Quantum Computing for CPS: Workshop Agenda

Abhishek Dubey

College of Connected Computing
Institute for Convergent Software Integrated Systems (ICONS)
Vanderbilt University

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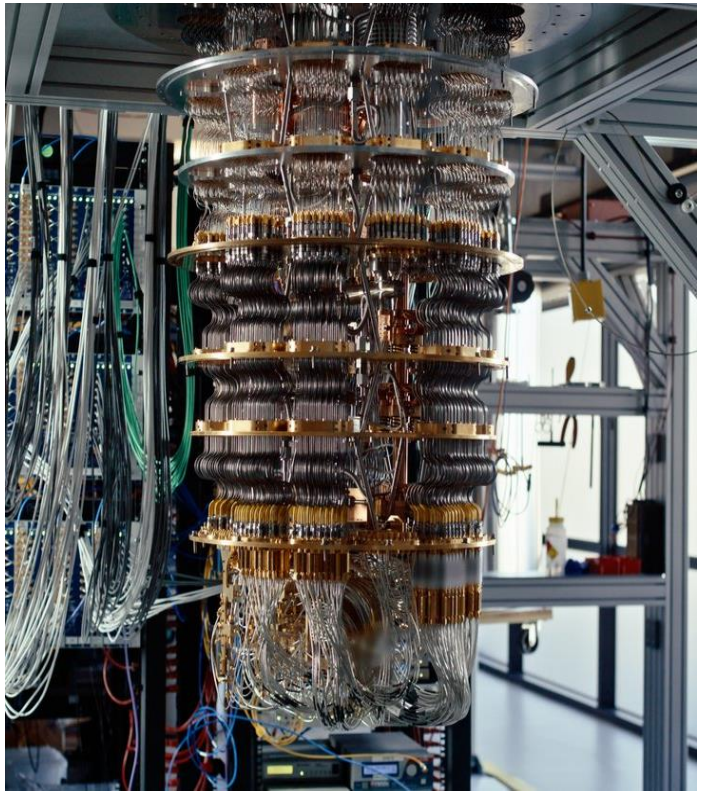
Quantum computing: state of the art

- **Core principle:** Quantum speedups come from problem structure and algorithms that exploit interference.
- **Demonstrated progress:** Advantages so far are in specialized sampling and quantum simulation.
- **Optimization today:** Practical advantage is still open; QOBLIB benchmarks quantum methods against strong classical solvers.



Google Quantum AI laboratory. 2029–2033 milestones are vendor and program targets, subject to validation

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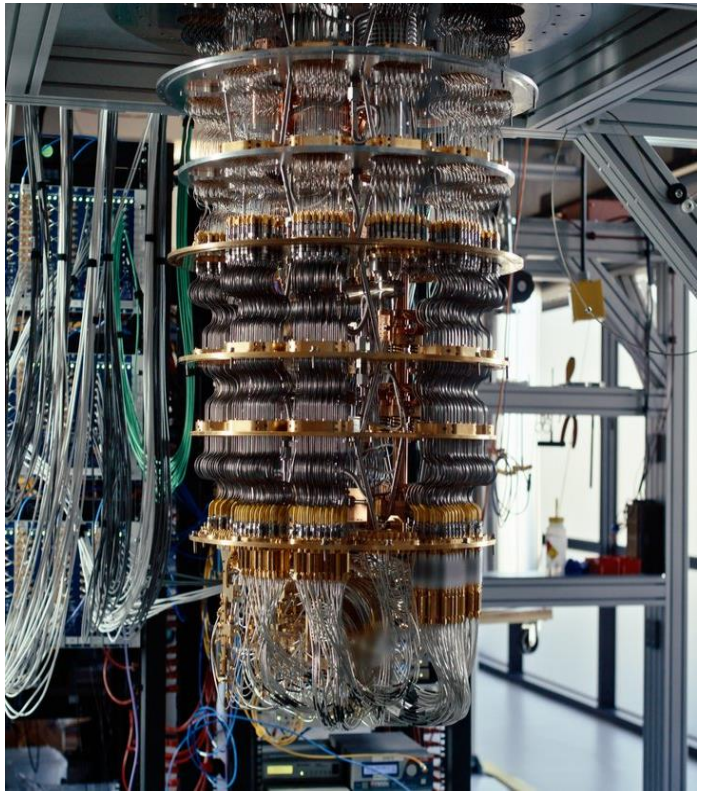
- **Optimization today:** Practical advantage is still open; QOBLIB benchmarks quantum methods against strong classical solvers.
- **Practical limits:** Hardware and error-correction overhead can outweigh modest theoretical speedups.
- **CPS opportunity:** Coupled uncertainties and many possible futures motivate sampling, planning and control research.
- **Central challenge:** Problem selection and encoding, judged on realistic CPS benchmarks of solution quality and total cost.



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A few exemplars

Planning and control

Contribution: Quantum optimization for black start and restoration, evacuation fleets under flooding, routing and scheduling cores; hybrid quantum–classical control and learning.

Challenge: Encoding and data loading; classical solvers still are much better at this (QOBLIB); quantum computing results are at toy sizes.

Risk, assurance and digital twins

Contribution: Quantum-enabled digital twins that screen scenarios days ahead; reachability and rare-event risk estimation.

Challenge: Circuit scale; probabilistic outputs; certifying a policy trained on sampled futures.

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Sensing, timing and coordination

Contribution: Quantum sensing embedded in CPS; timing and synchronization in distributed CPS (grid); structural monitoring.

Challenge: integration with CPS standards and certification.

Security

Contribution: Quantum-safe CPS security: post-quantum cryptography on embedded and legacy devices; quantum key distribution.

Challenge: Migrating long-lived fielded devices; key management at scale; latency budgets.

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Note that a quantum computer is itself a cyber-physical system: a noisy physical plant under closed-loop control, so the CPS toolkit applies to the machine as directly as the machine applies to CPS problems

Workshop 1, Day 1: Tuesday, January 12, 2027

- **Opening keynote, 40 min.** A short primer on quantum computing, then the state of the art in quantum optimization, including recent results.
- **Algorithms at two horizons.** Near-term hybrid classical–quantum methods, and a long-range view from an academic theorist on what is possible in 10–15 years.
- **CPS hard problems, 15-min talks.** Evacuation under flooding, wildfire hotbeds, black start and restoration, routing and scheduling, transportation coupling. The goal is to understand if the problem can be decomposed so a hybrid method applies?
- **Extended breakout, after lunch.** Short- and long-horizon quantum researchers with CPS problem owners; per problem: what, how (encoding), timeline, and the gap that unlocks it.
- **Close of day.** Translation to practice, a lighter session; scribes write summaries and slides overnight.

Workshop 1, Day 2, and what follows

Day 2: Wednesday, January 13, 2027 (half day)

- **Report-outs.** At least 20 minutes per group with discussion; the report's recommendations crystallize here.
- **Program-manager session.** NSF and DARPA: what have you heard, what do you still want to hear, which questions remain.
- **Adjourn.** Early afternoon; the report follows this agenda block by block.

Second workshop and the roadmap

- **Workshop 2, Quantum Sensing and Networking for CPS.** Proposed for April 2027, one day; date and venue to be confirmed.
- **Roadmap.** One combined 5–10-year quantum-CPS roadmap: report-out at CPS-IoT Week. A published article at TCPS