Anycast is a routing paradigm, which allows delivery of packets from one source to any destination out of the anycast group. Compared to the most common routing paradigm, unicast, which considers only one source and one destination, the anycast can be utilized when several nodes in the network serve the same role or offer the same service. Anycast has been applied to routing in wired networks, to provide efficient delivery when several possible destinations served the same role in the system. It has been utilized in IP networks for DNS server search, for FTP server search and mirroring, for load-balancing of web-servers, and has many potential applications in the wireless world. When there are several ad-hoc nodes serving as internet gateways in wireless ad-hoc network, or when there are several wireless nodes serving as data collection sinks in the wireless sensor networks, those are typical situations for utilizing anycast routing techniques.

Main goal in this study is to conduct a deep study into potentials of the anycast routing paradigm in the wireless world. Many real applications in the wireless networks utilize the main advantage of the links without wire, thus, mobility. However, mobility in the wireless network is also one of the main sources for link failures and has tremendous impact on the overall performance of the network. The conducted research is on the routing techniques, which consider the characteristics of the network as the network density and mobility.

The thesis is logically separated into two core parts of investigation.

The first part exploits the network density of the wireless ad-hoc networks by considering count of possible routes from source to destination. This is built on the theoretical study of the network connectivity. The probability of the connected link is evaluated through simple one-dimensional model and the relation between probability of the connected link and the mobility of nodes is shown, as well as between the transmission radius and the number of neighbors, thus density.

Furthermore the influence of the anycast on the probability of the connected route from random source to the destination is investigated. When there are several potential destinations in the network, the probability of the connected route from source to any destination is significantly increased. Based on this theoretical study, anycast routing protocol, which considers the count of routes in the network, is designed. The performance of this protocol and impact of the mobility and number of anycast nodes on the overall performance is thoroughly evaluated. The proposed protocol is compared with other anycast routing protocols and it is shown that considering count of routes in the mobile environment leads to increase of the reliability of the network as the denser areas have higher probability of connected route to the destination.

In the second part of the thesis, the focus is on the utilization of anycast routing techniques in the wireless sensor networks. It this case, anycast group is created by multiple data sinks collecting sensed data from the network.

At first, the application scenario, where the proactive anycast routing techniques can be utilized, is discussed. Such application is animal habitat monitoring or mass human probe system, where sensor nodes are mobile. This application is targeted with an aim of energy efficient routing in mobile environment with high network reliability and relatively low end-to-end delay.

Furthermore, distributed function, which describes the transfer of heat between molecules in the nature for routing in the wireless sensor networks, is utilized. This distributed function naturally considers the density of the network and allows anycast routing. In the theory of heat transfer, the temperature conductivity is the main characteristic of the chemical substance, which directly influences how much temperature will be transferred from one substance to another. Based on this knowledge, the characteristics of nodes are mapped to this value. To prove this concept, Temperature exchange based Energy Adaptive Routing (TEAR) protocol for wireless sensor networks is designed and the conductivity value is mapped to a relative residual energy of the sensor node. Thorough evaluation of the concept is provided through comparison with other potential candidates for mobile sensor networks.

The thesis is organized into five chapters, starting by an introduction, and terminated by a conclusion.

Chapter 1 describes the objective on this study by introducing the main challenges in wireless ad-hoc and sensor networks. Then it also discusses the potentials and main usages of the wireless ad-hoc and sensor networks.

Chapter 2 discusses routing techniques in Wireless Ad-hoc and Sensor Networks and provides classification of the
routing techniques in the wireless ad-hoc as well as sensor networks. It firstly classify the routing approaches based on their features into categories and describes the main advantages and disadvantages of each type. It also provides overview of the main routing protocols in the field and discusses their features. In this chapter the motivations behind this research are explained and the main challenges are introduced.

Anycast routing in wireless ad-hoc networks is investigated in Chapter 3 of the thesis. Firstly, the connectivity problem in dynamic wireless ad-hoc networks is analyzed and the relation between the network density, mobility and connectivity is drawn. The principal advantage of anycast compared to traditional unicast approach is also shown.

In this chapter, a density-aware routing based on the counting of possible routes towards the destination is proposed. The utilization of this algorithm in the wireless ad-hoc networks is described and the comparison with other routing protocols, which are suitable candidates for such mobile network with multiple anycast group members, is shown.

Temperature transfer based Routing in Wireless Sensor Networks is investigated in Chapter 4. Firstly, the application of wireless sensor network and the motivations behind that idea are discussed. Then, the theory of thermal fields from thermodynamics is introduced and the main features of this theory are studied when applied to wireless networks.

This theory is adapted to the residual energy of the sensor nodes and the overall idea is wrapped into the novel routing technique. Also, the performance comparison with other routing protocols for mobile environment shows that this routing technique performs very effectively and saves energy of the sensor nodes when adapted to the residual energy.

The thesis is concluded in Chapter 5. It summarizes the research work presented in this thesis. In detail, it concludes the main results from study in this thesis and discusses about overall outputs and its usefulness. Firstly, it sums up the result of the research study about utilization of anycast in wireless ad-hoc networks, when considering density of the network as important factor directly influencing the overall network connectivity in dynamic networks.

The impact of density on the network performance through count of routes, when different amount of anycast members in the network, is also shown. The route count based anycast techniques in dynamic ad-hoc networks can significantly increase the network performance, thus offer more reliable network. In the latter part, the usefulness of the theory of thermal fields is discussed when applied to the routing in sensor networks. This algorithm is adapted to the node’s characteristics and energy adaptive anycast routing protocol in the wireless sensor networks is proposed. In the conclusion, the usefulness of this technique for certain applications in the wireless sensor networks is also discussed.