The Future of Computer Science

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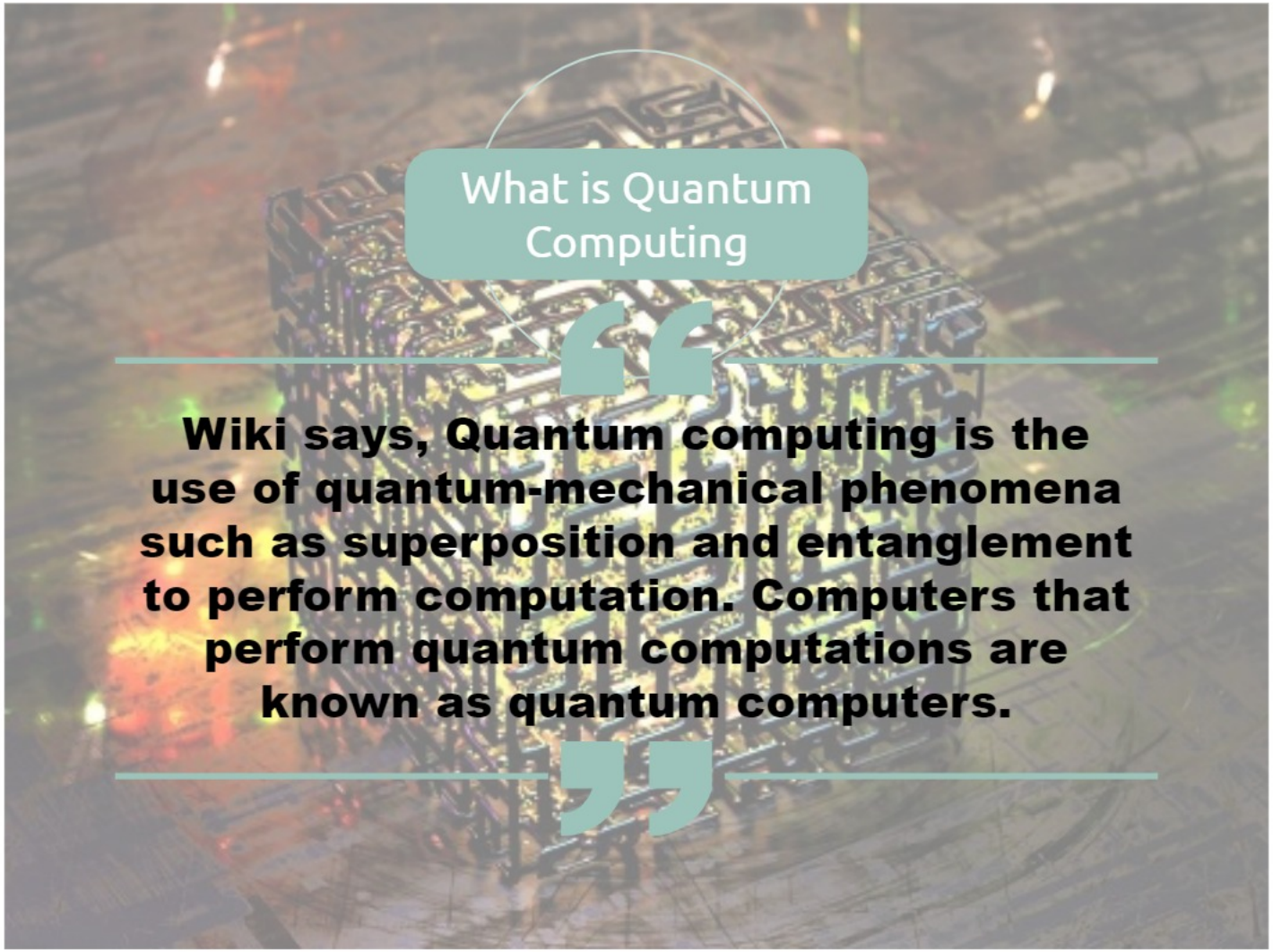
CSE Q


What is Quantum Computing
Wiki says, Quantum computing is the use of quantum-mechanical phenomena such as superposition and entanglement to perform computation. Computers that perform quantum computations are known as quantum computers.

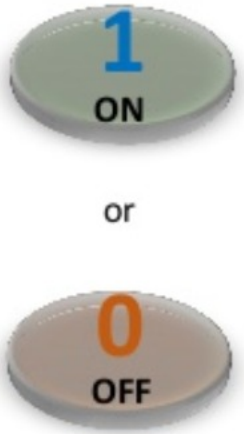
Use of Qubit- A two state Quantum Mechanical Model

All computing systems rely on a fundamental ability to store and manipulate information. Current computers manipulate individual **bits**, which store information as binary 0 and 1 states. Quantum computers leverage quantum mechanical phenomena to manipulate information. To do this, they rely on quantum bits, or **qubits**.

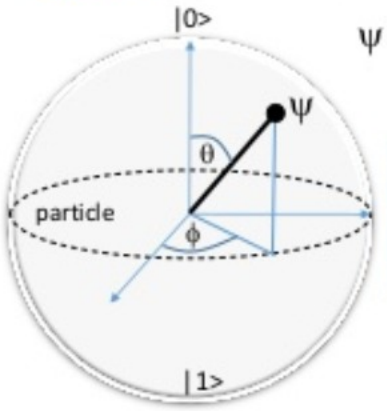
NECTEC

Qubit vs Bit

Bit can have one of two states



Qubit has many more possible states at the same time



$\Psi = \cos(\theta/2)|0\rangle + \exp(i\phi)\sin(\theta/2)|1\rangle$

α β $|\alpha|^2 + |\beta|^2 = 1$

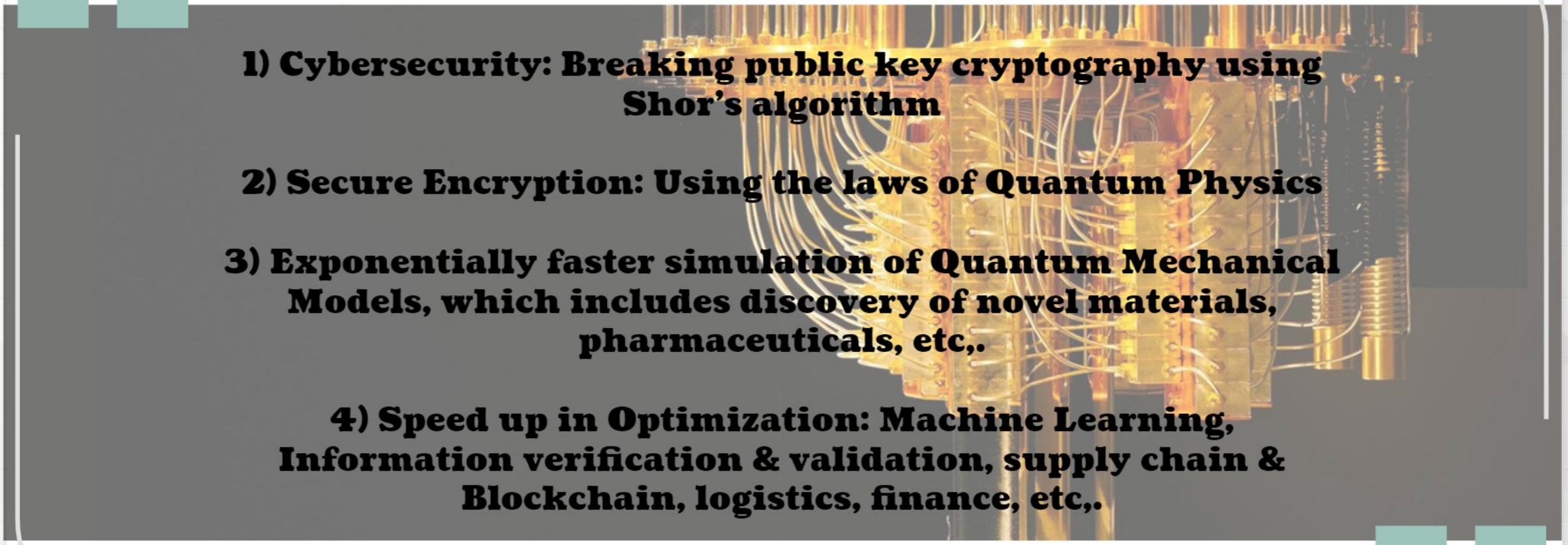
Superposition
Qubit can be in more than one state at the same time

Entanglement
Qubits can affect each other over huge distances (i.e., a type of correlation)

Equivalent to Parallel Computing

- Qubit seems to contain an infinite amount of information
- The information can be extracted by a measurement
- When measured, qubit collapses, resulting in |0> or |1> with probability α, β associated with qubit's latitude

Impact of Quantum Computing



1) Cybersecurity: Breaking public key cryptography using Shor's algorithm

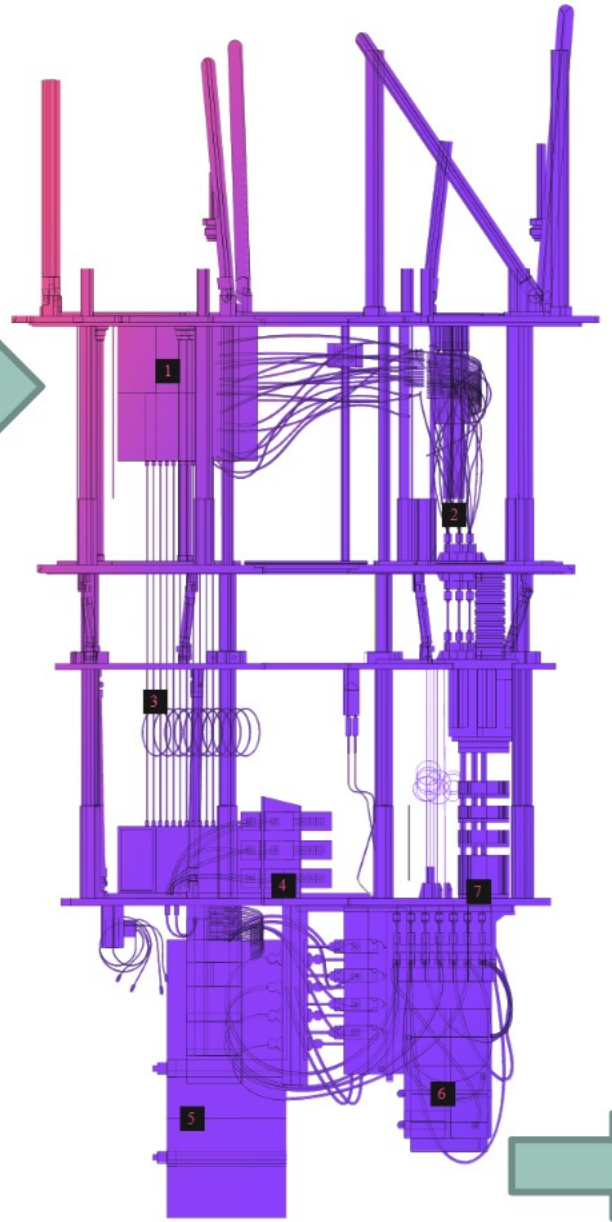
2) Secure Encryption: Using the laws of Quantum Physics

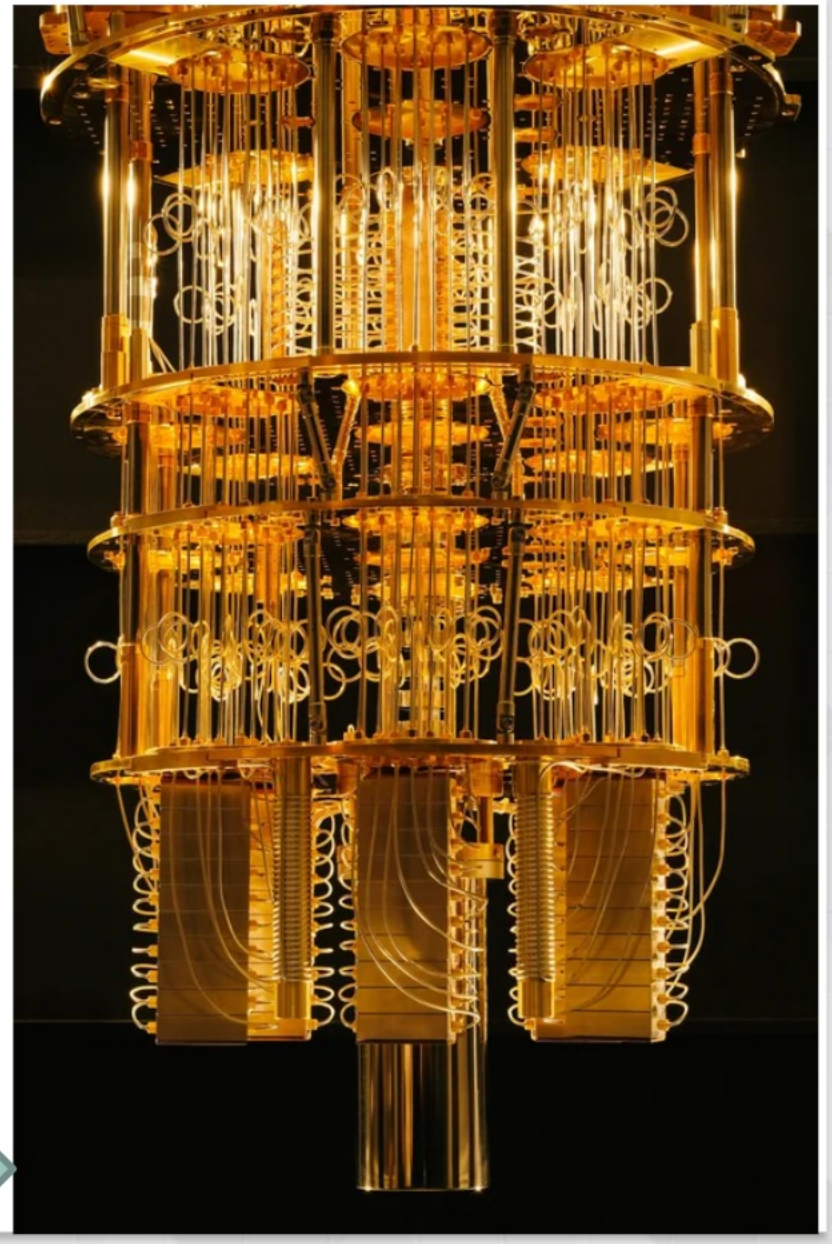
3) Exponentially faster simulation of Quantum Mechanical Models, which includes discovery of novel materials, pharmaceuticals, etc,.

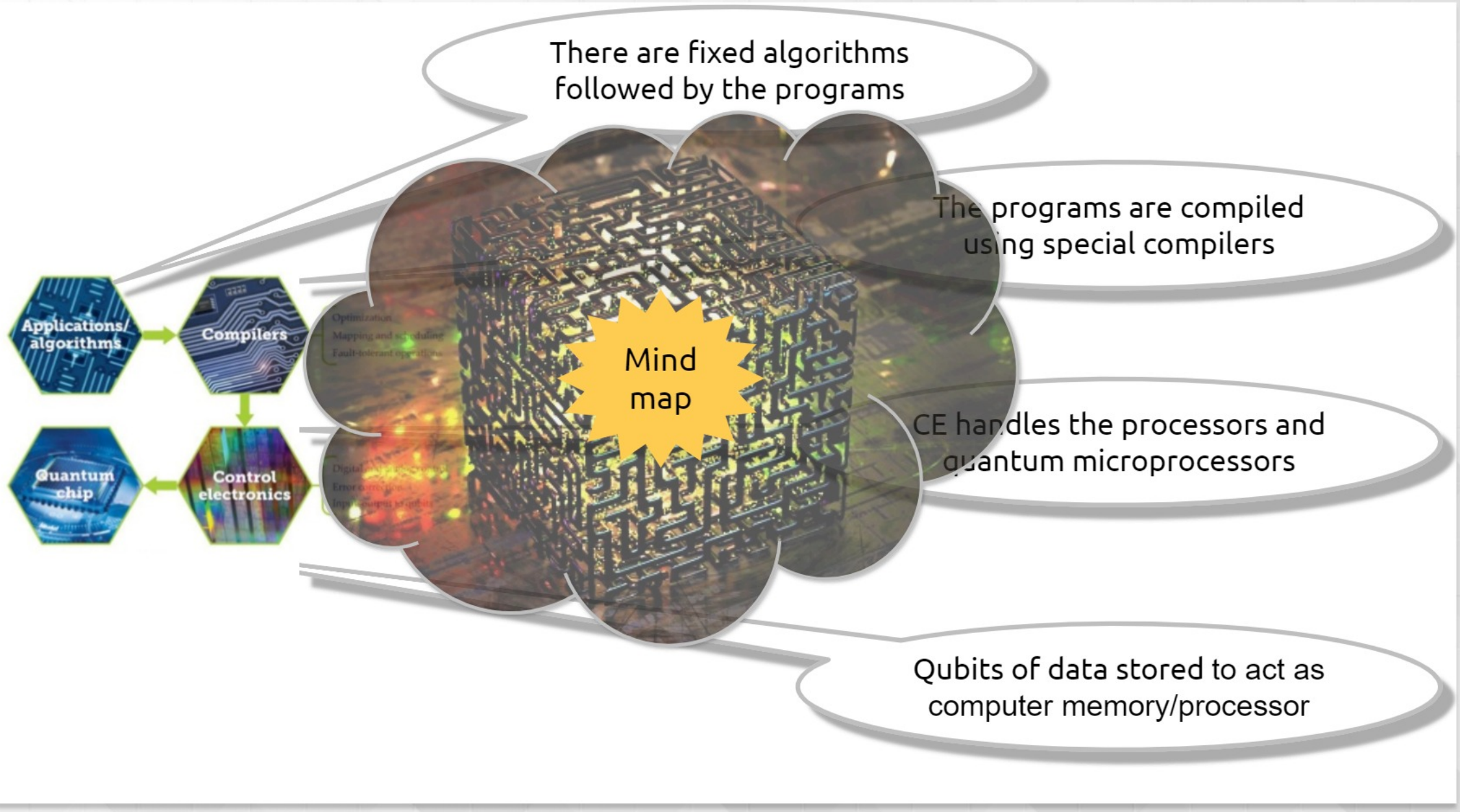
4) Speed up in Optimization: Machine Learning, Information verification & validation, supply chain & Blockchain, logistics, finance, etc,.

Components of a Quantum Computer

1) **Qubit Signal Amplifier**: One of two amplifying stages is cooled to a temperature of 4 Kelvin.
2) **Input Microwave Lines**: Attenuation is applied at each stage in the refrigerator in order to protect qubits from thermal noise during the process of sending control and readout signals to the processor.
3) **Superconducting Coaxial Lines**: In order to minimize energy loss, the coaxial lines that direct signals between the first and second amplifying stages are made out of superconductors.
4) **Cryogenic Isolators**: These enable qubits signals to go forward while preventing noise from compromising qubit quality.
5) **Quantum Amplifiers**: Quantum amplifiers inside of a magnetic shield capture and amplify processor readout signals while minimizing noise.
6) **Cryoperm Shield**: The quantum processor sits inside a shield that protects it from electromagnetic radiation in order to preserve its quality.
7) **Mixing Chamber**: The mixing chamber at the lowest part of the refrigerator provides the necessary cooling power to bring the processor and associated components down to a temperature of 15 mK — colder than outer space.

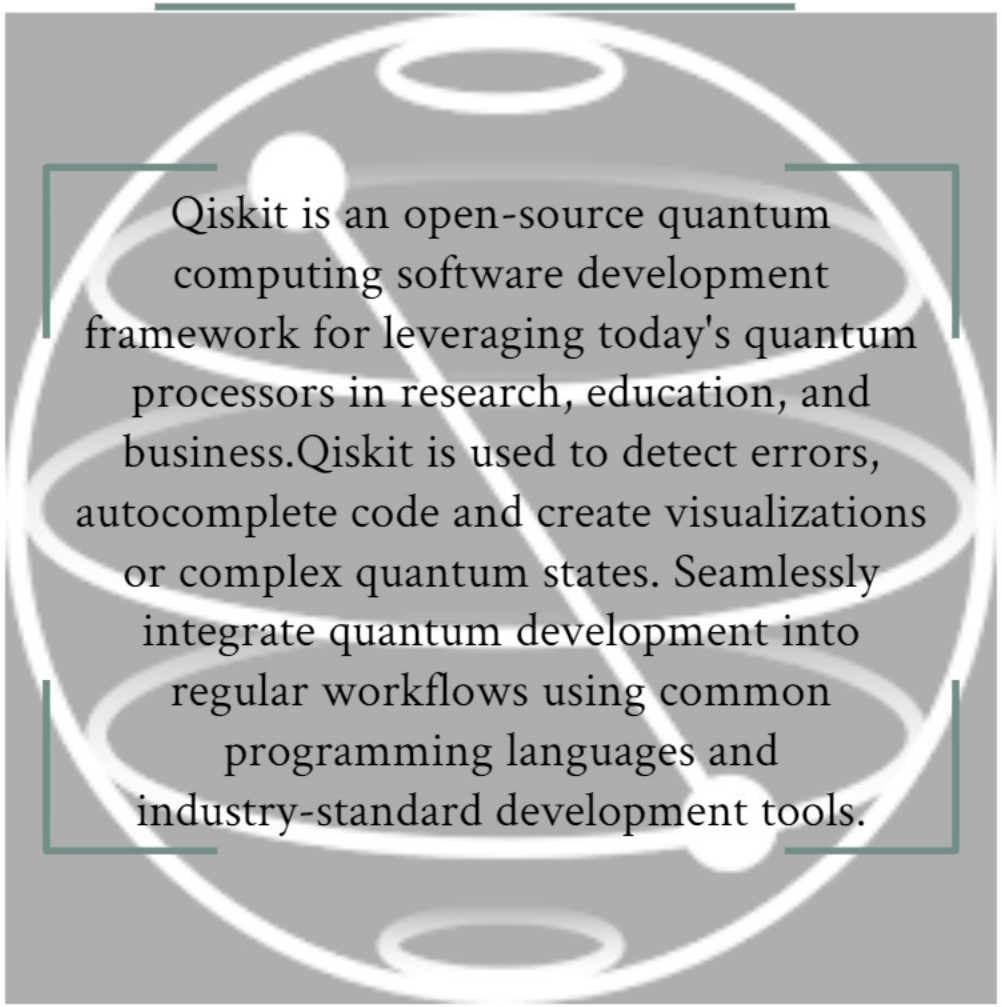





There are fixed algorithms followed by the programs
The programs are compiled using special compilers
CE handles the processors and quantum microprocessors
Qubits of data stored to act as computer memory/processor
Mind map
Applications/ algorithms
Compilers
Quantum chip
Control electronics

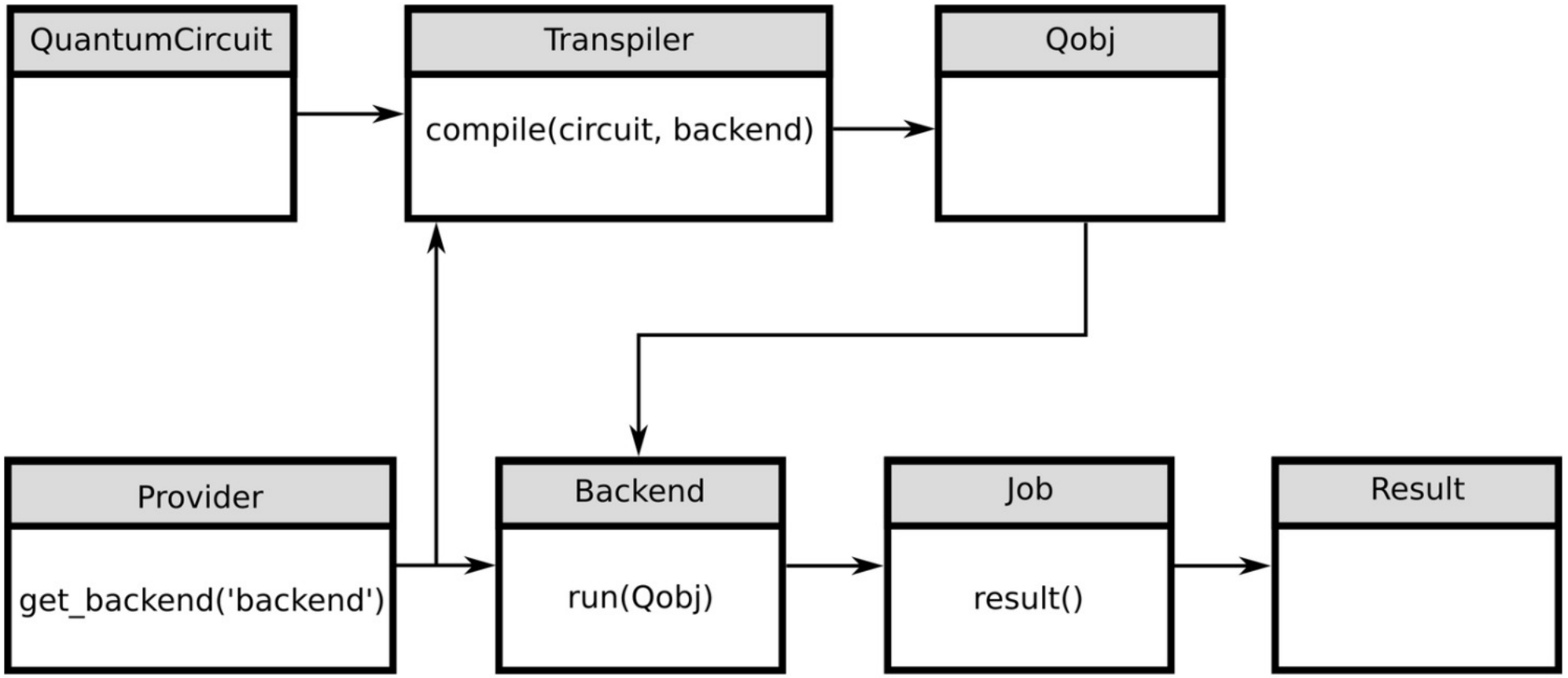
QISKIT

Elements for building a quantum future

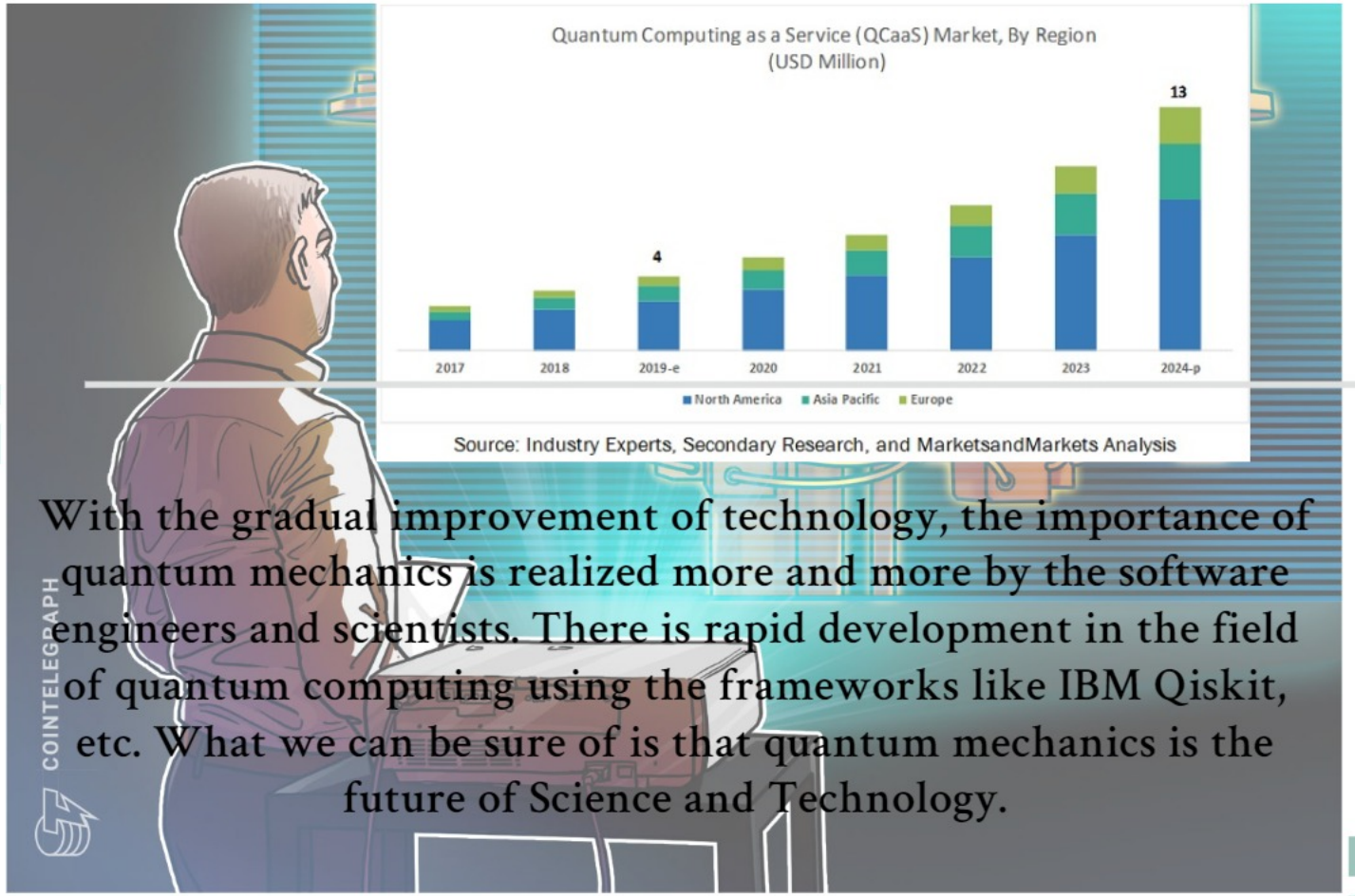


Qiskit is an open-source quantum computing software development framework for leveraging today's quantum processors in research, education, and business.Qiskit is used to detect errors, autocomplete code and create visualizations or complex quantum states. Seamlessly integrate quantum development into regular workflows using common programming languages and industry-standard development tools.

Backend of the Qiskit framework



Summary



With the gradual improvement of technology, the importance of quantum mechanics is realized more and more by the software engineers and scientists. There is rapid development in the field of quantum computing using the frameworks like IBM Qiskit, etc. What we can be sure of is that quantum mechanics is the future of Science and Technology.

Thank You

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Acknowledgements:

Https://www.ibm.com/quantum-computing/

https://www.slideshare.net/Advanced-Concepts-Team/quantum-computing-137316619