalability.

Furthermore, AODV can support hierarchical routing, which can be used to improve scalability in large WBSNs. Hierarchical routing can be achieved by dividing the network into multiple levels, with each level having a designated set of nodes that are responsible for forwarding packets. This reduces the overall routing overhead in the network, and can improve the scalability of the protocol.

Overall, AODV has some features that can improve scalability in WBSNs. Its on-demand nature, use of sequence numbers, and support for hierarchical routing can all contribute to better scalability in large and dynamic WBSNs.

Latency : Latency is an important metric to consider in wireless body sensor networks (WBSNs), as it can impact the real-time performance of the network. AODV (Ad hoc On-Demand Distance Vector) is a reactive routing protocol commonly used in WBSNs that has some features to address latency.

One of the main features that can affect the latency of AODV is the route discovery process. When a source node needs to send data to a destination node that is not within its communication range, it initiates a route discovery process to find a route to the destination. The route discovery process involves flooding the network with route request packets, which can cause some delay in finding a route to the destination.

However, AODV includes some mechanisms to reduce the latency of the route discovery process. For example, the protocol uses a route cache to store recently used routes. If a source node has recently sent data to a destination node, it can use the route from the route cache, which can reduce the delay in finding a route to the destination. Additionally, AODV can use multiple route replies to speed up the route discovery process. When a source node receives multiple route replies, it can select the shortest or most reliable route, which can reduce the delay in establishing a route to the destination.

Another feature that can affect the latency of AODV is the use of local route repair mechanisms. If a link in the network breaks, AODV can use local route repair mechanisms to repair the link without the need for a global route update. This can reduce the delay in re-establishing the broken link and ensure that data packets are still delivered in a timely manner.

Overall, while the route discovery process in AODV can cause some delay in finding a route to the destination, the protocol includes some mechanisms to reduce the latency of this process. Additionally, the use of local route repair mechanisms can also help to reduce the delay in re-establishing broken links in the network. These features can help to ensure that data packets are delivered in a timely manner in WBSNs using AODV.

Security : Security is an important concern in wireless body sensor networks (WBSNs) as the data transmitted by the sensors can contain sensitive personal and medical information. AODV (Ad hoc On-Demand Distance Vector) is a reactive routing protocol commonly used in WBSNs, and it includes some mechanisms to provide security.

One of the primary security mechanisms in AODV is the use of sequence numbers. Sequence numbers are used to prevent malicious nodes from spoofing or replaying route control messages, which can disrupt the network and compromise its security. Each node in the network maintains a unique sequence number for each route it discovers, and it increments the

sequence number when it broadcasts a route update message. This ensures that any older or invalid route information is not used in the network.
Another security mechanism in AODV is the use of hop-by-hop authentication. In this mechanism, each node in the network verifies the authenticity of the incoming packets by checking the digital signature attached to the packet. This ensures that the packet was sent by a valid node and has not been tampered with in transit.
AODV also includes support for message encryption, which can provide confidentiality for the data transmitted in the network. Encryption can prevent unauthorized nodes from accessing the contents of the data packets and can protect against eavesdropping attacks.

In addition, AODV can support the use of intrusion detection systems (IDS) to detect and respond to security threats in the network. An IDS can monitor the network for suspicious activity and can alert the network administrator or take other actions to mitigate the threat.
Overall, AODV includes several mechanisms to provide security in WBSNs. The use of sequence numbers, hop-by-hop authentication, message encryption, and IDS can all contribute to a more secure network and help protect the sensitive data transmitted by the sensors.

DSDV (Destination-Sequenced Distance Vector)
Energy Consumption : One of the key considerations when evaluating any routing protocol in WBSNs is its energy consumption.DSDV is a proactive routing protocol, which means that nodes in the network maintain routing tables that contain information about the paths to all other nodes in the network. These tables are periodically updated to ensure that the nodes have the most current information about the network topology.
The periodic updates in DSDV can result in higher energy consumption compared to reactive routing protocols like AODV. This is because nodes in the network have to constantly broadcast their routing tables to all other nodes, even if there have been no changes to the network topology. This can result in a higher overhead and energy consumption in the network.
However, DSDV also has some features that can help to reduce its energy consumption. For example, the protocol uses sequence numbers to ensure that only the most recent updates are used in the network. This helps to reduce the number of unnecessary updates that nodes have to broadcast, which can lower the energy consumption.
Additionally, DSDV supports the use of periodic updates with a smaller interval in areas with higher mobility or in areas with frequent topology changes. This can help to ensure that the routing tables are updated more frequently in areas where changes are more likely to occur, which can help to reduce the energy consumption in the long run.
Overall, while DSDV is a proactive routing protocol that can result in higher energy consumption compared to reactive protocols like AODV, it includes some features like sequence numbers and variable update intervals that can help to reduce its energy consumption in WBSNs.
Scalability: DSDV (Destination-Sequenced Distance Vector) has some characteristics that affect its scalability. One of the main scalability challenges in DSDV is the size of the routing tables maintained by each node in the network. Since DSDV is a proactive routing protocol, each node maintains a routing table that contains information about the paths to all other nodes

in the network. As the network grows in size, the routing tables become larger and more complex, which can affect the performance of the protocol.

To address this issue, DSDV uses several techniques to optimize its routing tables and reduce their size. For example, it uses sequence numbers to ensure that only the most recent information is used in the network, which can help to reduce the size of the routing tables. DSDV also includes a mechanism for purging stale entries from the routing tables, which can help to keep the tables up-to-date and reduce their size.

Another factor that can affect the scalability of DSDV is the frequency of updates. Since DSDV is a proactive protocol, each node periodically broadcasts its routing table to all other nodes in the network. As the network grows in size, the frequency of updates increases, which can cause more network traffic and higher energy consumption. To mitigate this, DSDV includes a mechanism for adjusting the update interval based on the stability of the network, which can help to balance the update frequency with the energy consumption.

Overall, while DSDV has some challenges with scalability, it includes several mechanisms to optimize its routing tables and reduce their size, as well as adjusting the update interval to balance the update frequency with energy consumption. These features can help to improve the scalability of DSDV in wireless body sensor networks.

Latency: DSDV (Destination-Sequenced Distance Vector) that maintains a routing table at each node in the network, which contains information about the paths to all other nodes. This means that the nodes in the network have a complete view of the network topology, which can help to reduce latency by allowing them to make faster and more efficient routing decisions.

However, the periodic updates in DSDV can also contribute to latency, as each node in the network periodically broadcasts its routing table to all other nodes. This can result in additional network traffic and delays in the transmission of data, especially in large networks or in areas with high node density.

To mitigate latency in DSDV, several techniques can be used. One approach is to adjust the update interval based on the stability of the network, which can help to reduce unnecessary updates and lower the overhead of the protocol. Additionally, DSDV can be combined with other techniques, such as route caching and route discovery, to further reduce latency and improve the efficiency of communication between the nodes.

Overall, while the periodic updates in DSDV can contribute to latency, the protocol's proactive nature and complete view of the network topology can help to reduce latency by allowing nodes to make faster and more efficient routing decisions. The use of additional techniques, such as adjusting the update interval and combining DSDV with other techniques, can further improve the latency performance of the protocol in WBSNs.

Security : One of the main security challenges in DSDV is the vulnerability to various types of attacks, such as packet dropping, packet modification, and routing table poisoning. These attacks can disrupt the communication between nodes in the network, compromise the integrity and confidentiality of data, and even cause the nodes to malfunction or fail.

To address these security challenges, DSDV can be combined with various security mechanisms, such as encryption, authentication, and key management. For example, encryption can be used to protect the confidentiality of data transmitted between the nodes, while authentication can be used to verify the identity of the nodes and prevent unauthorized access. Key management can be used to ensure that the encryption and authentication keys are securely distributed and updated.

Another approach to enhancing security in DSDV is to use intrusion detection and prevention techniques. These techniques can be used to monitor the network for suspicious behavior and to prevent or mitigate attacks before they can cause significant harm.

V.CONCLUSION:

Most probably there is no exact routing protocol is invented to overcome the pitfalls of the above parameters. By considerations, the Directed Diffusion routing protocol, which is a data-centric protocol that utilizes gradient-based communication and adaptive mechanisms to reduce energy consumption and latency. Directed Diffusion can also be combined with various security mechanisms, such as encryption and authentication, to enhance the security of the network. However, Directed Diffusion may not be as scalable as other protocols, particularly in large WBSNs.

Another example is the LEACH (Low-Energy Adaptive Clustering Hierarchy) routing protocol, which is a hierarchical protocol that utilizes clustering and adaptive mechanisms to reduce energy consumption and improve scalability. LEACH can also be combined with various security mechanisms, such as encryption and authentication, to enhance the security of the network. However, LEACH may have higher latency than some other protocols, particularly when the nodes are far from the sink.

AODV (Ad-hoc On-demand Distance Vector) is another routing protocol that has been shown to perform well in terms of energy consumption, scalability, security, and latency in WBSNs. AODV is a reactive protocol that utilizes on-demand route discovery to reduce energy consumption and latency. AODV can also be combined with various security mechanisms, such as encryption and authentication, to enhance the security of the network. However, AODV may have scalability issues in large WBSNs.

Ultimately, the best routing protocol for a WBSN depends on the specific requirements of the application and network. It is important to evaluate different protocols based on their performance in terms of energy consumption, scalability, security, and latency, and choose the protocol that best meets the specific needs of the WBSN.

Overall, while DSDV has some security challenges, it can be combined with various security mechanisms and intrusion detection and prevention techniques to enhance its security in WBSNs. By using a combination of these techniques, it is possible to mitigate the security risks associated with DSDV and ensure the safe and secure operation of the WBSN.

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