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WLANs; 3.3.1. Physical layer-based energy-efficient schemes; 3.3.2. Medium access control (MAC) layer-based energy-efficient schemes; 3.3.3. Cross-layer-based energy-efficient schemes; 3.4. Energy efficiency strategies in IEEE 802.11n; CHAPTER 4. ENERGY HARVESTING IN WIRELESS SENSOR NETWORKS; 4.1. Energy harvesting; 4.1.1. The harvesting concept; 4.1.1.1. Universal energy-harvesting model A universal energy model is the link between the energy harvester and the WSN node [J]; 4.2. Harvesting techniques 4.2.1. Mechanical energy sources 4.2.2. Thermal energy sources; 4.2.3. Radiation energy sources; 4.2.4. Comparison of harvesting sources; 4.3. Energy harvesting storage devices; 4.4. Power management for EH-WSN; 4.4.1. Discussion on power management for energy harvesting systems; 4.5. Conclusion; CHAPTER 5. FUTURE CHALLENGES AND OPPORTUNITIES; 5.1. Energy efficiency in cellular networks; 5.1.1. Low-energy spectrum sensing; 5.1.2. Energy-aware medium access control and energy-efficient routing; 5.1.3. Energy-efficient resource management in heterogeneous cellular networks 5.1.4. Cross-layer design and optimization 5.1.5. Energy considerations in practical deployments of cooperative and cognitive radio systems; 5.2. Energy efficiency in ad hoc networks; 5.2.1. Sampling techniques; 5.2.2. MAC protocols; 5.2.3. Routing; 5.2.4. Mobility challenges; 5.2.5. Cognitive radio technology applied in wireless ad hoc networks; 5.3. Energy efficiency in WLAN; 5.3.1. IEEE 802.11ac (gigabit Wi-Fi); 5.3.2. MIMO-based WLAN; 5.3.3. Super Wi-Fi (IEEE 802.22); 5.4. Energy harvesting in wireless sensor networks; 5.4.1. Challenges for energy harvesting in harsh conditions 5.4.2. Radiation-based energy harvesters

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## Sommario/riassunto

The last decade has witnessed an unprecedented development and growth in global wireless communications systems, technologies and network "traffic" generated over network infrastructures. This book presents state-of-the-art energy-efficient techniques, designs and implementations that pertain to wireless communication networks such as cellular networks, wireless local area networks (WLANs) and wireless ad hoc networks (WAHNS) including mobile ad hoc networks (MANETs), and wireless sensor networks (WSNs) as they are deployed across the world to facilitate "always on" reliable high-speed

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