Quantum Computing in 7G Networks for Optimum Intersystem Integration: Survey

Savo Glisic, Worcester Polytechnic Institute, Massachusetts
(sglisic@wpi.edu; savo.glisic@ieee.org)

Abstract- Every new generation of mobile networks (n^{et}*'s*) brings significant advances in two segments, enhancement of the n^{et}*'s* parameters within the legacy technologies and introduction of new technologies enabling new paradigms in designing the n^{et}s. In the first class of enhancements the effort is to increase data rates, improve energy efficiency, enhance connectivity, reduce data transmission latency etc. In the second class of innovations for 6G and 7G, we anticipate focus on optimum integration of ML (AI in general) and quantum (q-) computing (QC) with the continuous interest in the satellite n^{et}*'s* for optimal q-key distribution (QKD). By introducing q-technology 7G will be able to speed up computing processes in the n^{et}, enhance n^{et}-security as well as to enable distributed QC, which is a new paradigm in computer sciences.

Using advanced networks as a basic ingredient of intersystem integration, here we focus only on the second segment of anticipated innovations in networking and present a comprehensive survey of the subset of technology enablers for the above concept with special emphasis on the interdependency of the solutions chosen in different segments of the network. In Section I, we present a number of anticipated 6G/7G network optimization examples resulting in new paradigm of network optimization indicating a need for QC and QC based optimization algorithms. In Section II we survey work on continuous variable quantum technology approach since it seems more feasible for practical implementations. Section III discusses the problem of entanglement which is an essential component of quantum cryptography.

Entanglement distribution and routing in q- n^{et}*'s* discussed in Section IV together with optimum n^{et} topology design in Section V. Implementation of QKD is discussed in Section VI and energy and decision latency efficiency in Section VII. In Section VIII we come back to network optimization and propose explicitly optimization frame work satellite network topology optimization in Section VIIIA, cost optimization in Section VIIIB and optimum resource allocation in q-network in Section VIIIC.

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: Quantum Computing (QC), 7G Networks, Quantum Key Distribution QKD), Continuous Variable QC

NOTE on the writing style: In this paper we use specific notation where some characteristic terms, often repeated in the text, are replaced with corresponding acronyms representing the original term and its derivatives (conjugations). This approach (compressed language) enables more precise characterization of the system (s^{yst}) processes and operations and a specific term sound 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 HAI language. Light acronymization used in this paper, only for illustration purposes, may be further intensified. The depth of acronymization would depend on specific application.