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A Brief Survey on QCA and CMOS Technology

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Abstract

Quantum Dot Cellular Automata (QCA) is the latest emerging innovation in the nanotech field. This technology is coming as a successful alternative platform to CMOS (Complementary Metal Oxide Semiconductor) technology. Nowadays, in this technical era, we are used to gadgets. The technical journey is a platform dependent or biased parameter. In the technical field growth and development depend on the way gadgets are being used by the users. The other parameters that play an important role in this context are the application of gadgets in a versatile manner. We are habituated by the use of technical gadgets so; it is well understood that the development of any technology platform depends on the rate of increasing demand of users for more and more flexibility and comfort. This comfort zone of human beings leads us to the generation of inventions and discoveries for better consequences in the technical era. The flexibility of the technical platform of unbiased parameters shapes the development journey of the platform. The best part of the technical platform is considered according to its power consumption or power dissipation parameter. In this context, QCA has proved itself the best alternative to CMOS. The digital logic circuits are mainly designed by QCA. These circuits consume very low power. This is the main key issue of the CMOS platform which is resolved by QCA. There are some best features of QCA that are attracting the attention of lots of researchers. The QCA is used for nanoscale devices. This platform is known for ultra-low power consumption, high packing density, parity generator and parity checker circuit. These circuits are used in nano communication for error detection and correction in the message.

Keywords: Quantum dot cellular automata; QCA; Nanotechnology; Nanoscale devices

Introduction

We spent years in grasping knowledge and learning. The application of knowledge makes us curious. We are then left with lots of ideas regarding the topic. Our mind has a functional ability that always works on the processed data, we feed it while analysing our learnings. The application of positive thoughts into the real world transforms our imagination into reality. The chain of growth and development in the relevant area results in the starting of new technology.

We are in a generation that is surrounded by advanced technology. Engineering is the language of goals, achievements, knowledge, applications, creativity and targets. It is about how well you are, in designing your self-idea in this real world, an era where the beauty of the world is based on the beauty of imagination. Other than this, the technical field is the story of those achievers who accepted their own reality, struggled in this field and invest their time in learning, creating their own identity by proposing their contribution to this field. In other words, we can say that the technical field is a consequence of the applications of those learnings which we study. The deep and deep study of new techniques, inventions and discoveries helps us to become smart and better use of technical gadgets. Our technical senses, knowledge about technical gadgets their use and misuse and advantage and disadvantage, all are essential parameters. These parameters decide how fastly we connect with a new topic of research and development. Regarding these points, we can carve out the best possible. The art of working hard day and night to solve the problem and bringing new ideas as a solution to the problems is termed an art of living. These positive thoughts are the ray of hope for us to continue the life cycle, sometimes it sounds like a turning point of the era. This is a transition period for the transistor based circuits, for the hardships the gadgets designed on this platform are facing are actually game changers in the technical field. We are surrounded by CMOS based designed transistors and circuits which are designed by using these transistors. From the 1960's till now we are using transistors as essential devices in circuits [1]. The journey of CMOS goes through a lot of research and development according to the failures it has faced from time to time. The solutions to the problem are suggested by scholars, in the form of ideas to redesign, to create something better than earlier. So, by the diligent efforts of the VLSI chip designers, the CMOS platform has tried to become the best and best version of it day by day. The project is about the designing of an XOR digital logic gate using quantum dot cellular automata technology. This logic gate is also termed as ex-or gate and it is pronounced as exclusive or logic gate. This logic gate is used mainly for additional purposes. The gates are used as binary addition tools in the computer system. The circuits like a half adder, full adder, half subtractor, full subtractor, comparators and controlled inverters are designed using this logic gate. In VLSI (Very Large Scale Integrated circuits) for designing chips the two logic positive aspects creatively. The technical journey is platform-dependent. It is a field where growth and development are biased parameters.

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The future depends on the pros and cons of the relevant ideas proposed in the form of technical equipment. The versatile application of the gadgets is also responsible for the growth of the desired product. The use of gadgets and their parts on different platforms. Well, it is an important keyword of our life that is inventions. The new approach in any field is termed an invention. New ideas are proposed in our life to meet our basic needs. The other purpose of inventions is to fulfill our own creative and innovative desires. Now let's come to the point that to create something new, we need inspiration. The source of inspiration may be social and economic reasons. In this project, we are bound to discuss the transition period coming in the technical era.

The platform of CMOS (Complementary Metal Oxide Semiconductor) is changing to the platform of QCA (Quantum dot Cellular Automata). It is well understood that CMOS is in use since the 1960's. To this date, there are lots of stories have been created and proved successful. Due to a long term, we are being a part of this platform, so there are some flaws and failures faced by the systems designed on it, which are tried to solve by our experienced chip designers. It has been reduced to its maximum extent but then also there are problems regarding power consumption. As we know the famous defect in transistor based circuits is to reduce leakage current due to which power consumption is more and sometimes it causes a serious issue in the types of equipment. The need for high speed running technology and the growing demands of customers for better results or to have a better version of techniques based design gadgets; leads to a search for new ideas or inventions to meet their demands. The continuous effort of scientists and researchers has been changing the technical platform regularly and launching the next version of technical systems at regular intervals. In the coming future, we are ready to have a platform where flawless gadgets will also be designed but then growth and development in the technical era will be reduced [2]. As we can see development is the story which is designed or shaped by the defects and flaws get detected in the last version of devices. So, to get better and better technology flaws to play an important role. The human brain is also getting designed by working on next level technologies; has developed to its next version. We should always be grateful for the problems and tough situations By working on the project the lesson of life we get is that we should always be grateful for the problems, hardships and tough times we face gate mainly used are the XOR gate and AND gate. XOR gate is a multipurpose digital logic circuit. The digital logic circuits are based on binary numbers. The purpose of these circuits is to keep the balance or equivalence between the two binary numbers. The circuits work according to binary logic it gets ON for logic 1 and gets OFF for logic 0. These circuits are designed to generate output according to voltage 5 for logic 1 and show voltage 0 for logic 0. Some common devices where digital circuits are used are calculators, computers, TV, ALUs and many other devices.

The advantage of using this technology is that the circuit designed using this technique is consuming ultra-low power. There are no such problems as leakage current, issues in packing density, etc. to be faced in transistor based technology. So, working on this platform is totally profitable as we are saved from electronic waste issues also. The objective of this project is to support nanotechnology. Nano engineering is becoming so advanced version of the technical platform to serve users best through a program of continuous regular research and development.

Materials and Methods

Journey of CMOS

QCA (Quantum dot Cellular Automata) is one of the latest emerging technologies. The technical platform is designed so that it becomes the best substitute for the CMOS (Complementary Metal Oxide Semiconductor) in the upcoming near future.

The features that have attracted the attention of the researchers are its high speed, ultra-low power consuming ability and small size. These attributes are impossible to achieve in transistor based circuits. The gadgets are designed so to represent the information and execute the computations. It doesn't matter the laws and principles based on which science and technology work has been cared for or not. The materials that are used in these circuits become a part of electronic waste in case the device is rejected. Cellular automata are used in most software programs [3].

Before we go into a deep analysis of the QCA technology discussion, let me put some light on CMOS technology. In the below section we will discuss the CMOS journey in brief.

Introduction: The CMOS stands for complementary metal oxide semiconductor and is also known as complementary symmetry metal oxide semiconductor. It is termed as it is a type of metal oxide semiconductor. It is constructed of two types of transistors. These transistors are field effect transistors. These transistors are of two types:

- PMOS
- NMOS

These transistors are part of MOSFETS, semiconductor field effect transistors. The complementary and symmetry pairs of both PMOS and NMOS are used in CMOS. This new technology is used to design integrated circuit chips. Microprocessors, microcontrollers, digital circuits, memory chips and many other circuits are present in one chip. CMOS technology is extensively used for analog circuits. Some examples of analog circuits are image sensors, data converters, RF CMOS circuits and highly integrated transceivers. The process of fabrication of CMOS is started by Frank Wanlass at Fairchild. He was the first person who provokes this idea strongly on the technical platform. The whole idea was presented by Wanlass and Chi Tang Shah at the conference in the next year 1963. Later on, Wanlass filed a US patent for the CMOS circuit. The proposed patent was granted in 1967. RCA the Radio Corporation of America was an American electronics company came into existence from 1919 to 1986. The RCA is one of the oldest and most well-known brands in the consumer electronics industry. So, let's come to the point that the RCA commercialized the CMOS technology in the late 1960s with the trademark "COS-MOS'. This company was keenly interested in this technical story and was forcing other companies to support it by providing another name for the CMOS technology. This incident took place in the early 1970's. The CMOS eventually overtook NMOS as the dominant MOSFET fabrication process. This technology was used to fabricate the integrated circuits on a very large scale termed a Very Large Scale Integration (VLSI) chip. It was done in the 1980's to replace the earlier technology the Transistor Transistor Logic (TTL) technology. The transistor transistor logic technology is based on the NMOS concept. Since CMOS has remained the standard fabrication process for MOSFET semiconductor devices in VLSI chips [4]. In the latest development, in this platform, 99% of IC chips including most

digital, analog and mixed signal ICs are fabricated using this technology. There are two most important characteristics of CMOS devices:

- High noise immunity.
- Low static power consumption.

As we have discussed earlier that there are two transistors that function in this platform out of them one transistor is always OFF of the relevant MOSFET pair. CMOS devices do not produce much heat as compared to TTL (Transistor Transistor Logic). Due to these characteristics, a high density of logic functions is integrated on a chip using CMOS logic. The capacity to function on a large scale it is the most widely used technology that is implemented in VLSI chips. The physical structure of the MOS field effect transistor is referred from a phrase *i.e.* "metal oxide semiconductor". This is constructed by having a metal gate electrode placed on top of an oxide insulator which in turn is on top of semiconductor material. Once aluminium was used but now the material is polysilicon. The table below shown gives a comparison between TTL and CMOS (Table 1).

TTL (Transistor Transistor Logic)	CMOS (Complementary Metal Oxide Semiconductor)
Large physical size as compared to CMOS.	Small physical size.
It prefers Schottky diode based transistors. They have a higher switching speed.	Smaller switching speed as compared to TTL.
Dissipates a lot of power in static state.	Uses almost no power in static state *i.e.* during the change of input positions.
It requires more space and isolation.	The CMOS logic family requires less area compared to TTL.
It has lowest fan out.	It has highest fan out compared to TTL and ECL.
It has not too much facility.	It works well in high temperature.
It does not have much noise immunity.	It has better noise immunity compared to TTL and ECL.
It has no good saturation facility.	It has fastest saturation facility compared to other logic family.
It dissipates a lot of power.	It dissipates much less power compared to TTL.

Table 1: Comparison between TTL and CMOS.

IC technology: The IC technology is based on semiconductors. Silicon is mostly used for this purpose. The Si-IC technology is categorized into three types:

- Bipolar
- MOS (Metal Oxide Semiconductor)
- BICMOS

Now let us discuss each topic in detail one by one technologies:

- NMOS
- PMOS
- CMOS

These semiconductor based technologies comprise a metal gate, semiconductor and oxide. Earlier, silicon is used as a semiconductor. But at present poly silicon is generally used as a gate terminal. The voltage applied to the gate terminal controls the flow of current between the source and the drain. These elements use less power and metal oxide semiconductor permits higher integration. And now at last we are to discuss the last IC technology "The BICMOS Technology". The Bi CMOS technology is built with CMOS and bipolar transistors. These are connected together on a similar semiconductor chip. Here two technologies are incorporated CMOS technology and bipolar transistor technology. Both technologies are united together at a sensible cost to get the high density integration of MOS (Metal Oxide Semiconductor) logic.

CMOS technology: CMOS technology is used in digital logic circuits. The logic circuits were designed to construct ICs, microprocessors, static RAM and microcontrollers. The technology is also used in lots of analog circuits. The analog circuits are image sensors, data converters and integrated transceivers. The important features of this technology are

- High noise immunity.
- Low static power consumption.

In CMOS technology the pair of transistors is in OFF condition and the group of series transistors draws an important power only through the transition of switching states between ON and OFF condition states. The MOS (Metal Oxide Semiconductor) devices do not generate as much dissipate heat as other types of logic devices. The TTL devices retain some standing current even when not in use [5]. This counts as a flaw of logic devices and due to these reasons; the CMOS devices are termed the best platform for designing VLSI chips.

Advantages of CMOS technology: Under this topic we are to discuss the advantages of CMOS Technology over NMOS technology:

- The CMOS devices have low static power consumption.
- The complexity of the circuit reduces.
- The chip designed on this platform has a high density of logic functions.
- High noise immunity.

CMOS inverter: The inverter logic in any IC technology is one ofthe most important digital circuits. There is no difference between CMOS inverters and MOSFET inverters. These inverters are most widely used in chip design. These inverters work at a high speed and also consume very less power. These inverters have also very good logic buffers. The CMOS inverter is made up of two transistors:

- NMOS transistor.
- PMOS transistor.

The PMOS transistor and an NMOS transistor are connected to the gate and drain terminals and a GND terminal which is in turn connected to the NMOS source terminal. The NMOS transistor input voltage is connected to the gate terminal and the output terminal is connected to the drain terminals. It is important to observe that the

CMOS devices don't have any resistors. As we know resistors are power absorbing elements, so due to the absence of these resistors, the power capacity of CMOS devices increases more than regular resistor MOSFET inverters.

NMOS technology: The technical term NMOS stands for negative channel metal oxide semiconductor. It is pronounced as in-mos. It is a type of semiconductor that charges negatively. This is the reason that the transistors are switched by the movement of the electron. The positive channel metal oxide semiconductor PMOS, functions by moving electron positions. Thus, NMOS technology is faster than PMOS new on this platform.

The bipolar transistors are constructed using NPN or PNP structures. The very small amount of current in the solid base layer controls the huge amount of current between the terminals of an emitter and the collector. The base current in the transistor limits the additional density of the bipolar devices. The next one is MOS (Metal Oxide Semiconductor) technology.

Preference of CMOS technology over NMOS technology

This Table 2 is showing below.

CMOS (Complementary Metal Oxide Semiconductor)	NMOS (Negative Channel Metal Oxide Semiconductor)
It is a complementary metal oxide semiconductor.	It is a negative channel oxide semiconductor.
It is a two logic family device. It uses two MOS transistors PMOS and NMOS.	It uses only field effect transistors for design.
It is selected over NMOS for designing an embedded system.	CMOS is not selected for these purposes.
It transmits both logic "0" and "1".	It uses only logic "0".
It keeps energy and it does not generate heat.	Due to presence of resistors energy is dissipated when it is in changing states between "0" and "1".
Lots of people use this technology for its tough art work of fabrication and designing due to which black market of manufacturers is in control.	It is not so tough to work in this field.

Table 2: Preference of CMOS technology over NMOS technology.

Limitations of CMOS: The CMOS logic family has some limitations which are discussed in this section:

- The devices designed under this technology have a slow speed of operation.
- The propagation delay time is found to be 50 ns.
- The devices that are designed under the TTL logic family have a 4 to 12 ns propagation delay.

There were lots of limitations in the CMOS platform discussed above, due to which in recent research it is found that the technical platform isn't developing. There are blockages in implementing something new on this platform. QCA is thus emerging as a solution for transistor based circuits. Lots of limitations were resolved using the quantum dot cellular automata technology. The paper presents a detail explanation to understand the QCA platform and CMOS platform.

Results and Discussion

QCA technology

Lent, et al. implements an automaton in 1993 [6]. In this automaton, he used quantum dot cells. The automaton designed by the lent has got its popularity very fast. These cells are first time fabricated in 1997. The quantum dots are semiconductor particles. It is nanometer in size. They are also termed artificial atoms. The discrete nature of cellular automata and quantum mechanics were combined by Lent. This is done to create devices at the nanoscale. This is why the gadgets designed at the nanoscale have to perform computation speeds very high. The switching speed of these gadgets is also very high. It is in order of terahertz. The devices designed for this platform consume power in a very small amount. In a digital electronic system, the transistors play a key role in controlling the energy due to which it becomes very easy for computation on this considers the distance between the quantum dots. These quantum dots are located at a distance of 20 nm. The distance between the cells is about 60 nm. The cellular automata are a model of computation a part of automata theory. They are also termed cellular spaces, tessellation automata and homogeneous structures. The theory of automata is enough rich itself eligible to produce a lot of variety of unexpected behaviors. The cellular automata are discrete models of computation, a general model of complexity. The QCA is a part of Cellular Automata (CA).

This platform is based on the simple rules of interaction. There is an interaction between the cells placed on the grid. The cell consists of four quantum dots. These dots are arranged in a square pattern (Figure 1). The quantum dots are sites were electrons platform. The QCA cell design in its standard state can reside by tunneling into them. The figure of a single quantum cell is shown below:

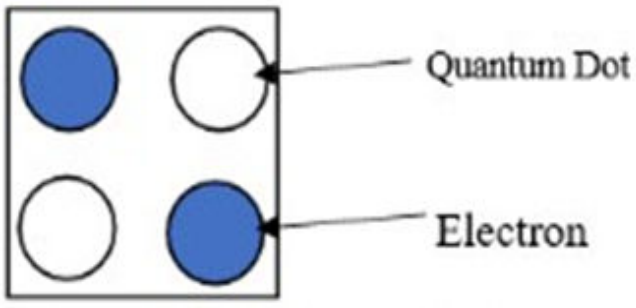

Figure 1: A simplified diagram of four dot QCA cell.

Jon Von Neumann introduced the models of cellular automata. He was a Hungarian-American mathematician, physicist, computer scientist, engineer and polymath. He was born on 28 December 1903. He is best known for the efforts he did in the early development of

computers. He is appreciated for his great contribution to the widest coverage of Mathematics. He was at that time known as the last representative of the great Mathematicians who were not so certified in pure and applied mathematics. He was the explorer of the operator theory. His ideas in the implantation of the operator theory to quantum mechanics. He is the role model figure for the development of game theory. He gave the concepts of cellular automata. From 1993 till 1957; the last days of his glorious life he worked on the Manhattan project. The purpose of this project is to develop atomic weapons. He gave the original expression of the cellular automata. Stanislaw Ulam one of his close friends gave him suggestions about his work on cellular automata. Thus, his contribution to cellular automata is regarded.

Von Neumann published more than 150 papers in his life. These papers were dedicated to physics, pure mathematics applied mathematics. According to his point of view in the technical field that quantum mechanics is one of the most essential parts of his research work in his whole carrier life as a researcher. His contributions to the modern era are supported heartily by all the researchers and scientists. That is why in honour of his achievements and efforts contributed to the field of science and technology, he was named as "financial times person of the century".

Problems identified in CMOS technology

The concept of novel digital technical platforms is designed by keeping focus to fulfill the previous requirement which is the reason of emerging of new inventions and ideas. It is important for digital technologies that it always led us to high density and very low power consumption. This new emerging nanotechnology is based on coulomb repulsion. Quantum dot Cellular Automata (QCA) is interest seeking nanotechnology. It has the potential to become an alternative to CMOS Technology. It provides an interesting prototype for faster speed, smaller size and lower power consumption in the compartment of CMOS. It is a multidisciplinary field [7]. It brings together many science and engineering disciplines. It has direct applications in sensing, sensor miniaturization and new materials development. It is also applied in electronics and electrochemical devices. Gordon Moore states that the number of transistors used in one microchip, the next year this number doubles and it is observed by him that about every two years the microchip doubles the number of transistors. This is known as Moore's law. In 1965 Gordon E. Moore has made this observation.

The law predicts that exponential growth is taking place in this development. The doubling of transistor density within two years is exponential in terms of mathematics. Gordon E. Moore is the co-founder of Intel. He observed that the number of transistors per square inch on ICs had doubled every eighteen months. This is how IC is discovered. These developments have a positive impact on the social, organizational and economic levels. This observation leads to fast growth and rapid reduction in manufacturing costs. He did not make any equation regarding his observation. But we can create Future processing power=current processing power 2n. Here n is the number of years that is needed to develop a new microprocessor and it is then divided by 2. No doubt his prediction has benefited the technology industry a lot but now it comes to an end. Engineers are unable to develop chips with smaller transistors [8]. Now the law has its failure time has arrived and Intel is currently working on 10 nm architecture. This is the atomically small size which means according to simple physics this process is going to an end permanently. The prediction is hopefully accurate for more than 40 years. The physical limitations faced by Moore's law are

- Quantum effect.
- Unpredictable behavior in low currents.
- Power consumption.
- Design issue.
- Lithography complexity.
- This complexity prevents the development of microelectronic systems.

Proposing QCA technology

Atomic size transistors are being used so it becomes challenging day by day, for the engineers to work on this platform following this rule. The best way to deal with the above complexity is to change the platform. Now we are trying to propose QCA technology as the best way to implement the technical issues to replace the CMOS technology permanently. Or you can say by keeping in mind the above discussed issue regarding growth and development in speed and calculation we are trying to take over the CMOS platform completely by QCA technology.

The Quantum dot Cellular Automata (QCA) is becoming an attractive nanotechnology. The proposed idea is termed to have more potential than CMOS. So, it is believed that it will be the best replacement for CMOS technology. It provides an interesting platform for faster speed, smaller size and lower power consumption. In comparison to transistor based technology, this platform proves itself better in both communication and computation. It has its own language of digital circuits. It is based on electron functioning which works under electrostatic force. The nanotechnology field is a multidisciplinary field. It includes disciplines of engineering, science, physics, chemistry, biosciences, material sciences, computer science, electrical engineering and mechanical engineering. It is directly applied in sensing, sensor miniaturizations and new materials development. It has applications in electronics and electrochemical devices.

Out of the top six emerging technologies, this is preferred as the most trustable platform. Let's come to know, how? It is observed that by proper implementation of this technology, we have significantly low density 10 raised to power 12 per centimeter square devices and very low power consumption is achievable. So, it is decided that this technology can be used for general purpose designing of computational circuits and memory circuits, combinational circuits and other sequential circuits. But after all the discussions at present, we cannot completely rely on this on becoming the best replacement for the CMOS platform. Our researchers and their experience with technologies tell us that QCA has some benefits and capacities which can't be observed in CMOS technology. For getting good and desired results we have to work on it with full dedication. To implement this platform, we need to work on some methods of applying to simplify and optimize designs. The basic knowledge is needed for this purpose *i.e.,* we need to know about principles related to designing purpose primitive components of QCA technology. Till now the main building block of QCA circuits are majority gate. The technology is a realization of circuit designs on a nano-scale. The novel digital technologies always led to high density and very low power consumption.

Quantum dots and building cells of QCA circuits

As we discussed before, the logical states or logical values in QCA are not calculated by voltage levels. It is to be done by using the position of electrons. The quantum dot creates this structure by making a site with very low potential. The dot is surrounded by a ring with a higher potential. QCA cell consists of four or five quantum dots. The quantum dots are in nano size semiconductors. These dots are having a hundred atoms. These atoms are located beside each other in different arrangements. It is observed by an electronic microscope. The dots are in a tetragonal or pyramid shape. In normal conditions, the QCA technology works according to the interaction between the QCA cells. These two are electrons are mobile. They are able to tunnel between neighboring dots of a cell. Due to the coulombic repulsion between these electrons, they tend to occupy the longest distance from each other. Therefore, they occupy antipodal dots of cells. In other words, we can say that two electrons never occupy dots of cells that are on the same edge. There are two stable states of polarizations where electrons put the least energy on each other (Figure 2).

Figure 2: Figure showing two stable states of polarization in a basic QCA cell.

In the above figure, there are two states of polarization in a basic QCA cell, binary zero and binary one. The polarization of each cell measures the electron probability density among four dots. In this concept, the two polarizations are considered as binary one and zero. Now as we discussed now, the coulombic repulsion forces electrons to occupy diagonal sites of the cell. Cell polarization is a quantity that measures the extent to which the charge density is aligned along these axes.

As shown in the figure above, the electrons are occupied in diagonal sites. After computing for two different diagonal sites, two quantities are obtained. They represent binary zero and one.

Background of QCA

This technology is based on a special type of cell designed by the VLSI community. The cell is square in shape and it is nano in structure. It is termed a QCA cell as it has quantum dots placed in it. This type of arrangement is termed QCA technology. The square shaped cell has four corners. Each corner is assigned a quantum dot. Out of which only two dots are having electrons and two dots are empty. The electrons are connected with tunnel junctions. These dots with electrons are placed diagonally opposite each other. The other two quantum dots which are empty are also placed tunneling action takes place inside the cell no action occurs outside the cell diagonally opposite to each other. There are two charge configurations that represent the binary "0" and "1". The respective configurations occur with the cell polarizations. There are two types of cell polarization to represent the binary language that is "-1" to represent binary "0" and "+1" to represent binary "1".

The cells in QCA exchange their information, with the help of coulombic interactions. The cells which are polarized force their neighbouring cells to get polarized in the same way. This works under the effect of coulombic interaction. The signal propagates in this way (Figure 3).

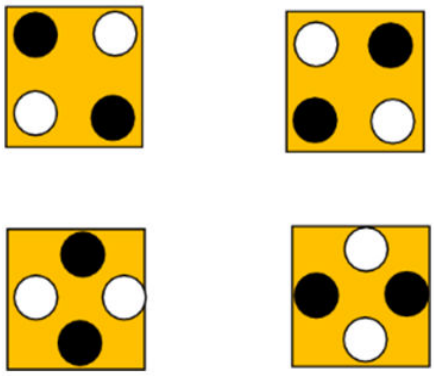

Figure 3: Propagation of the signal in QCA Cells.

QCA *vs.* CMOS

We are used to transistor based designed circuits and gadgets. Now we are proposing transistor less based designed circuits. So, the interesting points that conclude the crowd are the efficiency of the new platform. The below Table 3 is proposed to explain the differences between the two technologies and the benefits that we are having in replacing the old technology.

QCA	CMOS
Very small size	Large size comparatively
Acquires very less area	Transistor based circuit requires area
Faster speed comparatively	Slow speed
Higher switching speed	Lower switching speed
Highly scalable	Less scalable
Ultra low power consumption	Due to leakage current comparatively high power consumption

Table 3: The differences between the two (QCA and CMOS) technologies.

QCA application

The QCA technology is a trustworthy platform in the eyes of researchers who are continuously working very hard in the technical field. The cellular system of this technical concept gives us lots of reliability from the drawbacks we were facing in CMOS based devices. The best place where it is utilized more is in image sensing. Its performance becomes better by maximizing clock speed and very low power consumption. The four electron dots and two electrons work well under the force of Colombian repulsion as a complete set of circuits and give us the best results in the technology field. It is also used as a computing fabric at the nanoscale level. All nano work is going to be based on this concept in near future.

The reason behind this is that it has the potential to replace circuit based products and has some good qualities that are helping us to believe in it blindly. The fabrication process is if done nicely then we are going to dominate in this era. The new advantageous platform is going to work hard at the bottom level in the nanotech field. This field is going to meet all our demands related to technology like security communication software navigation satellites and radar etc.

Conclusion

This chapter includes a discussion of the QCA technology in detail. The CMOS technology is also discussed in detail in the literature review chapter. The motto of the discussion of both platforms one by one is to understand the story of both technical journeys. The discussion includes a short story about the CMOS journey written by me. The QCA technology is cell based technology. So, it becomes more interesting to understand the difference between circuit based technology and cell based technology. The technical journey of gadgets is beautifully described above in three stages.

The first stage is the journey of NMOS technology. The NMOS stands for Negative channel Metal Oxide Semiconductor. This technology uses only field effect transistors. The logic gates designed under this platform dissipate a lot of energy. This is due to the presence of resistors in these circuits. The next most important point is that it uses logic zero only. These are the reasons that this platform does not rule for a long time in the technical dynasty.

The second stage is the journey of the CMOS technology. The CMOS stands for Complementary Metal Oxide Semiconductor. This platform uses two transistors in its device. The concept of this platform is designed so that it uses PMOS and NMOS transistors both. The logic gates designed under this concept use both the logic “0” and “1”. The energy dissipation is very low. The noise margin of the devices designed under this platform is very high. The fabrication process is very tough due to which black marketing is under control. Overall, very few drawbacks were there at that time, so it dominates as a leading platform for a long time.

Till now we were discussing circuit based platforms. Now in the third stage, this concept is totally changed and a cell based platform is launched. This is the third stage of the technical revolution. The QCA technology is very efficient and comes as a strong zone in the technical field. The platform is ultra-low power consumption using the ability. No issue of energy dissipation or leakage current. The cost of fabrication is very cheap. The e-waste is under control. These are a few reasons why it is coming an interest of figure for researchers. This is the complete discussion of our beautiful technical era in short.

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