Chapter 7
Zero-Energy Communication Networks and Self-Sustaining Systems

Jawahar Muthusamy
https://orcid.org/0000-0001-7955-7546
Panimalar Engineering College, India

S. Monika
https://orcid.org/0009-0006-1244-0830
Panimalar Engineering College, India

Badria Sulaiman Alfurhood
https://orcid.org/0000-0002-7626-5262
College of Computer and Information Sciences, Princess Nourah bint Abdulrahman University, Saudi Arabia

ABSTRACT

Self-operated systems and zero-energy networks function as basic requirements for improving communication technology. The chapter gives a detailed view of ongoing research and achievements which work to maximize energy efficiency and sustainability in communication systems. Artificial intelligence together with machine learning tools enable the optimization of networks and their resource management according to the chapter. This study examines how edge computing and blockchain technology along with IoT devices can affect distributed communication infrastructure weak points. It also analyzes the development of environmentally friendly wireless optical systems that work toward minimizing negative ecological impacts. The work

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conducts an essential examination of the security risks with privacy implications relevant to smart communication technology systems. Also it analyzes technological alongside socio-technical innovative elements to forecast the establishment of adaptable communication systems sustaining environmental sustainability and operational success for digital environments

INTRODUCTION

The existing communication infrastructure faces a massive voltage of the rapid growth of data traffic resulting from the growing rates of intelligent devices and mobile applications and interconnected systems. Anti-carbon reduction practices together with sustainable practices create an urgent demand for ecological technologies and energy efficiency solutions. This development marks a crucial change in contemporary network methods, since it introduces self -sufficient zero energy communication systems. These zero energy communication networks do not need dependence on external energy systems for their operation. The systems implement energy collection methods to collect environmental energy that then convert into usable energy. The main sources of which zero energy communication systems derive energy include solar radiation and kinetic energy and thermal gradients along with radiofrequency signals (RF). These sources allow independent functioning of communication equipment, minimizing the need for battery replacements along with feed cables in remote distant locations. The procedures through self -sufficient networks are possible due to the electronic components of ultra -low power in its structure. The development of low energy consumption components capable of maintaining the maximum performance skills came from semiconductor companies that used energy management advances and circuit design. The network reaches its maximum energy efficiency through the integration of microcontrollers of energy efficiency transceiver sensors that cooperate together. Zero energy communication systems need equally important intelligent management capabilities. Operating Network Optimization benefits from automatic learning procedures when used with artificial intelligence systems. Smart systems decrease the use of operational energy by evaluating traffic patterns to assign resources correctly while conducting switches of the instant communication method. The devices can activate sleep modes during low activity times, while the transmission power is adjusted in accordance with the quality of the communication channel through the implementation of automatic learning models.

Industries apply emerging technologies to develop solutions for the viability of the zero energy network. The internet technology of things is integrated with high importance due to how its millions of low power devices connected to each other