Information hiding in chosen constrained network models

Abstract

This thesis focuses on securing some protection aspects of communication in different network models. For the popular SINR model, different algorithms are presented for blocking the wireless signal at some chosen fragments of space, called *restricted areas*, using the *protective jamming*. This approach utilizes jamming stations, which generate interference that floods the restricted areas, blocking the signal of the network being protected. The algorithms are designed to maximize the *coverage* of the network - the value that allows measuring the negative impact of jamming on the network reception zones outside of restricted areas. Moreover, as the secondary goal, they target minimizing energy usage by the jamming networks. The solutions for this problem are presented for 1D and 2D versions of the network model.

In the 1D SINR part, the thesis presents multiple algorithms for the uniform network model, wherein all stations transmit with the same power. Two basic algorithms apply a positioning scheme for the restricted area represented by one or two barrier points but with some limited guarantees about the coverage effectiveness of the solution. The precise positioning algorithm is also described, which applies the procedure with a potentially high number of iterations to place the jamming stations but guarantees almost perfect coverage of the solution. For the 1D non-uniform model, there are two algorithms. One is based on single-side jamming with a high-power jamming station. The second one utilizes the noisy-dust strategy to position many jamming stations with relatively small power - effectively flooding the restricted area with interference. This algorithm has the property that with the decrease of jamming station power and increase of their number, the overall energy utilization converges to zero. A variant of the noisy algorithm is presented, which simplifies the positioning scheme but increases energy utilization.

The thesis defines particular types of restricted areas for the 2D SINR model, wherein the problem complexity increases substantially. For the uniform 2D networks, an algorithm is presented that allows for jamming the restricted areas surrounding the spaces shaped as convex polygons. It presents how to utilize this algorithm for the areas surrounding circular shapes and the experimental analysis of its effectiveness. The noisy-dust extension is presented for the non-uniform model, wherein stations with small powers are positioned inside the hexagonal grid, tiling the restricted areas. The algorithm shows its 1D version property of reducing the overall energy usage of the jamming network with a decrease in the jamming stations' powers, arbitrarily close to zero. Coverage, measured experimentally, also shows the high effectiveness of this algorithm.

The thesis investigates the problem of hiding the number of stations executing some types of protocols for the single-hop networks in the beeping model. The *size-hiding* property is defined, based on the popular *differential privacy*, along with the universal algorithm, which can be used as a pre-processing step for chosen types of protocols. The limitations of this universal algorithm are discussed and compared with the size-hiding properties of an algorithm from the literature.

The aforementioned problem is generalized in the last part of the thesis, wherein preliminary studies for hiding network details and executed algorithms facing an adversary observing the execution in a multi-hop network are presented. We present an extensive taxonomy of the considered model, including the capabilities of the adversary and network configurations. We also presented two general algorithms for chosen model settings.

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