Maximum Matching in Multi-Interface Networks*

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Abstract. In heterogeneous networks, devices can communicate by means of multiple wireless interfaces. By choosing which interfaces to switch on at each device, several connections might be established. That is, the devices at the endpoints of each connection share at least one active interface.

In this paper, we consider the standard matching problem in the context of multi-interface wireless networks. The aim is to maximize the number of parallel connections without incurring in interferences. Given a network $G = (V, E)$, nodes $V$ represent the devices, edges $E$ represent the connections that can be established. If node $x$ participates in the communication with one of its neighbors by means of interface $i$, then another neighboring node of $x$ can establish a connection (but not with $x$) only if it makes use of interface $j \neq i$. The size of a solution for an instance of the outcoming matching problem, that we call Maximum Matching in Multi-Interface networks ($3MI$ for short), is always in between the sizes of the solutions for the same instance with respect to the standard matching and its induced version problems. However, we prove that $3MI$ is \textit{NP}-hard even for proper interval graphs and for bipartite graphs of maximum degree $\Delta \geq 3$. We also show polynomially solvable cases of $3MI$ with respect to different assumptions.

1 Introduction

Wireless networks have been deeply considered as one of the most interesting topics from both practical and theoretical points of view. One of their more challenging characteristics is certainly related to the heterogeneity of the involved devices that might interact in order to exchange data. Wireless networks are, in fact, composed of devices with different capabilities like computational power, energy consumption, radio interfaces, supported communication protocols, and so forth. In this paper, we are interested in devices equipped with multiple interfaces (e.g., Bluetooth, WiFi, GPRS). Connections among devices might be accomplished by means of different communication networks according

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to connectivity and quality of service requirements. The selection of the most suitable interface for a specific connection might depend on various factors. Such factors include: its availability in specific devices, the required communication bandwidth, the cost (in terms of energy consumption) of maintaining an active interface, the available neighbors, and so forth.

We study communication problems in wireless networks supporting multiple interfaces. In the considered model, the input network is described by a graph \( G = (V,E) \), where nodes \( V \) represent the set of wireless devices and \( E \) is the set of possible connections according to the devices’ proximities and the available interfaces that they may share. Each \( v \in V \) is associated with a set of available interfaces \( W(v) \). The set of all the interfaces available in the network is then determined by \( \bigcup_{v \in V} W(v) \); we denote the cardinality of this set by \( k \). We say that a connection is satisfied (or covered) when the endpoints of the corresponding edge share at least one active interface. In this setting, we study the problem of establishing the maximum set of communication edges without incurring in interferences. We assume that two communications/edges do interfere if they share a node or if they are activated by means of the same interface and connected by one edge. Note that, in the latter case, i.e., when two edges at distance one are activated by means of the same interface, then also the edge in the middle is activated by means of the same interface, since its endpoints do share a common active interface. An example of such a behavior is shown in Figure 1. The two black full edges represent a possible solution to 3MI if the black edge on the top is activated by means of the WiFi interface and the one on the bottom by means of the GSM interface. If both edges are activated by means of the GSM interface, then it will not represent a feasible solution since the connection between the laptop and the PDA on its top will be activated as well.