The project deals with multi-hop wireless networks with broadcast radio transmission serving multicast packet streams. The last term means that a packet stream generated at a given node (source) is in general destined to more than one destination (sink). The term “mesh”, in turn, means that the network connects a large number of nodes, and each node is connected (in a wireless way) with several neighbors. Because of that, the considered networks apply multi-hop routing: in general, on its way to the appropriate sinks, each packet is transferred from its source via a sequence of intermediate nodes. As the network nodes utilize radio transmission to send the signals, a packet sent from a node transmitter is actually broadcast so that it may be simultaneously received and decoded by all the neighbors of the transmitting node. Clearly, this feature, not present in the wired networks, is extremely useful in realizing multicast packet streams.

Important examples of the networks considered in project are Wireless Mesh Networks (for example providing affordable Internet access for local communities) or recently emerging wireless sensor networks (for example applicable in the Internet of Things and Smart City projects).

The main purpose and goal of the project investigations is to develop a rigorous yet algorithmically effective comprehensive theoretical framework (model) for multicast packet transfer optimization in the considered kind of networks. It should be noted that such a framework has not been elaborated so far, and its development will require advanced research means since including the multicast feature into traffic optimization modeling of multi-hop wireless networks requires substantial, non-straightforward extensions of the corresponding optimization models existing for the unicast traffic (i.e., assuming single-destination packet streams). In order to achieve computational efficiency, the necessary extensions require methods of combinatorial optimization and integer programming. The basic scientific methodology of the project will consist in applying multicommodity flow theory to formulating (in the language of *mixed-integer programmming*) optimization problems for the considered wireless networks, and in elaborating specialized methods and algorithms for resolving the problems based on a general (and most effective) approach called *branch-and-bound* that is available in commercial optimization solvers. The actual approach applied in the project will in fact make use of enhancements of the branch-and-bound method collectively termed *branch-and-price-and-cut*. The enhanced approach will require original (specific to the considered optimization problems) algorithms for finding compatible sets (of node transmissions) by means of advanced *column and constraint generation* methods of linear programming, unavoidably using difficult pricing problems, as well as algorithms for generating *valid inequalities* in order to strengthen the optimization problem formulations. Additionally, in order to shorten the computation times, specialized heuristics supporting branch-and-bound will be introduced. Finally, combinatorial approaches for modeling and generating multicast trees (*arborescences* in terms of graph theory) and computing packet transfer scheduling (*job scheduling* in terms of combinatorial optimization) will be applied.

The main reason of undertaking the described research area is an observation that elaborating a comprehensive and computationally efficient optimization model for multicast traffic optimization will allow for fast (as compared with simulations) and reliable assessments of the performance bounds and traffic throughput benefits from applying multicast packet transfer protocols in Wireless Mesh Networks and in multi-hop wireless sensor networks. This will allow for identifying benefits in traffic handling resulting from introducing multicast transfer in place of commonly used unicast transfer for multicast applications, and, in consequence, to identify applications whose traffic would substantially benefit from introducing multicast transfer. Another important motivation is that the project is scientifically challenging and thus interesting to work on.

In the scientific aspect, the project results will contribute to developing advanced optimization methodologies applicable to wireless networks and, more broadly, to developments in operations research. Original achievements of our investigations will be presented at highly ranked conferences and published in leading scientific journals and thus will become known to appropriate research communities. In the practical aspect, the comparative numerical studies undertaken within the project can contribute more common usage of multicast packet transfer protocols in wireless networks what can be advantageous for their evolution.