QUAPP - A CLOUD-HOSTED PLATFORM-AS-A-SERVICE FOR HYBRID QUANTUM-HPC COMPUTING

Quantum Application Cloud

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Introduction

Quantum computing is transitioning from theory to practical utility, with diverse hardware now accessible via cloud services. However, a key barrier remains: the lack of unified infrastructure bridging quantum research and production deployment.

Current quantum cloud platforms operate as isolated ecosystems, each requiring specialized expertise in provider-specific tools and workflows. This fragmentation forces researchers to spend time on platform adaptation rather than algorithmic innovation. The steep learning curve further challenges domain scientists without quantum computing backgrounds.

Research Question: How can we design a unified platform that democratizes access to heterogeneous quantum resources while reducing complexity through intelligent development assistance?

Our Contribution: We introduce Quapp Functions, a quantum computing platform that unifies access to diverse quantum environments with AI-assisted development capabilities. Key features include:

. (1).A Unified Gateway: Single abstraction layer accessing eight major quantum providers (superconducting, trapped-ion, and annealing architectures) without vendor-specific concerns
. (2).AI-Assisted Development: Large language model integration via Model Context Protocol, enabling context-aware quantum algorithm generation within an embedded JupyterHub environment
. (3).Enterprise-Grade Infrastructure: Multi-tenant workspaces, granular access control, quota-based resource allocation, and comprehensive auditing

We detail the system architecture, hybrid quantum-classical computation lifecycle, priority-based job scheduling, and real-time execution monitoring. Quapp Functions streamlines the pathway from algorithm conception through multi-platform execution and analysis.

Keywords: quantum computing platform, quantum cloud integration, AI-assisted quantum programming, hybrid quantum-classical systems, multi-provider quantum gateway.

Quapp: A Cloud-Native Platform for Quantum Computing

This poster presents Quapp, a cloud-native Platform-as-a-Service that simplifies quantum computing through an integrated environment for algorithm development, deployment, and execution.

Desgin Rationale

. Cloud-Native Paradigm: Enables elastic scalability and fault tolerance for unpredictable quantum job execution times and varying hardware availability
. Microservices Architecture: Isolates quantum execution, device management, organization governance, and billing into independently deployable and scalable services
. Provider Abstraction (Adapter Pattern): Encapsulates vendor-specific APIs behind unified interfaces, mitigating vendor lock-in and future-proofing against API changes
. Serverless Execution (FaaS): Eliminates infrastructure overhead while enabling fine-grained metering for multi-tenant cost attribution
. Event-Driven Scheduling: Accommodates asynchronous quantum computations with extended queue times on constrained hardware

Architecture

. Client Layer: Four interfaces—Quapp Function Portal (web management), Showcase Web App (demos), Quapp SDK (programmatic access), and AI-powered JupyterLab IDE. All requests route through REST/WebSocket API Gateway.
. Cross-Cutting Layer: Enterprise security, logging, and audit capabilities enforced consistently across services.
. Core Services: Quantum Execution (Functions, Jobs, Invocations), Device Management (provider integration, availability), Organization (Workspaces, Projects, Users), and Billing (Subscriptions, Quotas).
. Platform Layer: Knative serverless execution with Container Registry, integrating six providers: IBM Quantum, Azure Quantum, AWS Braket, D-Wave, Rigetti, and OQC. External services include AWS Cognito, Amazon SQS, Stripe, Kubernetes, and OpenTelemetry.

Job Scheduling

Priority queue system where high-priority jobs execute immediately; normal-priority jobs proceed when high-priority queues empty. Includes comprehensive retry logic and failure handling for QoS differentiation.

Contributions

. Multi-provider abstraction: write-once, execute anywhere
. Enterprise capabilities: multi-tenancy, RBAC, job-level cost tracking
. AI-assisted quantum code generation via Model Context Protocol

Future Work: Standardized provider authentication, fault-tolerant quantum computer support, and automated backend selection based on availability, queue depth, and gate fidelity.

Conclusion

Quapp is a cloud-native platform that simplifies quantum computing through an integrated environment for algorithm development, deployment, and execution. It abstracts hardware heterogeneity across six providers—IBM Quantum, Amazon Braket, Azure Quantum, Rigetti, D-Wave, and OQC—letting researchers focus on algorithms rather than infrastructure.

Key Contributions:

- Multi-provider abstraction enabling write-once execution across gate-based processors and quantum annealers
- Serverless deployment supporting Qiskit, Cirq, PennyLane, and Braket SDK
- JupyterHub integration bridging prototyping and production
- Enterprise capabilities: multi-tenancy, role-based access control, job-level cost tracking
- AI-assisted quantum code generation via Model Context Protocol

By lowering barriers to quantum programming, Quapp accelerates discovery of practical applications in optimization, cryptography, materials science, and pharmaceuticals—demonstrating that cloud-native principles proven in classical computing apply effectively to quantum infrastructure.

REFERENCES

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Illustration