Quantum Virtualization for Scalable Fintech Workflows:

Multi-Tenant qVMs in Quantum Cloud Environments

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***Abstract*—As financial technology (FinTech) systems evolve toward increasingly sophisticated, data-intensive, and latency-sensitive computational pipelines, quantum computing is emerging as a transformative enabler for optimization, security, and high-performance analytics. However, practical deployment remains limited by scarce quantum hardware, noisy environments, and the need to support heterogeneous users with diverse workloads. This study introduces a quantum virtualization framework that leverages multi-tenant quantum virtual machines (qVMs) to provide scalable, flexible, and secure access to quantum resources in cloud-based environments. The proposed architecture virtualizes quantum hardware through layered abstraction, dynamic qubit allocation, and workload-adaptive circuit scheduling to support concurrent FinTech workloads such as portfolio optimization, fraud detection, blockchain verification, and quantum-safe cryptographic operations. Benchmark simulations demonstrate that qVM-enabled multi-tenancy improves hardware utilization by up to 40%, reduces queueing latency, and enables isolation between concurrent clients without compromising quantum circuit fidelity. These findings highlight the potential of quantum virtualization to accelerate the industrial adoption of quantum computing in the FinTech sector, enabling scalable, secure, and cost-efficient quantum-as-a-service (QaaS) ecosystems.**

The rapid expansion of financial technologies—ranging from algorithmic trading and decentralized finance (DeFi) to real-time risk modeling and fraud detection—has created an urgent need for computational systems capable of managing high-dimensional data under strict performance constraints [1]. Classical high-performance computing (HPC) and distributed architectures have supported these demands to an extent, yet they struggle with the growing complexity of global markets, the cryptographic challenges introduced by quantum adversaries, and the increasing demand for ultra-low-latency analytics [2]. Quantum computing offers a promising complement: its ability to explore exponentially large state spaces and accelerate certain optimization and sampling tasks positions it as a foundational technology for next-generation FinTech infrastructures.

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Despite this potential, widespread adoption is currently constrained by two structural barriers: limited quantum hardware availability and inefficient resource-sharing models [4]. Today's quantum processors are expensive, noisy, and have limited qubit counts, making it infeasible to dedicate entire devices to individual workflows. FinTech applications, however, often require simultaneous access by

