Post Silicon Architectures

Akash Suryawanshi

November 18, 2020

1 Quantum Computing

1.1 About

Computers are able to speed up process by a huge amount by using quantum bits (qubit) instead of bits. Imagine that we are at the bank of a lake and we want to cross the lake. One way is to go around. If we can swim and cross the lake given that we have the same speed (suppose) then we can cross the lake at a much lesser time. Such moves exploit quantum phenomenon. There can be many paths leading to correct answer and wrong answer. Paths to correct answer for constructive interference and paths to wrong answers form destructive interference. Hence the problem is solved much faster.

1.2 Advantages

1.2.1 Cryptography

Integer factorization which is one of the most important process in the security of cryptographic systems, does not yet have an efficient algorithm and is computationally infeasible for large values of integers. This problem can be overcome using Shor's Algorithm. Shor's Algorithm uses some concepts of quantum computing and is exponentially faster than most classical algorithms known.

1.2.2 Quantum search

Quantum computers provide polynomially faster results for problems like quantum database search, which can be solved by Grover's algorithm. Here, we are being gifted with faster as well as efficient process.

1.3 Disadvantages

1.3.1 Cost

The cost of a quantum computer is no less than $20,000,000. The additional cost which includes cost of maintenance, repair, maintaining environment conditions is very high too.

1.4 Quantum decoherence

One of the most difficult challenge is removing quantum decoherence. It basically means not letting the outside disturbances affect our system. Since decoherence is irreversible, it is one of the key concerns. A study concluded that cosmic rays can decohere the systems withn 20ms. This leads to incorrect results as well as consumes more time.

2 Spintronics

2.1 About

Spintronics is the study by exploiting spin property of electrons. Let us take the example of our RAM where our computer stores temporary information. RAM is made up of capacitors which stores temporary

information. These capacitors contain electrons and based on the amount of electrons present, the value of 1 or 0 is assigned. Since in order to store more information, we make the chips smaller and smaller, the problem of electron leakage occurs. To resolve this issue, we need to constantly supply power. Spintronics uses the spin of electrons to store information. Since the spin is conserved, we don't need to constantly supply energy. If we want to change the spin, we can use an external magnetic field.

2.2 Advantages

- Low power consumption
- Bigger Storage
- Smaller in size
- Non-volatile memory: Since even after power supply is off, spins don't change.

2.3 Disadvantages

- Unable to control spin for larger distances
- Electrons lose their spin state because of silicon

References

[1] https://en.wikipedia.org/wiki/SpintronicsApplications

[2] https://www.physics.umd.edu/rgroups/spin/intro.html

[3] https://uwaterloo.ca/institute-for-quantum-computing/quantum-computing-101What-is-quantum-computing

[4] https://www.iosrjournals.org/iosr-jece/papers/sicete-volume3/30.pdf