Types of Nano Computers and Challenges of Quantum Computing

T.Srilatha
Assistant Professor, Department of Computer Science
R.B.V.R.R Women's College, (Autonomous), Affiliated to Osmania University
Narayanaguda, Hyderabad, Telangana

Abstract: *Recent research on Nano Computers is giving a broad scope for Computer specialists to enter into a new world of Nanoscopic electronic era. The various types of Nano Computers like Nano Electronic Computer, Nano Mechanical Computer, Nano Chemical and Biochemical Computer and Quantum Computers will help in aid to use and ease to make the task to be simpler and easier. The wide area of research on the quantum computing is potentially a new technology, where a quantum computer maintains a sequence of qubits. Qubits is the fundamental unit in the Quantum Computing. There are quite a few challenges to be considered to build a large-scale quantum computer. Quantum cryptography is a best application for securing the internetwork communication. This paper focuses on Various Nano computers and mainly on importance of Quantum Computing.*

Keywords: Nano Computer, Quantum Computing, Nano Technology, Qubit

I. INTRODUCTION:

Nano Technology [1] has been developed mainly from the varied areas or different domains considering the diverse perspectives and computational techniques. Nanotechnology is actually a multi-disciplinary field. The researchers in all related areas and different domains have come together to make the success of Nano Technology. Computer Science has taken an important role mostly in research tools, example- a virtual reality system coupled to scanning probe devices in Nano Manipulator project. According to M. C. Roco, the third and fourth generation of Nano Technology would rely heavily on research in computer science. In maximum educational academic centers and government labs, Nano Technology is nurturing new discussions and making a mark for the students to notice and gain the knowledge. The impact of Nano Technology is slowly spreading the entire educational and research centers, mainly the Nano Computers are going to gain more advancement in the future.

II. APPLICATIONS OF NANO TECHNOLOGY

Nano Technology [2] is applied in various domains like Electrical Engineering, Information Technology, Computer Science, Physics, Mechanical Engineering, Material Science, Life Sciences, Chemistry, Molecular Biology, Medicine and Mathematics. Applications of Nano Technology is spread in varied other areas and most of the researchers are focused and continuing the advancements in the Nano exploration.

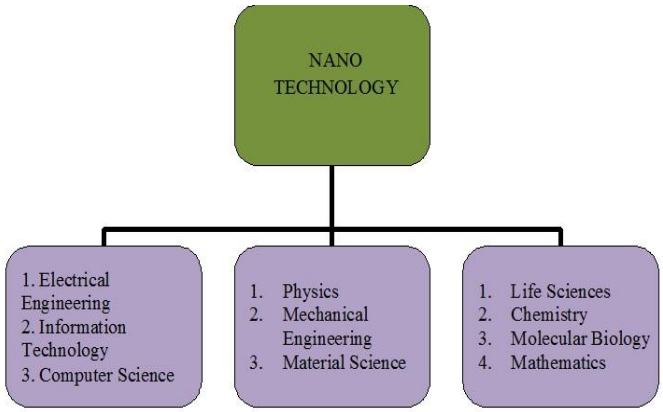

Figure: Applications of Nano Technology in various domains

III. IMPORTANCE OF NANO TECHNOLOGY

Nano Technology [3] can be stated as a capability to manipulate, control, assemble, produce and manufacture the things at atomic or minute precision. Nano technology allows with the construction of smaller circuits and computers. Smaller circuits [2] will run with a faster enabling capabilities with far greater computer speeds. Nano materials can make the computers to have a much longer life. A laptop computer could therefore have its efficiency increased by million times to live longer and work faster to give far better value for monetary terms. Nanometer sized

solar cells could be developed to provide much of the energy needed around the world and Nano materials will increase the efficiency of fuel cells and batteries. In the coming future, Nano Technology will be used to tackle and handle environmental problems. Green Nano Technology [5]is also a new ongoing research, in which 'Green' processing technologies will minimize the generation of undesirable product effluents by curbing poisonous emissions. In health care and medicine biological Nano Sensors are being advanced in the next few years and will be used for fast and accurate diagnostics. Further, Nano Technology plays an important role that may be used to build artificial muscle and 'Lab on a Chip' technology will develop efficient drug discovery processes.

IV. NANO COMPUTER TYPES

Nano Computer: Computer [5][6] with small & tiny circuitry that can be seen through a microscope. Nano computers deal with materials at a molecular level and hold the promise of creating increasingly smaller, very efficient and faster computers. In the computer manufacturing branch, the ability to shrink the size of transistors on silicon microprocessors will soon be reached with limits of speed and miniaturization. The silicon transistors in the computer may be replaced by transistors based on Carbon Nanotubes. A carbon Nanotube is a molecule in the form of a hollow cylinder with diameter of around a Nanometer which consists of pure carbon. Nanorods is an upcoming technology in the display techniques due to less consumption of electricity and less heat emission. Size of the micro processors are reduced to greater extent. Researchers at North Carolina state university says that growing arrays of magnetic nanoparticles are called Nanodots.
The various Nano Computer types are 1) Mechanical Nano Computer 2) Electronic Nano Computer 3) Chemical / Biochemical Nano Computer 4) Quantum Nano Computer

A. Mechanical Nano computer

The first mechanical computer was designed by Charles Babbage (Cambridge University) in 1837 called “Difference Engine No.1”. K.Eric Drexler proposed a design of mechanical Nano computer based on rods and gears made of molecules in 1988.

B. Electronic Nano computer

Electronic Nano Computer is used for the devices in which information is represented as electrostatic charge, a scalar quantity and magnitude is the charge of a single electron. Elementary components are based on soft materials, i.e. organic molecules, semiconducting polymers or carbon Nanotubes, instead of inorganic solid-state materials.

C. Chemical Nano computer

In Chemical Nano Computer, Computing is based on chemical reactions (bond breaking and forming). Inputs are encoded in the molecular structure of the reactants and outputs can be extracted from the structure of the products. Dr. Leonard Adleman proposed “DNA computing” in 1994, demonstrated that DNA, the spiraling molecule that holds life's genetic code and could be used to carry out computations.

D. Quantum Nano computer

A Quantum Nano Computer would be able to work by storing the data in the form of atomic quantum states or spin. This technology is in the developing stage, in the form of Single Electron Memory and Quantum dots.

V. QUANTUM COMPUTER & ITS IMPORTANCE

In quantum computers, [13] the binary rate in conventional computers are repeated by quantum bits or qubits, which can be in a state of 0, 1 and superposition (i.e) simultaneously both 0 and 1. Quantum computer can hold multiple states simultaneously, it is assumed that it has the potential to perform a million computations at the same time. This would make the computer much faster than before. The development of quantum computer is still under research.

Based on proposals given by Bennett, Deutsch and Feynman in 1980s, quantum bit (qubit) from the physical properties of materials, i.e. spin state, polarization is used. Quantum Computer will be able to calculate vast amounts of data that cannot be processed by present computers. A computing device using the super conducting tunnel junction can be used as the basic element for quantum computers and it is solid-state quantum bit operation. Quantum dots [1] are crystals that emit only one wavelength of light, once the electrons are excited. It is a new material made by bottom up method of Nano Fabrication. In the near future Quantum dots, could be used as quantum bits and will form the basis of quantum computers. Quantum Computing uses a completely different approach than classical computing. Quantum computing [14] is the area of study focused on developing computer technology based on the principles of quantum theory, which explains the

nature, behavior of energy and matter on the quantum level or in atomic or sub atomic level.

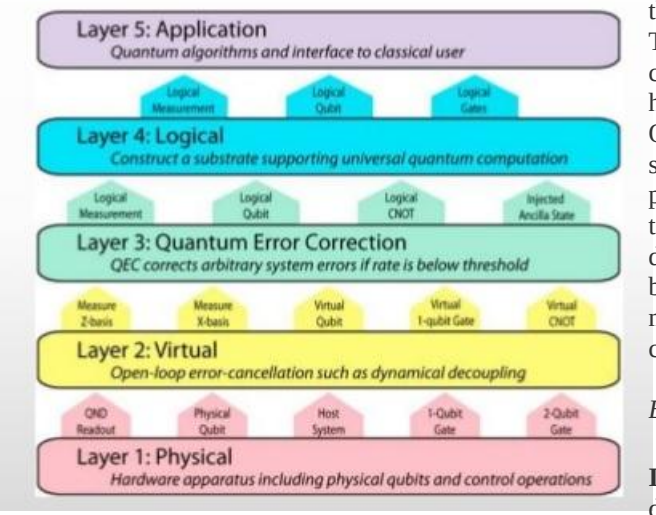

Figure: Layered Architecture of Quantum Computing

Quantum computation is a multidisciplinary field that endeavors to exploit and achieve the collaboration with quantum mechanics and computational prospect. Quantum Computer, whether analog or digital, will be probabilistic computers. Their basic states will be probabilistic in nature. It has been shown that for certain mathematical tasks, quantum computers will be faster than classical computers. The focus on developing new quantum algorithms is being taken up by the researchers, which helps in efficient and fast processing. Areas in which quantum algorithms can be applied include cryptography, search and optimization, simulation of quantum systems, and solving large systems of linear equations. In classical computer science, the concept of the random walk or Markov chain is a powerful algorithmic tool, and is often applied for searching and sampling problems. Quantum walks provide a similarly powerful and general framework for designing fast quantum algorithms.

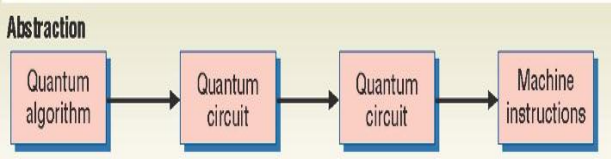

Figure: Abstraction of a Quantum Algorithm

A. Challenges of Quantum Computer

Simulation of quantum systems [15] cannot be done reliably through classical computer. A quantum simulator is a quantum computer which basically simulates another quantum system. This could help us simulate a new molecule or new Nano material and thereby help us to design better materials in the future. This task will be handled correctly on a quantum computer. In fact, this was the task for which Feynman had conceived the need for quantum computers. Quantum computing studies theoretical computation systems that make direct use of quantum mechanical phenomena, such as superposition and entanglement, to perform operations on data. Quantum computers are different from binary digital electronic computers based on transistors. A quantum computer will have massive processing power so that it can do computational tasks in parallel.

B. Advantages of Quantum Computers:

Integer Factorization: It is actually impossible for digital computers to factor large numbers which are the products of two primes of nearly equal size. Quantum Computer with 2n qubits can factor numbers with lengths of n bits (binary bits).

Quantum Database Search: Example: To search the entire Library of Congress for one's name given an unsorted database, the Classical Computer can take100 years whereas Quantum Computer can take half a second. These form a major advantage with the quantum computing.

VI. CONCLUSION

The rapid growth of Nano Technology is progressing in multidisciplinary fields including physics, chemistry, biology and material science, computers, medical, military and several other domains. There would be more advancement of Nano Technology in the future. This paper has outlined a literature study of Nano Technology, various Nano Computers and the importance of Quantum Computer in the field of computer science by using Quantum dots. In the future, a miniature world of Quantum and Nano Technology will definitely play a crucial role to speed up the processes and make the devices so simpler and tiny. This paper can give a gentle hope to make the research in the multidisciplinary fields using Nano and Quantum Computational Technology.

References

[1] Zobair Ullah, "Nanotechnology and Its Impact on Modern Computer", Global Journal of Researches in Engineering General Engineering, Volume 12 Issue 4, Year-2012, ISSN: 2249-4596 & Print:0975-5861
[2] C. Ganesh, "Nanotechnology its Importance & Applications", ICFAI National College 8E, Vengamedu, Vellur

[3] Boonserm Kaewkamnerdpong and Peter J. Bentley, "Computer Science for Nanotechnology: Needs and Opportunities", Department of Computer Science, University College London, UK
[4] Paul Beckett, "Towards Nano computer Architecture", Andrew Jennings School of Electrical & Computer Systems Engineering RMIT University PO Box 2476V Melbourne, Australia
[5] Jeremy Ramsden, "Essentials of Nano Technology", NanoTechnology @ 2009 Jermy Ramsden & Ventus Publishing ApS, ISBN 978-87-7681-418-2
[6] Sachin Kumar, Garima Pant, Vibhor Sharma, Pooja Bisht, "Nanotechnology in Computers", International Journal of Information & Computation Technology. ISSN 0974-2239 Volume 4, Number 15 (2014), pp. 1597-1603 © International Research Publications House
[7] http://www. zyvex. com/nanotech/feynman. html.
[8] http://science. howstuffworks. com/nanotechnology2. html
[9] http://www. cs. unc. edu/Research/nano/cismm/nm/index. html.
[10] http://www. nanotec. org. uk/evidence/92aUKCRC. html.
[11] K. E. Drexler, 1986. Engines of Creation: the coming era of nanotechnology. Anchor Press. [12] K. E. Drexler, C. Peterson and G. Pergamit, 1991. Unbounding the Future: The Nanotechnology Revolution.
[13]http://whatis.techtarget.com/definition/quantum-computing.html
[14] Simon J. DEVITT, William J. MUNRO, Kae NEMOTO, "High Performance Quantum Computing", National Institute for Informatics, NIT Basic Research Laboratories, January 2011
[15] A.G.Flower et. Al, "Long-Range Coupling and Scalable Architecture for Super Conducting Flux Qubits", Plug.Rev.B, Volume 76, 174507, Year:2007