How to become quantum ready

Learning objectives

By the end of this module, you should be able to:

- Describe the steps business leaders can implement now to prepare to use quantum computing in workflows in the future.
- Explain the concepts of quantum readiness and quantum potential.
- Explain the mission of quantum ecosystems.
- Locate the resources for staying current about quantum computing technology and the latest developments and breakthroughs.

Solving valuable problems with quantum technology

Many businesses would leap at the chance to go back in time to capitalize early on yesterday's game-changing technologies, such as the internet. The chance to get ahead of the competition is here again with quantum computing. The technology is maturing, and now is the time to build your quantum skills and understand quantum's immense potential for addressing computationally intensive problems.

In the era of quantum computing, system performance will be key in achieving full quantum potential and scale—when we can definitively demonstrate, in certain use cases, a significant performance advantage over classical computers. Specifically, when a quantum computation is either hundreds or thousands of times faster, needs a smaller fraction of the memory, or makes something seemingly impossible possible. Our

work with UC Berkeley demonstrates the power of currently available IBM Quantum processors to explore meaningful computations and realistic applications before the era of fault tolerance.

Quantum computers could soon solve valuable problems that have long challenged classical supercomputers. Governments and industry leaders worldwide are already exploring potential use cases in healthcare, materials science, machine learning, and more. Organizations that dive in now and become quantum ready will have a distinct advantage as these technologies evolve.

Quantum readiness

Quantum readiness is a continuously evolving measure of organizational proficiency in quantum computing strategy, technology and operations. It characterizes the company's progressive capabilities to leverage quantum technology to disrupt industries, create competitive advantage, and respond to threats from quantum-savvy competitors.

Click on the triangles below to see the capabilities of quantum ready organizations.

- ▶ Strategy
- ▶ Technology
- ▶ Operations

As described in *The Quantum Decade*, quantum readiness is crucial because we help clients visualize and prepare to use the future computational power of quantum computing. IBM works with clients to build their skills and explore use cases with high business impact. Key insights can already be developed by executing use cases that are small enough to run on current quantum computers. As the technology continues to improve, our clients will grow the scope of these use cases and use quantum computing for business advantage.

In the next sections, we describe three ways organizations can build their capacity to disrupt industries, create competitive advantage, and respond to threats from quantum-savvy competitors. Organizations can invest in quantum workforce development, identify quantum use cases to capture business value, and protect against quantum threats.

Talent transformation

Quantum computing is completely different from conventional computing, right down to replacing the bit, the base unit of information. People who are open to new problem-solving approaches should be at the top of your list. Becoming quantum ready involves upskilling across various domains (see image below).

People in your organization will see their quantum skills develop rapidly through routine contact with our in-house talent through the IBM Quantum Network. Member workforces gain access to advanced, in-depth training programs and individualized, and live talks from IBM Quantum experts. Learn more about the IBM Quantum Network.

Use case selection

The path to quantum adoption requires informed decisions about which quantum computing use cases have the potential to deliver the most business value.

What makes for a good quantum use case?

A good use case is one that is expected to be of strategic importance to the business and that can be explored with available Qiskit routines — while also offering the flexibility to experiment as quantum technology advances. A risky or poor choice for a use case is one that requires a certain level of performance or relies on nascent academic theories to generate solutions that address a mission-critical or peripheral business problem.

Take a moment to reflect on the industry applications of quantum computing in the previous module and think of your own business problems. Click on the triangles below to reveal factors that affect the potential for quantum computing to deliver business value. Consider these as you evaluate your business use case.

- ▶ Good choices
- ▶ Risky choices
- ▶ Poor choices

Responsible Quantum Computing

A use case should deliver business value and be responsible for its conception and execution. At IBM Quantum, we are committed to Responsible Quantum Computing, which is understood as developing quantum computing with an awareness of its power and potential impacts.

IBM Quantum upholds five principles for developing quantum responsibly:

– Make a positive societal impact.

– Explore use cases with foresight.

– Promote our products accurately.

– Make consistent and transparent principled decisions.

– Build a diverse and inclusive quantum community.

We've built responsibility into our business practices. We have language in our contracts that requires IBM Quantum clients to use our quantum computers responsibly, and that they not use our quantum computers for nefarious or illegal purposes. We call these our responsible use and our acceptable use clauses.

As members of the quantum computing community, you make important decisions around which use cases you are exploring. We hope that you will participate in the responsible development of quantum computing, too.

Becoming quantum safe

One of the ways in which we are protecting against the irresponsible development and deployment of quantum is with our IBM Quantum Safe offering, which helps organizations safeguard their data and systems from quantum cyberattacks.

As quantum computers mature, they will present challenges to the classical encryption algorithms and protocols on which modern cybersecurity relies. While the risks are likely still years away, cybercriminals could be using “harvest now, decrypt later” schemes to harvest data today and store it until a powerful enough quantum computer can decrypt it. Meanwhile, data that clients are storing today may need to remain confidential for periods of up to 30 years or more.

IBM has been pioneering in the research and development of quantum-safe security solutions. In collaboration with academic and industry partners, IBM researchers developed three of the four quantum-resistant encryption methods that the US Department of Commerce's National Institute of Standards and Technology (NIST) selected to use as part of its post-quantum cryptographic standard, which they expect to implement by 2024. IBM researchers have also submitted three new digital signature schemes as candidates for standardization. We are so confident in these quantum-safe cryptographic solutions that we have already begun implementing them in our infrastructure, such as in z16, the world's first quantum-safe mainframe, and IBM Cloud. Now, with IBM Quantum Safe technology and services, we are leveraging that expertise to help clients make the transition to quantum-safe cryptography.

Learn more about how we are supporting organizations on their journey to quantum safe on the IBM Quantum Safe website.

The IBM Quantum Network

IBM supports our clients to become quantum ready through the IBM Quantum Network.

The IBM Quantum Network is a worldwide collective shaping the future of quantum computing. The 250+ partners in the Network include Fortune 500 companies, universities, laboratories, and startups, all helping to build a quantum economy.

The mission of the IBM Quantum Network is to:

- **Accelerate research** – Collaborate with leading academic and research organizations to advance quantum computing technology.
- **Educate and prepare** – Expand and train the ecosystem of users, developers, and application specialists that will be essential to the adoption and scaling of quantum computing.
- **Develop and launch commercial applications** – Engage industry leaders to combine IBM quantum computing expertise with industry-specific expertise to accelerate development of the first commercial use cases.

Let's explore how IBM Quantum can help you prepare and take the lead in this new era with our products and services and through engagement

with the IBM Quantum Network. You will also learn how to stay current with IBM Quantum developments.

IBM Quantum is the world's most advanced quantum computing initiative, focused on propelling the science and pioneering business applications for quantum usefulness. IBM differentiates itself by having the most stable and powerful hardware, the fullest suite of programs and services, the largest fleet of quantum computers, and the most extensive Network of partners. IBM has deployed 20+ quantum computers to the cloud. These quantum computers have been used for 3 trillion+ executions (and counting), resulting in 2800+ research papers from our 600,000+ userbase.

Partners in the IBM Quantum Network span the breadth of innovative institutions, including startups, global systems integrators and consultancies, and large enterprises. Another partner category to note is the Quantum Innovation Centers; these serve as elite centers of expertise in the growing and ever-changing quantum ecosystem. Some of the Quantum Innovation Centers have on-premises quantum computers. Many operate as third-party providers, industry leaders growing a quantum community by partnering with IBM directly, and serving as a central contact point for other organizations.

Premium plan clients are granted membership to the IBM Quantum Network as part of their package. This membership allows access to exclusive meetings and selected channels where the latest knowledge and ideas in quantum computing are shared. Members of the IBM Quantum Network collaborate extensively and benefit from close working relationships with our in-house experts.

Develop your quantum workforce

People in your organization will see their quantum skills develop rapidly through routine contact with our in-house talent through the IBM Quantum Network. Member workforces gain access to advanced, in-depth training programs and individualized, live talks from IBM Quantum experts.

Being a partner in the IBM Quantum Network also comes with access to premium course content for upskilling in your organization. We have content for technical practitioners and also for business and organizational leadership. For example, if you are a partner in the IBM Quantum Network and would like to learn more about how to be successful in your partnership, please check out our course

Building Successful Quantum Initiatives. The course covers what to expect in early stages of your quantum journey, things to keep in mind when approaching members/clients, and much more! It also gives additional context to the IBM Quantum Network through interviews with leadership from a variety of partners, including large corporations, academic institutions, startups, and more!

Join quantum's inner circle

Hear from the brightest minds in the field at our monthly IBM Quantum Network Colloquium and Technical Exchange (Register for IBM Quantum Network Colloquium) and at the annual IBM Quantum Developer Conference. Use that access to stay at the forefront of quantum development. Progress your own work in collaboration with peers and IBM Quantum experts. Here is a short list of core events available to partners in the IBM Quantum Network:

- **The IBM Quantum Developer Conference**: An annual event bringing together developers worldwide to preview forthcoming updates to the IBM Quantum roadmap and get hands-on demos of state-of-the-art IBM Quantum software tools.
- **The IBM Quantum Partner Forum**: A conference-style gathering of leadership from across the IBM Quantum Network. Partners in the IBM Quantum Network can access the event recordings.
- **Qiskit 101 & 102**: A replay of live enablement sessions for those beginning their technical development in quantum computing with Qiskit. Access the event recordings at any time.

Navigate IBM Quantum Resources

Bookmark these pages to ensure you have access to IBM Quantum's industry-leading resources:

- IBM Quantum Computing: Login with your IBMid and navigate with the application switcher in the upper right hand corner to explore the suite of applications to support your quantum needs:
  - IBM Quantum Platform to access IBM's quantum computer on the cloud

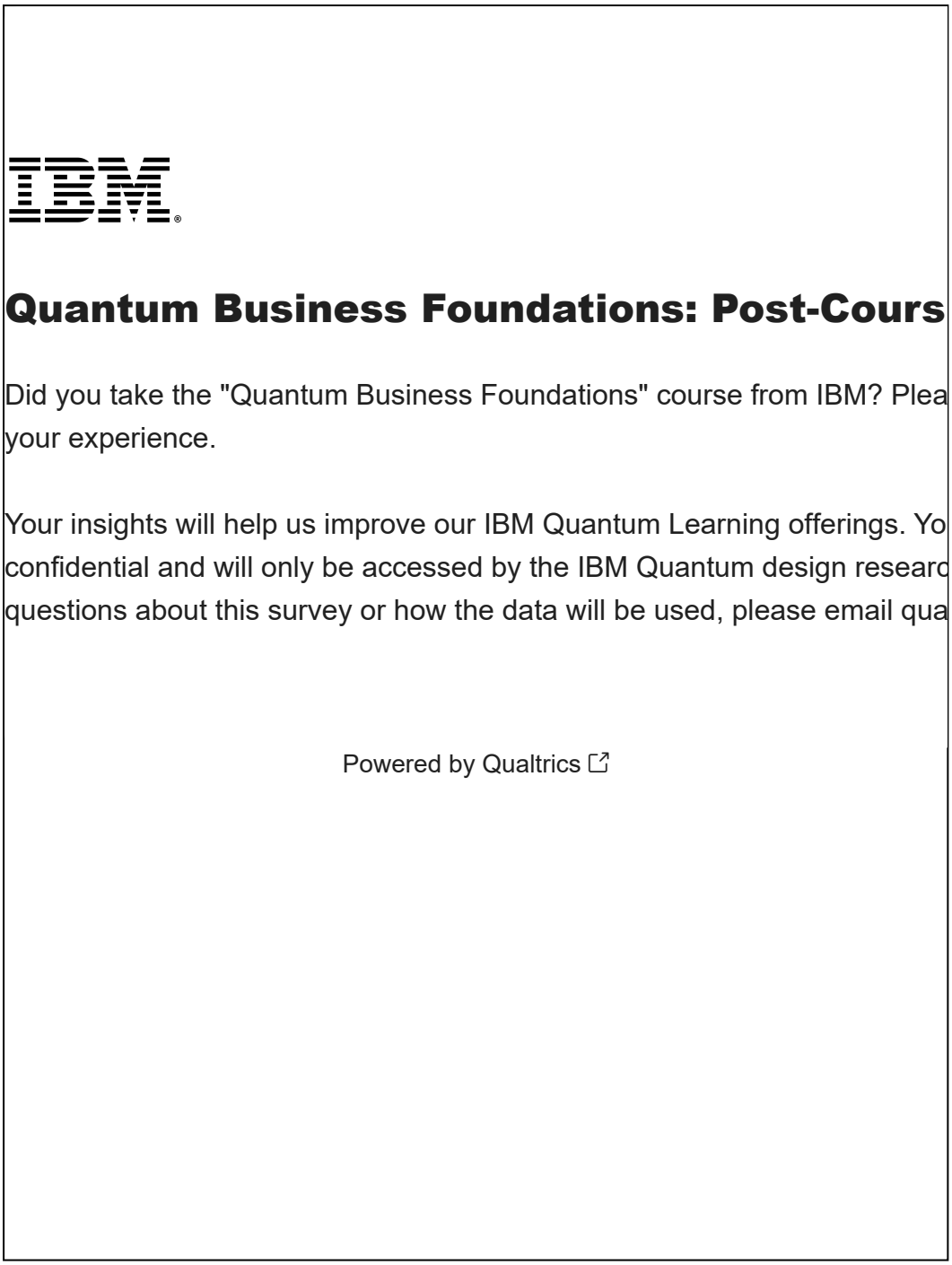
  - IBM Quantum Learning to take a course, follow a learning path, browse tutorials, and start experimenting with Composer
  - IBM Quantum Documentation to ensure you get the most of IBM's tools and services
- IBM Research Blog: Stay up to date with the latest news, research, and events from IBM Research
- Qiskit YouTube Channel: Engaging lectures, tips & tricks, tutorials, community updates, and access to exclusive Qiskit content. Subscribe here for weekly Qiskit videos

Join our communities:

- Qiskit Slack: Submit a request to join the Qiskit slack workspace and connect with a community of quantum computing professionals and enthusiasts
- Qiskit Stack Exchange: A Q&A platform for engineers, scientits, programmers, and computing professionals interested in quantum computing using Qiskit
- IBM Quantum Stack Exchange: Q&A space on Stack Exchange about IBM's Quantum Service - Circuit Composer
- IBM Quantum Events: Stay updated and take part in upcoming quantum events
- IBM Quantum Newsletter: Opt-in to stay tuned on quantum events, available only for the IBM Quantum Network.

Post-Course Survey

Please take a moment to help us improve our website with a quick survey below. We will use the feedback accordingly to improve the user experience and provide clearer explanations throughout the course.



Key takeaways

You can keep these key takeaways in mind:

- Quantum technology is maturing every day, and it's now at an early

Business impacts Take exam