Chapter 13
Conclusions and future perspectives

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The aim of the chapters contained in this book has been to introduce, overview, and discuss the concept of wireless mesh network (WMN) and its adoption in different heterogeneous contexts and scenarios. We have highlighted how this network topology has (and will have in the future) several implications in the architecture's modeling and requires to take decisions and actions at different layers.

First of all, the choice of the communication protocol (at low layers) at the basis of the WMN is crucial. As discussed in the book, Bluetooth Low Energy (BLE) and IEEE 802.11 seem to be attractive candidates to implement WMNs, yet requiring (i) a careful analysis of the constraints relevant for each network protocol proper of each network protocol and (ii) the definition and adoption of proper routing protocols to be able to forward the data from source to destination. Routing is fundamental in WMNs, since WMNs will be more and more heterogeneous (in terms of nodes' capabilities and architectures' characteristics) and, thus, will require to save even more energy in the presence of constrained devices. At the same time, reliability will also play a key role, with data having to flow from one side of the network to the other. In this regard, WMNs will also require appropriate decisions on network nodes' addressing policies. In fact, a large number of connected devices may require the adoption of (i) flooding-like strategies, in this case, the backbone portion of a WMN can support this mechanism (e.g., a BLE-oriented network would fit to this approach) or (ii) strategies which allow to address and target specific subsets of devices (e.g., *unicast*, *multicast*, and *broadcast*).

The choices described in the previous paragraph have impact on all scenarios, including the case of body sensor networks (BSNs), which will represent the next generation of wearable networks for monitoring people remotely, thus targeting the so-called Health 4.0 paradigm. To this end, *intra*-, *inter*-, and *beyond*-BSNs will face different requirements and challenges associated with each layer of their specific communication stacks. Moreover, BSNs will need to take into account emerging security aspects and threats that these particular WMNs will face: for example, wearable devices may represent gateways for the BSN and, in turn, should be

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carefully protected. Finally, there will be a need to carefully manage aspects such as energy efficiency, reliability, delay optimization, and bio-compatibility of the BSN nodes, since these will play a crucial role even on the communication side for the signal propagation and data formatting (e.g., customizable protocols will be needed to support emerging BSN applications).

The same considerations will apply even in the case of WMNs to be deployed in the presence of mobile nodes, such as flying drones used to monitor large areas on the ground and conveying data to remote processing entities through multi-hop communications (e.g., exploiting other Unmanned Aerial Vehicle (UAV) as relay nodes). Therefore, these mobile scenarios will require carefully modeling the interactions among the drones composing the storm and the backbone network (but possibly involving also other types of mobile nodes), as well as analyzing and defining alternative routing solutions in case certain routes disappear (i.e., their performance will become unacceptable). In this case, "mixed" networks solutions based on the parallelization of multiple heterogeneous network technologies, to be used as "backup" solutions in these situations, will represent a key decision to avoid connectivity lags and lacks.

Taking into account these heterogeneous contexts and scenarios, it is clearer how mesh-oriented architectures are suitable and useful to extend the network coverage in both *indoor* and *outdoor* contexts, from smart agriculture and rural-area-monitoring scenarios to smart industry and smart city-oriented applications. In several cases, in fact, either because of geographical position or because of the presence of obstacles, it is not always possible to rely on cellular networks or standard IEEE 802.11 connectivity. Therefore, all the data generated inside these WMNs—likely *big data*—not only will bring new challenges, in terms of data processing and management requirements but will also play a fundamental role, representing the real "treasure" which developers and entrepreneurs should exploit, especially in terms of information analysis and processing, to provide enhanced and intelligent services, especially through the application of artificial intelligence (AI)-based mechanisms and techniques.

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