

Chapter 1

Fundamentals of Wireless Sensor Network

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ABSTRACT

This book chapter explores into the fundamentals of Wireless Sensor Networks (WSNs), providing an extensive overview of all of their essential components and features. Beginning with an overview of sensor nodes and their capabilities in sensing, processing, and communication, the chapter elaborates strategies such as data aggregation and localization that enhance energy conservation and extend the

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operational lifetime of WSNs. The chapter investigates on the architectural aspects of WSNs. Communication protocols, including wireless standards such as ZigBee and Bluetooth, are examined, to shed light on the mechanisms that enable smooth connectivity between sensor nodes. Various network topologies, such as star, mesh, and Tree-based configurations, are studied in detail, pointing out their respective advantages and applications. This comprehensive exploration of the fundamentals of WSNs provides readers with a essential knowledge to design, implement, and optimize wireless sensor networks across a wide range of applications and industries.

1. INTRODUCTION

In the vast tapestry of modern technology, “Wireless Sensor Networks” (WSNs) represent a transformation of paradigms in the field of sensing, communication technologies and data-driven intelligences. These networks consist of spatially distributed autonomous sensing nodes that collaboratively monitor and collect data from the surrounding environmental factors like motion, pressure, temperature, sound, vibration, and pollution and send it to base center. These networks have significantly increased importance in various applications because of their capacity to collect data in real-time from the field. It is necessary to first understand the historical background that established the groundwork for the significant role that WSNs play in the modern world before we delve deeper into this study.

The concept of WSNs originated from military applications in the 20th century, primarily for surveillance purposes by the “Defense Advanced Research Projects Agency (DARPA)” in the United States. In late 2000s, Standardization efforts such as the “IEEE 802.15.4” standard for “low rate wireless personal area networks (LR-WPANs)” further facilitates the development of WSN. In the beginning, wireless sensor networks in houses worked similarly to simple smoke alarms, simply beeping when there was smoke. Now, with the evolution of new paradigms like Internet of Things (IOT) where WSN played crucial role in connecting physical objects to Internet, Smart homes can detect and identify exact position of fire or smoke and send instant notification to your phone and automatically notify emergency services. Continued advancements in communication protocols, energy-efficient sensor designs, and data analytics have solidified the role of WSNs in various industries. Integration with emerging technologies like “Edge Computing” and “Artificial Intelligence” further enhances the WSN potential and capabilities.

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