# Scheduling with interference constraints in wireless networks*

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Signals sent by different sources in multipoint radio networks need to be coordinated as simultaneously transmitted signals interfere with each other. If too many signals are sent at the same time in the same region of the network then none of them might get through because the interference is too high. Signals might get scheduled simultaneously, however, if they are exchanged in network regions that are sufficiently far apart so that the interference is relatively low. In order to achieve a good throughput one needs to schedule the signals carefully. The Media Access Control (MAC) layer is responsible for this important task in today's wireless communication networks. It provides single-hop full-duplex communication channels in multipoint networks to higher layers of the protocol stack. In this paper, we study the task of the MAC layer from an algorithmic point of view. We investigate scheduling algorithms that provide a set of channels between specified pairs of nodes in a wireless network.

In the *interference scheduling problem*, one is given a set of $n$ communication requests described by pairs of points from a metric space. The points correspond to devices in a wireless network. In the *directed version* of the problem, each pair of points consists of a dedicated sending and a dedicated receiving device. In the *bidirectional version* the devices within a pair shall be able to exchange signals in both directions. In both versions, each pair must be assigned a power level and a color such that the pairs in each color class can communicate simultaneously at the specified power levels. The feasibility of simultaneous communication within a color class is defined in terms of the Signal to Interference Plus Noise Ratio (SINR) that compares the strength of a signal at a receiver to the sum of the strengths of other signals. This is commonly referred to as the "physical model" and is the established way of modelling interference, see, e.g., [1], [2], [3], [4].

We study *oblivious power assignments* in which the power value of a pair only depends on the distance between the points of this pair. We prove that oblivious power assignments cannot yield approximation ratios better than $\Omega(n)$ for the directed version of the problem, which is the worst possible performance guarantee as there is a straightforward algorithm that achieves an $O(n)$-approximation. For the bidirectional version, however, we can show the existence of a universally good oblivious power assignment: For any set of $n$ bidirectional communication requests, the so-called "square

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root assignment" admits a coloring with at most $\mathrm{polylog}(n)$ times the minimal number of colors. The proof for the existence of this coloring is non-constructive. We complement it by an approximation algorithm for the coloring problem under the square root assignment. This way, we obtain the first polynomial time algorithm with approximation ratio $\mathrm{polylog}(n)$ for interference scheduling in the physical model.

# References


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