Chapter 11
Mobile Wireless Sensor Networks:
Applications and Routing Protocols

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ABSTRACT

The improved availability of sensor nodes has caused an increase in the number of researchers studying sensor networks. More recently, the introduction of mobility to these networks has been able to find solutions and create applications that were previously not possible. For this reason, this chapter firstly introduces the topic of mobile wireless sensor networks (MWSNs). It then explores the potential applications of the technology and discusses the challenges and requirements of the communications systems with a focus on routing. It also looks at performance metrics and evaluation techniques in terms of mathematical analysis, simulations and testbed implementations.

INTRODUCTION

The introduction of small, low cost sensor motes, with the ability to communicate wirelessly has inspired a vast array of applications (Akyildiz et al., 2002). These wireless sensor networks (WSNs) have shown a lot of potential for large-scale data acquisition. However, it's only within the last decade that mobility has been used together with these WSN nodes. This new paradigm of mobile wireless sensor networks (MWSNs) has enabled applications to be realised that hadn't been considered before and will be a key enabling technology in the future of ubiquitous sensing (Ekici et al., 2006).

The wide applicability of sensor networks in areas such as safety, research and military have made them a popular topic in the research community. Their ability to sense phenomena without human presence, in potential harsh or hostile environments, make them an invaluable resource. Research topics such as MAC (medium access control) protocols, localisation techniques, synchronisation methods and routing protocols

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have all been studied in some detail within the scope of static sensor networks. However, the addition of mobility gives rise to new constraints and challenges, which calls for novel approaches to these problems.

The two topics that have had the most influence over MWSNs are mobile ad hoc networks (MANETs) (Basagni et al., 2013) and, of course, WSNs (Dargie & Poellabauer, 2010). MANETs are general purpose mobile networks, in which each node is required to be able to communicate with any other node in the network. The nodes are often considered to be personal computers that are able to enter the network and leave whenever they want. This requires MANETs to provide methods of allowing any two nodes to communicate over a changing topology, with a dynamic number of nodes.

Contrastingly, WSNs are usually made up of small devices dedicated to gathering sensory data. All of the data in the network should then be delivered to the sink, where it can be stored, further analysed or passed over the internet to another location. The static nature of WSNs allows the nodes to establish efficient routes and medium access in an initial phase before the data is transmitted. However, these nodes are prone to failure from harsh conditions or battery depletion, which often means that the network is reinitialised periodically.

MWSNs generally use the many-to-one communication style, in which data is gathered from the sensors and sent to the sink. The mobility of the network can cause frequent topology changes, which makes the routing of data difficult. Medium access is also a challenge since the number of nodes within transmission range will vary with time. However, the total number of nodes in the network is usually fixed and less likely to suffer node failure.

In terms of network scales, WSNs can be made up of hundreds of nodes, whereas MANETs are often between ten and twenty. MWSNs can vary based on the application, but are usually in the order of ten to a hundred. The scale of deployment is mostly due to cost, in which WSN nodes are the cheapest. They also have the least processing power and the smallest memory, battery and physical size. These limitations require WSN nodes to be very power efficient; since they are expected to have a long lifetime and may never have a chance to recharge. MANET nodes are usually more expensive and therefore have larger memory size and higher processing power. Since they are mobile, it is also assumed that they may recharge when necessary so energy efficiency isn't so much of an issue. MWSN nodes can be expensive depending on the application, their processing capability and memory resources are often reasonably good. Also, large batteries may be required to provide mobility, which will lessen the demand for energy efficiency in the communications system, as will the nodes' ability to travel to a power supply for recharging.

In addition to these factors, all three network types are decentralised and distributed in an ad hoc manner, which will require self-organisation amongst the nodes. Also, they will all need to overcome the challenges inherent in wireless transmission.

Overall, MWSNs share commonalities with both WSNs and MANETs, however the main attributes that define this type of network are its mobility, the use of a dedicated sink and each network often has a specific task. As MWSNs are a unique network type, they will require specific solutions to the research problems they create. These problems include MAC and routing protocols, localisation techniques, security, physical layer transmission, resource management, quality of service and many more.

Along with this introduction, the rest of this chapter will provide as a good foundational introduction to the topic of MWSNs in terms of applications, requirements, challenges, testing and implementation. It will also provide an in-depth