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Genuine and optimized entanglement-based quantum networks

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Abstract

We consider entanglement-based quantum networks, where pre-shared multipartite entangled states -that can be generated prior to any network request- serve as a resource to fulfill general network requests on demand. This offers new possibilities and features such as speeding up network requests, and network optimization independent of the underlying physical structure. The main challenge is to identify suitable resource states shared between network devices that can be stored, and then modified by local means such that the desired output state (and hence the desired network functionality) can be guaranteed. This minimizes generation times for target states, and allows for optimizing network structures that are independent of the underlying physical network topology. We show how to design and optimize such entanglement-based networks, and demonstrate a storage advantage when using multipartite entangled states. Finally, we discuss how to make quantum networks genuine quantum by providing them with the possibility of handling superposed tasks and superposed addressing via a quantum control register. This allows one e.g. to prepare superposition of different target states, or to send information among a superposition of different paths.