# MCBGD: Multi-Path Cluster-Based Graph Distribution for Scalable Measurement-Based Quantum Computation

Guanting YU*, Yongzhe LIN**, Yiyang YU**, Zisen WEI**, Xiaofeng JIANG**
*Institute of Advanced Technology, University of Science and Technology of China, Hefei, China
**Department of Automation, University of Science and Technology of China, Hefei, China
(ygt991129, lyz, yuyiyang, wzs001)@mail.ustc.edu.cn, jxf@ustc.edu.cn

***Abstract*—This paper proposes Multi-path ClusterBased Graph Distribution (MCBGD), a novel framework enabling scalable Measurement-Based Quantum Computation (MBQC) in resource-constrained quantum networks.To address the challenge of large-scale cluster state requirements in the NISQ era—where quantum computers typically handle only a few dozen qubits while MBQC demands hundreds or thousands —MCBGD introduces a hybrid decomposition strategy that separates cluster states into horizontal and vertical components. The framework features a genetic multi-path routing algorithm for optimized horizontal cluster deployment across qubit availability, channel fidelity, and latency constraints, combined with an entanglement-efficient vertical segmentation scheme. NetSquid simulations on grid networks demonstrate MCBGD's significant advantages in both fidelity and resource efficiency compared to existing methods.The proposed approach provides a practical pathway for implementing quantum algorithms on distributed quantum processors with limited resources.**

***Keyword*—Quantum Networks, Measurement-Based Quantum Computation, Graph State Distribution**

**Guanting YU** received the B.E. degree in computer science and technology from the University of Science and Technology of China, Hefei, China, in 2022, where he is pursuing the M.E. degree in computer technology. His research interests include the quantum communication network and graph states.

**Yongzhe LIN** received the B.E. degree in automation from ShanDong University, Jinan, China, in 2023. He is curently pursuing the M.E. degree in computer technology with the Department of Automation, University of Science and Technology of China, Hefei, China. His research interests include quantum machine learning.

**Yiyang YU** received the B.S. degree in automation from the University of Scienceand Technology of China, Hefei, China,in 2024, where he is currently pursuing the M.E. degree in control science and engineering. His research interests include the quantum communication network and blind quantum computation.

**Zisen Wei** received the B.S. degree in automation from the University of Scienceand Technology of China, Hefei, China,in 2025, where he is currently pursuing the M.E. degree in control science and engineering. His research interests include the quantum communication network.

**Xiaofeng Jiang** (Member, IEEE) received the B.E. and Ph.D. degrees in information science and technology from the University of Science and Technology of China, Hefei, China, in 2008 and 2013, respectively, where he is currently an Associate Professor with the School of Information Science and Technology. He is also with the Institute of Artificial Intelligence, Hefei Comprehensive National Science Center. His recent research interests include discrete event dynamic system, tensor analysis and big data, future network.