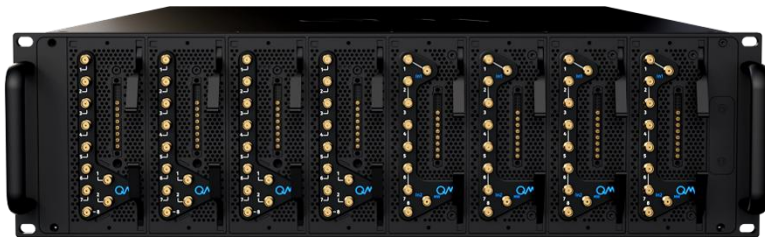


QUANTUM MACHINES' HYBRID CONTROL USES AMD TO REDUCE FRICTION IN QUANTUM COMPUTING



Quantum computing holds extraordinary promise, but today's quantum R&D is held back by friction. Long run times and latency can impede momentum. As qubits improve and systems scale, these challenges only intensify.

At the heart of the problem is disjointed control. Quantum operations often run on a completely different thread from the classical computations that support them. When quantum control units are poorly integrated with classical compute, performance suffers and iteration slows.

Quantum Machines set out to change that.

Hybrid Control Brings Classical and Quantum Computing Together

Hybrid Control is Quantum Machines' approach to harmonizing quantum and classical operations across software and hardware to reduce friction and unlock faster innovation. By tightly integrating classical computing into the quantum runtime itself, Hybrid Control allows builders to iterate at speed, resolve setbacks in real time, and bring ambitious quantum ideas closer to reality.

Central to this approach is the Pulse Processing Unit (PPU). The PPU is a purpose-built real-time processor that executes classical computations directly within the quantum control loop. It enables operations such as pulse processing, active reset, calibration routines, feedback, and other low-latency workflows that must happen deterministically while a quantum program is running.

This latency matters. Quantum operations are measured on nanosecond timescales and qubits rapidly decohere. By reducing latency and keeping critical computations inside the control loop, the PPU enables quantum systems to respond in real time and execute increasingly complex protocols.

At the hardware level, these PPUs are FPGA-based systems that translate digital code into the precise analog and digital signals that are required to control quantum hardware, whether that hardware lives in a vacuum chamber of trapped ions, neutral atoms, or other qubit technologies.

INDUSTRY

Quantum Computing

CHALLENGES

Quantum Machines needed to reduce latency and friction between quantum control and classical compute as quantum systems scale and workloads become more complex

SOLUTION

Quantum Machines uses AMD technology to power its Hybrid Control platform, bringing high-performance classical compute closer to quantum operations

RESULTS

With AMD technology, Quantum Machines can deliver low-latency feedback, real-time control and scalable compute for error correction and next-generation quantum systems

AMD TECHNOLOGY AT A GLANCE

AMD EPYC™ CPUs
AMD Versal™ adaptive SoCs

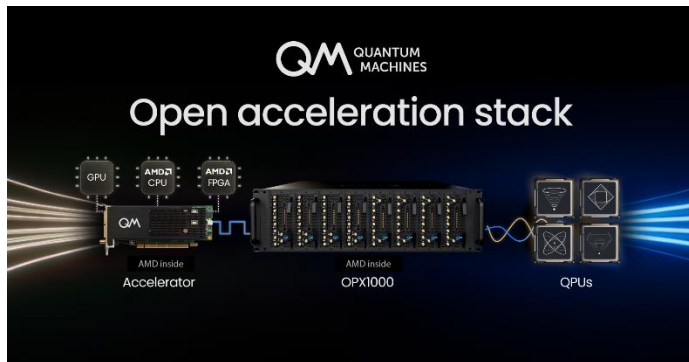
AMD Delivers Proven Compute Platform

Achieving this level of performance requires world-class classical computing hardware, and that's where AMD technology plays a critical role. Quantum Machines' Hybrid Control stack leverages multiple AMD platforms to span the full range of timescales required in quantum systems:

- **AMD adaptive computing devices** power real-time runtime pulse processing and computations at the 100–400 nanosecond scale. These FPGA-based devices enable ultra-fast feedback, decoding, and optimization during active quantum operations.
- AMD Versal™ adaptive SoC devices facilitate, QEC decoding and optimized, customer-specific computational workflows.
- **AMD EPYC™ CPUs** provide the high-performance classical compute backbone, enabling extremely low round-trip latencies for more complex processing outside the immediate quantum runtime.

Together, these AMD CPUs and adaptive SoCs form a unified classical computing fabric that seamlessly supports quantum operations, from nanoseconds to milliseconds.

“Hybrid control is doing classical computations fast on AMD technology, and then sending data back to the quantum computer,” explained product manager Ethan Baratz.



Why Hybrid Control Is Essential for Scaling Quantum Computing

Quantum computing doesn't replace classical computing, it complements it. Many quantum workloads depend on fast classical decision-making: decoding measurement results, running optimizations, and feeding new instructions back to the qubits before valuable quantum states decay.

This is especially critical for quantum error correction, which, today, is one of the biggest barriers to commercial-scale quantum computing. A single reliable logical qubit requires many physical qubits working together, coordinated by fast, trustworthy classical control.

“Moore's Law does not apply to quantum computing,” Baratz noted. “Quantum requires error correction and the ability to scale, connecting thousands of computers together.”

Hybrid Control, powered by AMD technology, makes that coordination possible. It allows Quantum Machines to accumulate data, perform rapid classical computations, and respond to the quantum system in real time, without overwhelming power budgets or physical infrastructure.

A Unified Computing Model for the Quantum Era

In a Hybrid Control system, users don't need to worry about where computation happens. Classical workloads may run on CPUs, GPUs, or within the quantum controller itself, depending on latency and performance requirements.

“When you run a task on a computer, you don't know if the data is going to the CPU, GPU, or QPU,” Baratz said. “The computation is optimized to do certain things.”

AMD performance leadership across CPUs and acceleration devices makes this flexibility possible. From high-performance computing layers down to nanosecond-scale runtime control, AMD devices enable Quantum Machines to deliver a tightly integrated, high-performance hybrid platform.

Looking Ahead

Quantum Machines is already thinking about the future, one where systems with tens of thousands of qubits are not just theoretical, but controllable.

“I'm looking forward to the day when we have 10,000 or 100,000 qubits to control,” Baratz said.

Reaching that scale will require powerful, efficient, and tightly integrated classical computing. With Hybrid Control built on AMD EPYC CPUs and Versal adaptive SoCs, Quantum Machines is laying the foundation for scalable, commercial quantum computing.

ABOUT QUANTUM MACHINES

Quantum Machines provides hardware and software solutions for quantum control and hybrid quantum-classical computing. The company's Quantum Orchestration Platform is designed to help researchers and developers control quantum processors, integrate classical compute into quantum workflows and support a range of qubit technologies. Its team includes quantum physicists, software and systems engineers, and chip designers working to advance quantum computing research and development.

ABOUT AMD

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