

# ENERGY-EFFICIENT ROUTING PROTOCOLS FOR WIRELESS SENSOR NETWORKS

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# INTRODUCTION TO WIRELESS SENSOR NETWORKS (WSNS)

- Networks of distributed devices (sensors) that monitor and record conditions in a different environments and coordinate to pass their data through the network to a main location.
- WSNs are crucial for applications like environmental monitoring, healthcare, home automation, and military uses.
- Most sensor nodes are battery-operated, making energy conservation a critical design consideration.



# CHALLENGES IN WSNS

- **Major Challenges:** Limited energy resources, sensor node failures, data transmission costs, and environmental factors affecting sensor operations.
- **Energy as a Prime Concern:** Optimizing energy use is essential for prolonging the network's operational lifespan.
- **Routing's Role:** Efficient routing protocols can significantly reduce energy consumption and extend network lifetime.



# UNDERSTANDING ROUTING IN WSNS

- **Routing Defined:** The method of choosing optimal paths in a network for data packets to travel from sensor nodes to the base station.
- **Significance:** Effective routing improves energy efficiency, network performance, and reliability.
- **Goal:** Develop routing protocols that conserve energy without compromising data transmission quality.



# DAA CONCEPTS IN ROUTING PROTOCOLS

01

**Optimization:** Finding the most efficient way to use resources, such as minimizing energy consumption per data packet transmitted.

02

**Efficiency:** Ensuring the algorithm performs its task within a reasonable time and resource bounds.

03

**Complexity Analysis:** Studying how the protocol's performance scales with an increase in network size and data volume.



# REAL-WORLD APPLICATIONS OF WSNs

01

**Agriculture:** Use WSNs for precision farming techniques, monitoring soil moisture and conditions, optimizing irrigation schedules, and reducing water usage.

02

**Healthcare Monitoring:** Implement WSNs for remote health monitoring, tracking patient vital signs, and providing real-time data to medical professionals, enhancing patient care.

03

**Environmental Monitoring:** Deploy sensor networks for monitoring air and water quality, detecting forest fires early, and observing wildlife, contributing to conservation efforts.

04

**Smart Cities:** Utilize WSNs for managing traffic flows, monitoring public infrastructure, enhancing public safety, and optimizing energy use in urban environments.



# ENERGY-EFFICIENT ROUTING PROTOCOLS OVERVIEW

- **Concept:** These protocols aim to minimize energy consumption during data transmission and processing.
- **Strategies:** Include cluster formation, data aggregation, and adaptive duty cycling to conserve energy.
- **Examples:** Mention LEACH, PEGASIS, and Directed Diffusion as key protocols developed with these goals in mind.



# CASE STUDY: LEACH PROTOCOL

- **LEACH Operation:** Describes the cyclic process of cluster formation, cluster-head selection, and data transmission phases.
- **Energy Efficiency:** Cluster-heads change over time to evenly distribute energy consumption among nodes.
- **DAA Aspect:** The randomized rotation of cluster-heads represents an algorithmic strategy to balance load and conserve energy.



# CASE STUDY:

## PEGASIS PROTOCOL

- **Concept:** Nodes form a single chain to pass data along to the base station, reducing the amount of energy spent on communication.
- **Key Feature:** Each node communicates only with a close neighbour and takes turns being the leader to transmit data to the base station.
- **DAA Insight:** By minimizing the distance data travels, PEGASIS efficiently reduces overall energy consumption, demonstrating an application of greedy algorithms for local optimization.



# CASE STUDY:

## DIRECTED DIFFUSION

- **Approach:** Data is diffused through the network by creating gradients directed towards the data source, optimizing path establishment based on data query.
- **Feature:** Employs data aggregation to reduce redundant data transmissions, enhancing energy efficiency.
- **DAA Connection:** The use of gradient-based routing and query-driven data dissemination illustrates the use of data-centric and distributed algorithms for energy conservation



# COMPARING PROTOCOLS

	LEACH	PEGASIS	DIRECTED DIFFUSION
APPROACH	Hierarchical	Chain-based	Data-centric
ENERGY EFFICIENCY	Moderate	Higher	Average
COMPLEXITY	Moderate	Higher	High
PRIORITY	Energy conservation	Network lifetime	Data diffusion



# CHALLENGES IN REAL-WORLD DEPLOYMENTS

- **Environmental Factors:** Discuss how natural elements like water, foliage, and terrain can affect sensor operation and data transmission.
- **Maintenance and Durability:** Highlight the challenges of maintaining sensor nodes in hard-to-reach areas and ensuring they are durable enough to last without frequent replacements.
- **Scalability and Adaptability:** Address the need for protocols that can scale with the network and adapt to changing environmental conditions and monitoring requirements.



# THE FUTURE OF WSN'S IN OUR WORLD

- **Technological Advancements:** Touch on potential advancements in sensor technology, energy harvesting, and AI that could enhance the capabilities and efficiency of WSNs.
- **Expanding Applications:** Speculate on new and emerging applications of WSNs, such as in autonomous vehicles, advanced manufacturing processes, and smart energy grids.
- **Integration with IoT:** Discuss how WSNs are becoming an integral part of the Internet of Things (IoT), enabling smarter, more connected environments.



# CONCLUSION

The development and analysis of energy-efficient routing protocols for wireless sensor networks (WSNs) stand at the intersection of innovation and sustainability. By leveraging design and analysis of algorithms (DAA), these protocols not only optimize energy consumption across the network but also extend the operational lifespan of WSNs, enabling them to serve a wide array of critical applications from environmental monitoring to smart cities. The ongoing advancements in this field promise not only to enhance the efficiency and reliability of WSNs but also to pave the way for a future where technology and sustainability go hand in hand.



# REFERENCES

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THANK YOU