

On Quantum Network Coding

Emina Soljanin

Rutgers University

We mathematically represent communication networks (like their transportation or fluid counterparts) as directed or undirected graphs. Results originally derived for fluid flows in networks of pipes or vehicle movements on highways hold for data packet flows through communication networks. However, the reverse does not hold because classical (as opposed to quantum) information allows duplication, merging, and processing in ways that (non-quantum) physical entities cannot. We examine quantum multicast networks where multiple sources generate quantum states that must simultaneously reach several receivers. Our findings reveal that, beyond their apparent similarity to multicommodity flow problems, quantum networks exhibit behaviors akin to classical communication networks. Specifically, we demonstrate that lossless compression of multicast quantum states is possible, significantly reducing the edge capacity requirements for multicast transmission.

In Special Session 40 on Network Coding and Related Fields at the Mathematical Congress of the Americas 2025.