

## **Opatrix: Energy Aware Cross Layer Routing Using Convex Optimization in Wireless Sensor Networks**

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**Abstract :** Energy minimization is of great importance in wireless sensor networks in extending the battery lifetime. One of the key activities of nodes in a WSN is communication and the routing of their data to a centralized base-station or sink. Routing using the shortest path to the sink is not the best solution since it will cause nodes along this path to fail prematurely. We propose a cross-layer energy efficient routing protocol Opatrix that utilizes a convex formulation to maximize the lifetime of the network as a whole. We further propose, Opatrix-BW, a novel convex formulation with bandwidth constraint that allows the channel conditions to be accounted for in routing. By considering this key channel parameter we demonstrate that Opatrix-BW is capable of congestion control. Opatrix is implemented in TinyOS, and we demonstrate that a relatively large topology of 40 nodes can converge to within 91% of the optimal routing solution. We describe the pitfalls and issues related with utilizing a continuous form technique such as convex optimization with discrete packet based communication systems as found in WSNs. We propose a routing controller mechanism that allows for this transformation. We compare Opatrix against the Collection Tree Protocol (CTP) and we found that Opatrix performs better in terms of convergence to an optimal routing solution, for load balancing and network lifetime maximization than CTP.

**Keywords :** wireless sensor network, Energy Efficient Routing

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