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Quantum circuit physical design methodology with emphasis on physical synthesis

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Abstract In our previous works, we have introduced the concept of "physical synthesis" as a method to consider the mutual effects of quantum circuit synthesis and physical design. While physical synthesis can involve various techniques to improve the characteristics of the resulting quantum circuit, we have proposed two techniques (namely gate exchanging and auxiliary qubit selection) to demonstrate the effectiveness of the physical synthesis. However, the previous contributions focused mainly on the physical synthesis concept, and the techniques were proposed only as a proof of concept. In this paper, we propose a methodological framework for physical synthesis that involves all previously proposed techniques along with a newly introduced one (called auxiliary qubit insertion). We will show that the entire flow can be seen as one monolithic methodology. The proposed methodology is analyzed using a large set of benchmarks. Experimental results show that the proposed methodology decreases the average latency of quantum circuits by about 36.81 % for the attempted benchmarks.

Keywords Quantum computing · Physical design methodology · Physical synthesis

1 Introduction

The planar CMOS process has been the basis for the semiconductor industry for the past 40 years. However, it seems that we are beginning to reach the fundamental limits of the materials used in the planar CMOS process. Further improvements in the planar

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