Modelling Implementation Imperfections in Quantum Network Optimizations

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Abstract - Our recent paper provides a detailed survey of the work on Post-Quantum (*q-*) and Quantum Cryptography schemes (s^{ch}*'s*) and emphasizes their applicability in 7G networks. A comprehensive insight is provided into the s^{ch} 's which could possibly replace RSA and ECC s^{ch} 's.

The paper argues that most probably post-quantum s^{ch} 's will dominate 6G networks and due to implementation complexity quantum solutions will be fully employed in 7G.

Since the paper focuses on the cryptography algorithms (a^{lg}*'s*) as a follow up, in this paper, we survey in detail the work on enabling technologies for the practical implementation of these a^{lg}*'s* including the most important segments of quantum hardware (h^{rdw}) in 7G. As always in engineering practice practical solutions are a compromise between the performance and complexity/cost of the implementation. For this reason, in addition to the survey of the existing work, as the main contribution the paper presents a network optimization framework that includes implementation imperfections.

The paper is organized as follows: In Section II we start with elementary component of the system, q-bit physics. Work on q- h^{rdw} building blocks, q-computing gate libraries, are surveyed in Section III including q-memories surveyed in Section IV. Section V surveys several implementation examples of q-key distribution (QKD). Finally, Section VI presents a q-network optimization framework that includes implementation imperfections.

The paper is designed to be used as a seed material for setting up a research group in this field, be a base for the initial research papers of the group and the first project proposals to NSF solicitations in this field.

Index Terms- Q memories, Qubit Physics, Quantum Circuit Libraries, Implementation Examples of cv QKD -h^{rdw}

NOTE: At this point we would like to point out that 6/7G n^{et}*'s will be, as all previous generations, open standards enabling competition between different technical solutions and standardizing a minimum of the system parameters that will be required to secure the compatibility of these solutions. For these reasons here we do not propose specific solutions for different problems that 6/7G* n^{et}*'s will face, but rather a performance/complexity comparison of a variety of technology enablers to choose from when building up a specific solution*

NOTE on the writing style: In this paper we use specific notation where some characteristic terms (t^{rm}*'s), often repeated in the text, are replaced with corresponding acronyms representing the original* t^{rm} *and its derivatives (conjugations). This approach (compressed language) enables more precise characterization of the system (*s^{yst}*) processes (*p^{ro}*'s) and operations (*o^{per} *'s) and a specific* t^{rm} *sounds more like a* s^{yst} *parameter that can be used more efficiently throughout the text. While this opens new options for the* s^{yst} *presentation the writing occasionally sounds like an AI synthesized text. We hope the readers will easily get used to this style. In anticipation of what is coming in the field of ML and AI, this approach of integration of classical language and language of acronyms, might be further studied to increase the efficiency of Human-AI communication, maybe in the long run resulting in H-AI language. Light acronymization used in this paper, only for illustration purposes, may be further intensified. The depth of acronymization would depend on specific application.*