UNIVERSIY OF WESTMINSTER &

INFORMATICS INSTITUTE OF TECHNOLOGY

Trends In Computer Science

4COSC008C.2

1 : Quantum Computing

1a. Overview of Quantum Computing. How does it compare to the conventional Von Neumann computer architecture?

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Group	L-7
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Abstract

Many technologies are coming up with new forms of them in the twenty-first century. Every invention has numerous problems. They are solved by various ways. There is new era of technology states with Quantum Mechanism. This is used in many ways and it helpful in the computing as Quantum Computing.

Research was carried out to find about Quantum Computing. This research was carried out by IIT students who were divided into groups at random. It would find out with the help of books and study of video clips about which is in the still research and update of quantum computing as well in the report.

Acknowledgements

Firstly, we would like to express our special thanks of gratitude to the lecturers, especially our module leader Ms. Sulochana Rubasinghe and tutor Ms. Niwarthana Kariyabadhuge who gave us the golden opportunity to do this wonderful project.

Secondly, we would thank our lovely parents and colleagues for their unwavering support. Finally, our team members Rakshaagar, Nishanthan and Amhar for being so dedicated and hard-working to accomplish the Project on time.

Thank You.

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Introduction

A quantum computer is a computational framework based on the quantum mechanism, which has gotten a lot of attention in the last few decades. When compared to traditional computers, it has achieved remarkable success in some specific tasks. In this report, I am summarize the Overview of Quantum Computing. How does it compare to the conventional Von Neumann computer architecture? You'll see how quantum computing can be used in everyday life. The problem and solutions are presented, along with the benefits of the solutions. The benefits of the solution include automation, cost reduction and profit improvement, efficiency enhancement, and defect reduction. This research solutions are related to cryptography, optimization, and cybersecurity. In 1965, Richard Feynman proposed quantum electrodynamics. Quantum electrodynamics is concerned with the interaction of electrons through the use of the electromagnetic force of the photon. He created the particles known as antiparticles. Antiparticles are particles with opposite charges to mirror particles. In 1980, he developed new concepts related to quantum physical processes. He proposed that binary numbers be used to represent quantum particles.

A quantum computer is a physically scalable system comprised of well-characterized quantum bits. It must be able to set the quantum bits' initial state. The decoherence times of a quantum computer are long and it has error correction for data retention in memory. In 2000, David Divincenzo created a list of criteria for quantum computer technology. The von Neumann architecture is the foundation of modern computer architecture. Von Neumann divides the computer into four components: memory, the bus system, input and output (IO), and the Control Unit (CU). An ALU can perform addition, subtraction, multiplication, and division.

Real-Life Problems and Solutions

Quantum solutions are associated with the development of quantum algorithms for improving computational tasks in quantum computing, artificial intelligence, data science, and machine learning. This chapter examines a variety of solutions, including optimization problems, quantum cryptography, and cybersecurity. We look at drug discovery and protein folding solutions in pharma. In the manufacturing domain, supply chain optimization and purchasing solutions are presented. Energy distribution and optimization problems are explained in detail, along with solutions, in the utility industry. Media and technology verticals cover advertising scheduling and revenue optimization solutions. Nanoparticles, material discovery, chemical design, drug design, pattern recognition, and classification are some of the areas where machine learning is being used. The following list presents use cases from different domains. These use cases prove that quantum computing can help human life by using quantum technology and its high-performance processing features.

- Stock market
- Medicine

Figure 1:Medical sciences

- Medical sciences
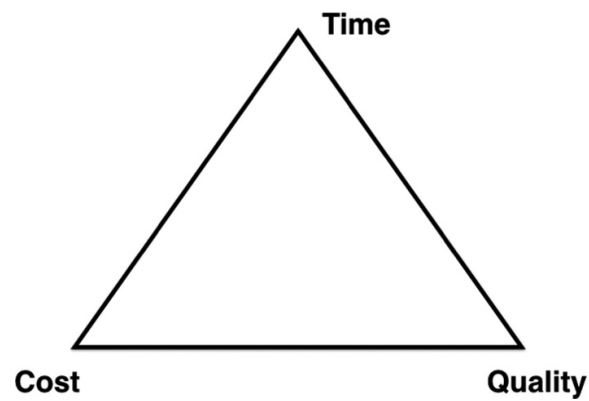
Figure 2:Natural sciences

Figure 3:Triangle showing the IT challenges

- Information technology

- Automating Manual and Semi-manual Processes

- Reducing Costs and Improving Profits

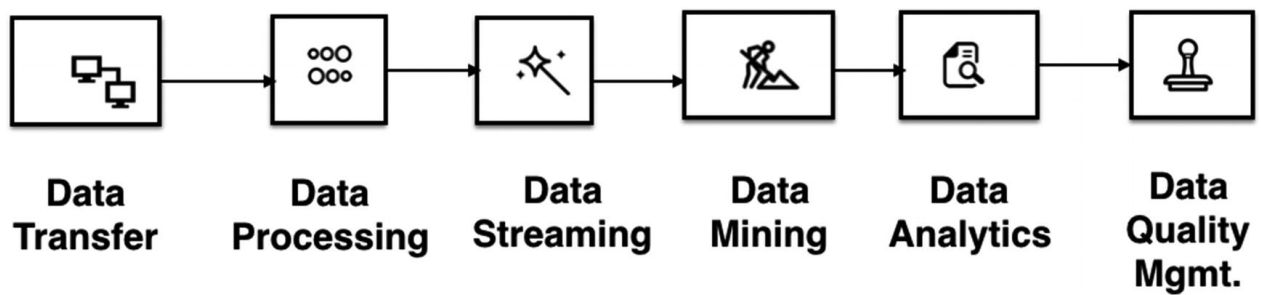- Improving Efficiencies and Reducing the Defects
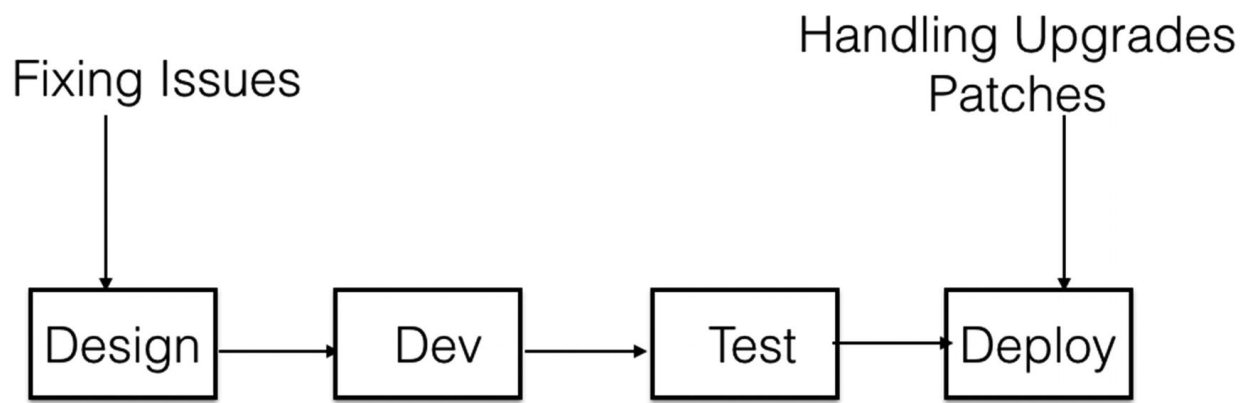

Figure 4:Data management process

Fixing Issues

Handling Upgrades
Patches

Design → Dev → Test → Deploy

Figure 5: Solution development process

Quantum Computer

Predictive and prescriptive analytics are solutions that can help enterprises make better decisions. Quantum computers allow for the superposition of zeros and ones, known as quantum-bits (qubits), which are in the state of one and zero at the same time.
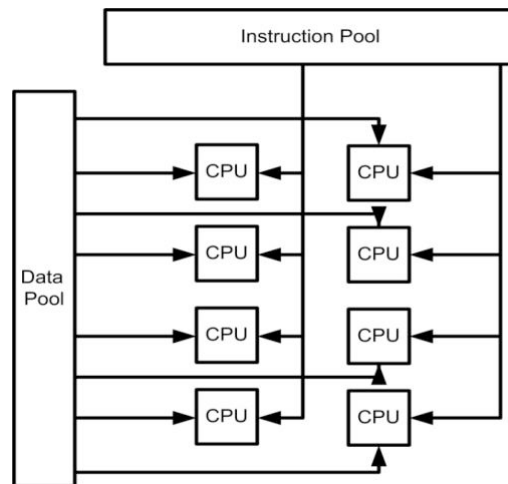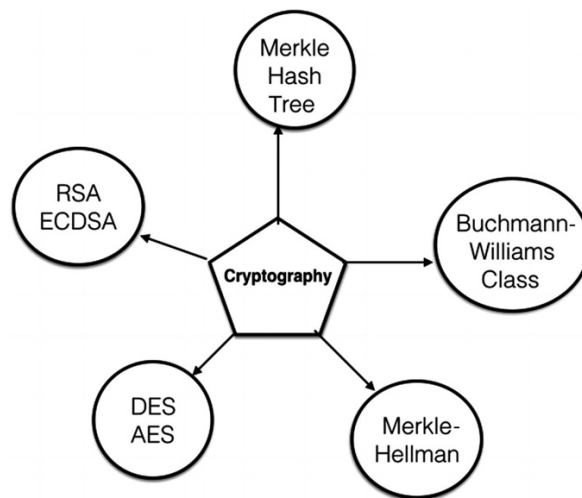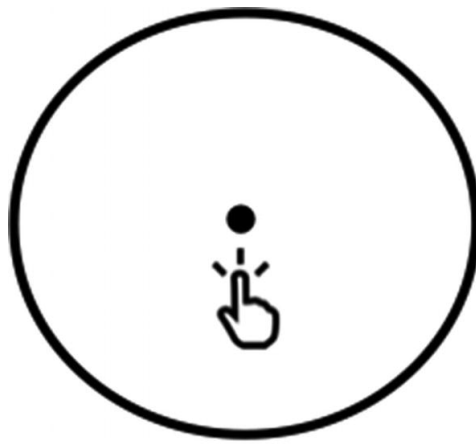

Figure 6: Information Technologies

Figure 7:Cryptography Models
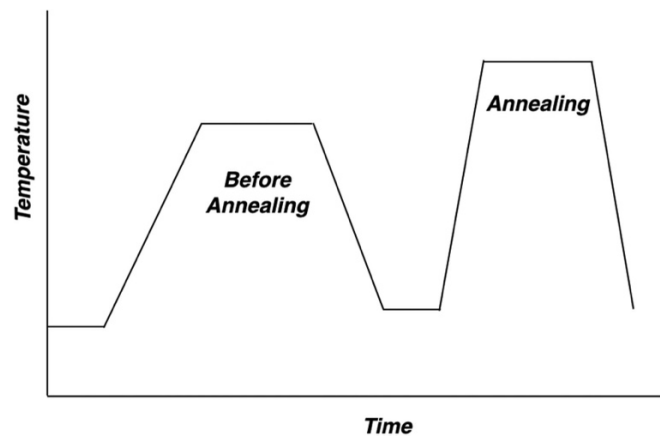
Figure 8: Opptimization

Figure 9: Annealing

- **Types of Quantum Computers**

A quantum computer isn't something you download off the internet or buy at a store. Quantum computers are big hulking beasts that require careful and delicate installation. They have to be cooled to temperatures close to absolute zero—that's just a few bone-chilling degrees above -273°C, if you want to be precise. Your refrigerator, by comparison, is a sauna where your quantum computer may go after a hard day at work.

- Quantum Circuit Computers
- Adiabatic Quantum Computers

IBM has made it a cinch for the public to get access to a quantum circuit computer. In this book, we will learn to write quantum programs for these quantum computers. Many concepts are a distant cousin of conventional computers and, thus, easier to digest.
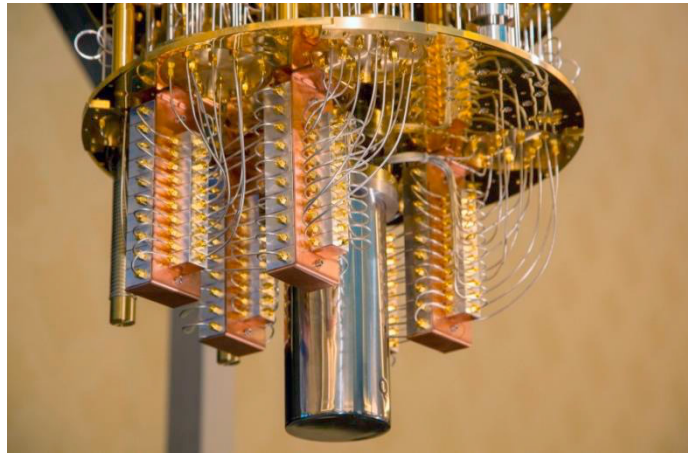

Figure 10: Quantum Computing

Characteristics of Quantum Computer.

- Quantum computers moderate the difficulty of various computational programs.
- Quantum systems are able to proficiently simulate other quantum systems.
- Moore's law possesses physical restrictions
- Even small quantum circuits may be advantageous.

Architectures

Scholars are attempting to create novel computing devices based on quantum physics. These machines would use quantum properties to perform infinite parallel calculations. Current and future computer systems cannot be classified as Princeton, Harvard, or parallel systems.

- Computer Architectures limitations

Mainframes were mainframes - the name refers to the time when the computer occupied the entire large border or mounting frame, extending from the floor to the ceiling. The various types of architectures, as well as their limitations

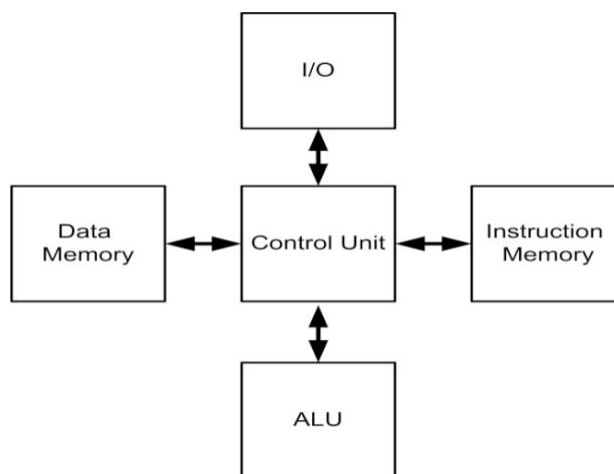- Single CPU architecture
- Multiple CPU architecture

Figure 11: CPU

Critical Evaluation

Quantum computing is the new technological era which is researched in the field of Quantum Mechanics. There are many discover, and inventions carried out in the research state, but it is the hope and the next step to reach out explore the world in many ways such as health, industry, mathematics, Information technology, etc.… It would be great change to Information Technology field with having more security and storage capability. I am trying my maximum in this research to find out more about quantum and Information Technology.

Conclusion

Computer systems have evolved over the last decades. Quantum systems, which are founded on quantum mechanics, differ from a digital computer and are capable of executing the processes faster than supercomputers. It is believed that the future of computer systems would be altered due to this new invention. This paper discussed the concepts of quantum computing to develop quantum-based computer systems. The paper also examined the relationships between the computer architecture and building quantum-based computers. Furthermore, we also describes the characteristics of quantum computers and explain how quantum-based computer differ from traditional computers. It has been argued that quantum computers are able to simply resolve applications that cannot be finalized with the aid of current systems. Developing a useful quantum system is just a matter of time, where it would be one of the major steps in science and could reform the applied computing systems.

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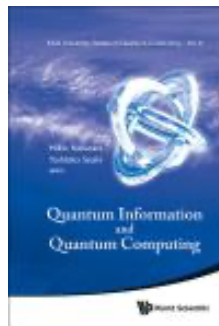
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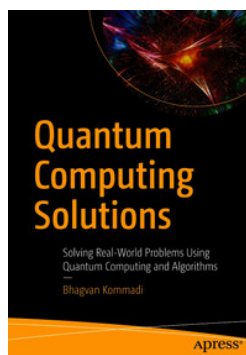
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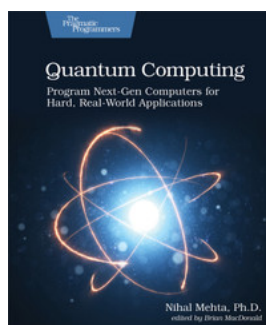
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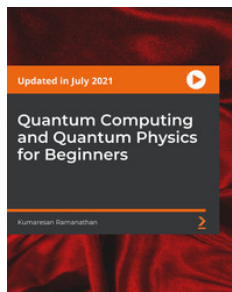
APPENDICES

- 1003 Words Introduction to Conclusion
- **Workload matrix**

No.	NAME	TASK	ASSIGNED DATE	SUBMITTED DATE
1	Mohamed Amhar	1d. What impact might Quantum computing have on computer security?	17.02.2022	03.03.2022
2	Rakshaagar	1e. What benefits might we be able to achieve using Quantum Computing than we cannot achieve with conventional computers?	17.02.2022	03.03.2022
3	Nishanthan	1b. Overview of Quantum Computing. Which new opportunities does it bring?	17.02.2022	03.03.2022
4	Mohanaranjan	1a. Overview of Quantum Computing. How does it compare to the conventional Von Neumann computer architecture?	17.02.2022	03.03.2022