

# Quantum Computing

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## Overview

A rapidly emerging technology that harnesses the laws of quantum mechanics to solve problems too complex for classical computers. This introduces new concepts to traditional programming methods that allow us to innovate and discover with Quantum Computers (QC).

## Market

- The quantum computing market is projected to grow from \$712.2 million in 2022 to \$4.75 billion by 2029 <sup>1</sup>
- Out of the players working on and innovating in quantum<sup>2</sup> computing, the majority are startups (40%) and universities (33%)
- Venture capital funding grew by 500% from 2015 to 2020<sup>3</sup>

# Impact

Time	Global	Industries
<b>Present</b>	<p>EXPLORATION</p> <ul style="list-style-type: none"> <li>Data analysis and optimization is almost entirely classical</li> <li>Pilot programs and startups catalyze initial adoption</li> <li>Exploration of potential uses and education on hardware/software functionality</li> </ul>	<ul style="list-style-type: none"> <li>Health Care - Drug R&amp;D <sup>5</sup></li> <li>Finance - Risk Management <sup>6</sup></li> <li>Government - Standardized NSA QC Requirements <sup>4</sup></li> </ul>
<b>Year 3</b>	<p>DEVELOPMENT</p> <ul style="list-style-type: none"> <li>Upscaling of current data scientists to be quantum capable <sup>8</sup></li> <li>QCs force Cybersecurity evolution</li> <li>Rudimentary decision processes streamlined by QCs</li> </ul>	<ul style="list-style-type: none"> <li>Health Care - Lifestyle Analysis</li> <li>Advertising - KPI Optimization</li> <li>Cyber Security- Security/Communication Evolution</li> </ul>
<b>Year 5</b>	<p>SUPPLEMENTATION</p> <ul style="list-style-type: none"> <li>Hybrid Computing <sup>7</sup></li> <li>Big data analysis and machine learning accelerates</li> <li>New QC aided discoveries propel global growth</li> </ul>	<ul style="list-style-type: none"> <li>Retail - Supply Chain Advancement</li> <li>Transportation - Ground/Air Traffic Optimization</li> <li>Automotive - Self Driving Cars</li> <li>Oil and Gas - Drilling Development</li> </ul>
<b>Year 10</b>	<p>DISCOVERY</p> <ul style="list-style-type: none"> <li>QC data processing is exponentially faster</li> <li>Proliferation as QC becomes a cornerstone for analytical work/innovation</li> </ul>	<ul style="list-style-type: none"> <li>Manufacturing - Material Composition Innovation/Discovery</li> <li>Healthcare - Genome Sequencing, Silico Clinical Trials</li> <li>National Security - Emergency Response</li> </ul>

# Industry Impact

## High Priority: Cyber Security

Today's data safety hinges on security protocols that would require unfeasible amounts of time to decrypt. QCs can break modern cryptography, which jeopardizes data encrypted in the past. However, QCs also provide the answer in strengthen cyber security to allow forward secrecy.

### Impacts

- Entropy Source for True Encryption
- Quantum Secure Communications, Eavesdrop Detection<sup>9</sup>
- Novel Attack Adaptation and Recognition
- Establish Standard for Cryptography Practices

## Most Potential: Global Energy & Materials

Implementation of QC within this sector could revolutionize our current infrastructure and approach to manufacturing.

### Impacts

- Effective Energy Distribution
- Pioneer development of new energy production and storage
- Optimize Grid Infrastructure
- Innovate Material composition
- Weather Simulation
- Carbon Footprint Reduction

# Appendix

## Citations

- <sup>1</sup> Klein, Jon. “The Business Case for Quantum Computing - MIT Initiative on the Digital Economy.” MIT Initiative on the Digital Economy, MIT, 24 Jan. 2022, <https://ide.mit.edu/insights/the-business-case-for-quantum-computing/#:~:text=Quantum%20computing%20will%20eventually%20help,such%20as%20chemicals%20and%20pharmaceuticals> Skyscrapers and blue sky with clouds
- <sup>2,3</sup> Digimenali, Cem. “Quantum Computing Stats: Forecasts & Facts for 2022 & Beyond.” AIMultiple, 5 Nov. 2020, <https://research.aimultiple.com/quantum-computing-stats/>. Close-up building with opened window
- <sup>4</sup> “NSA Releases Future Quantum-Resistant (QR) Algorithm Requirements for National Security Sys.” National Security Agency/Central Security Service, 7 Sept. 2022, <https://www.nsa.gov/Press-Room/News-Highlights/Article/Article/3148990/nsa-releases-future-quantum-resistant-qr-algorithm-requirements-for-national-se/>.
- <sup>5</sup> “The Impact of Quantum Computing on Society.” DigiCert, <https://www.digicert.com/blog/the-impact-of-quantum-computing-on-society>.
- <sup>6,8</sup> Kaafarani, Ali El. “Council Post: Four Ways Quantum Computing Could Change the World.” Forbes, Forbes Magazine, 14 Apr. 2022, <https://www.forbes.com/sites/forbestechcouncil/2021/07/30/four-ways-quantum-computing-could-change-the-world/?sh=3c4145c44602>.
- <sup>7</sup> Christine Hall | Aug. “What Has to Happen for Quantum Computing to Hit Mainstream?” Data Center Knowledge | News and Analysis for the Data Center Industry, 26 Aug. 2021, <https://www.datacenterknowledge.com/data-center-world/what-has-happen-quantum-computing-hit-mainstream>. Low angle glass designed skyscrapers
- <sup>9</sup> Sun, Shihai. “Quantum Secure Communication.” Frontiers, <https://www.frontiersin.org/research-topics/34515/quantum-secure-communication>. Low angle view of city skyline