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The end of Moore's law-finding an alternative

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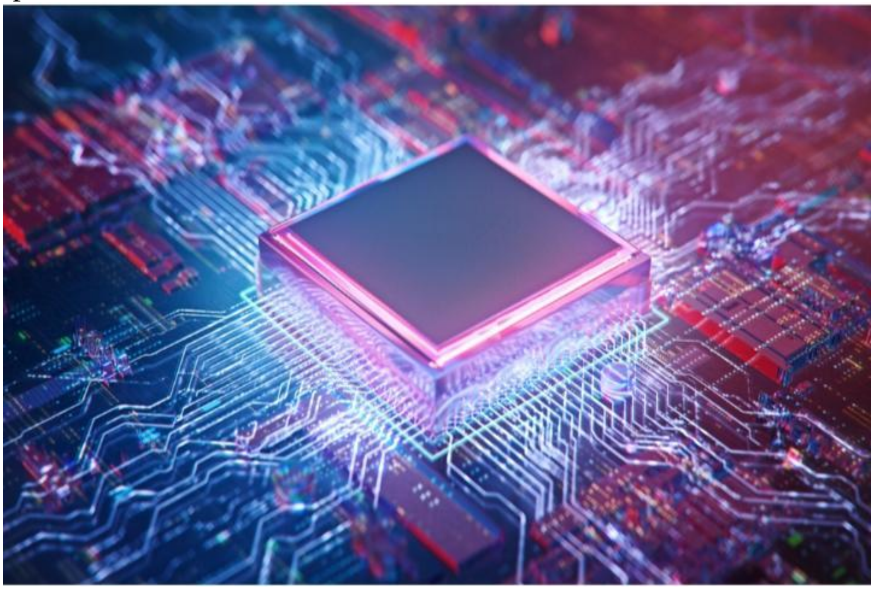
ABSTRACT
In the year 1965, Gordon E. Moore, the Co-founding father of Intel, made a remark that the number of transistors in an integrated circuit doubled about each 2 years which as a result will increase the computation power exponentially and the size of transistors also maintains decreasing.
As transistors get efficient, computer systems emerge as smaller and faster. The faster a microchip approaches electric indicators, the performance of a pc will increase with growth in microprocessors sign processing speed.



source: mit.edu

With miniaturization of transistors , the scale of the transistors is likewise coming to a physical limit, beyond which the dimensions of a transistor couldn't be reduced in addition. Smaller circuits can also ultimately now not be made because of the excessive temperatures of transistors.
So with the intention to face the end of Moore's law sooner or later of time which is nearing, we are able to want to locate an opportunity for this. The research to update those transistors with specific technology and thoughts is in process.
Keywords-Moore's law, Transistors, temperatures, computation power

INTRODUCTION

A computer's central processing unit, or CPU, is another name for a computer's processor.
The main element of a computer that moves and processes information is called a processor. One of the main selling points of a computer is its processor, often referred to as the speed at which the processor can process the computer's instructions per second, measured in hertz.
The computer you are using to read this page uses a microprocessor to perform its functions. On November 15, 1971, just over 50 years ago, Intel published an ad in Electronic News promoting the first single-chip Intel 4004. 740 kHz, nearly eight clock cycles for each instruction cycle (fetch, decode, etc.), which means the chip could execute up to 92,600 commands per second. That innovation allowed the 4004 to contain at least 2300 transistors.

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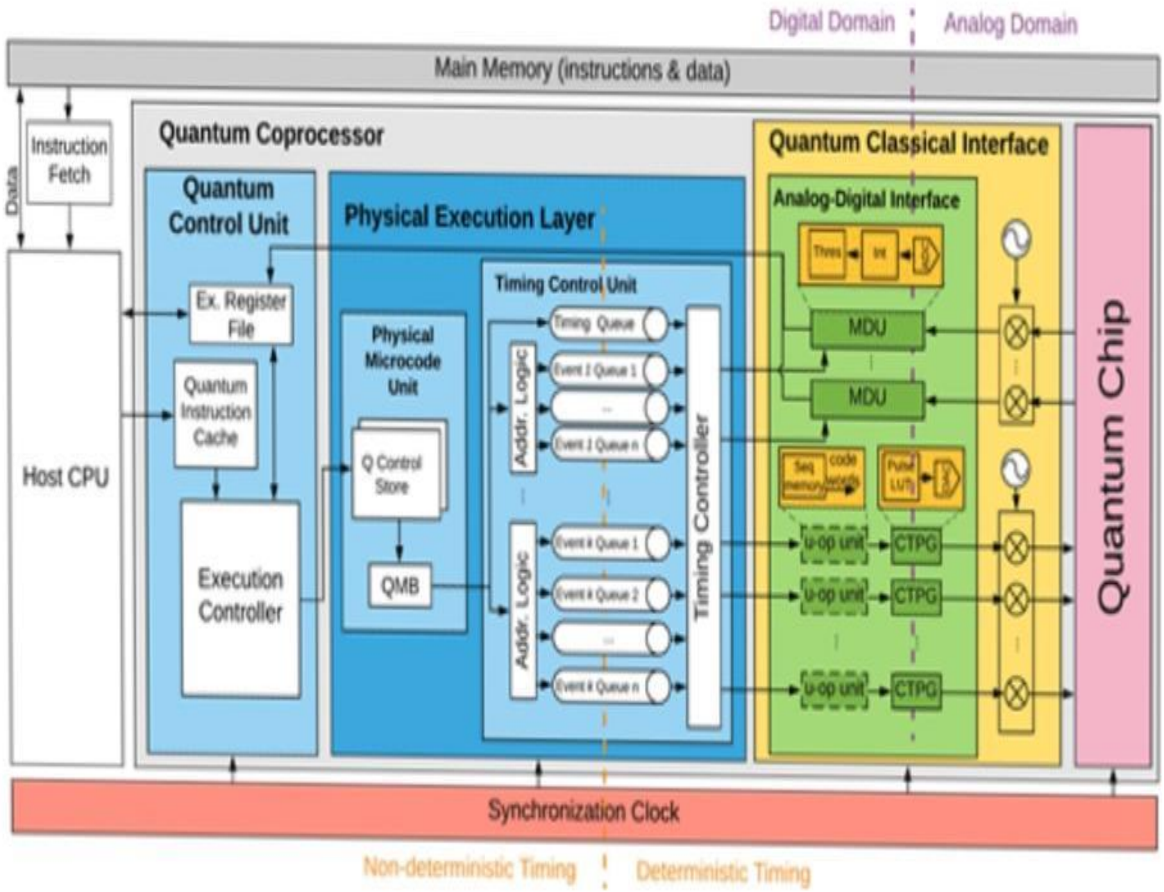
Currently, Intel's 13th generation Core Raptor Lake processors can have up to 24 cores and P-Core Turbo overclocking, which can reach up to 5.8GHz, depending on the model type. With 16 E-cores and 8 P-cores, the Core i9-13900K with a peak frequency of 5.8GHz and 4.3GHz is Intel's current flagship processor. The 13th generation i9-12900K chip has 2.95B transistors and a 7nm node size In 1965, Gordon Moore noticed that transistors were shrinking so much that every 18 months the size of a chip doubled. In 1975, Moore revised his results, doubling them every two years.

(fig.)Architecture of a quantum processor (source:umd.edu)



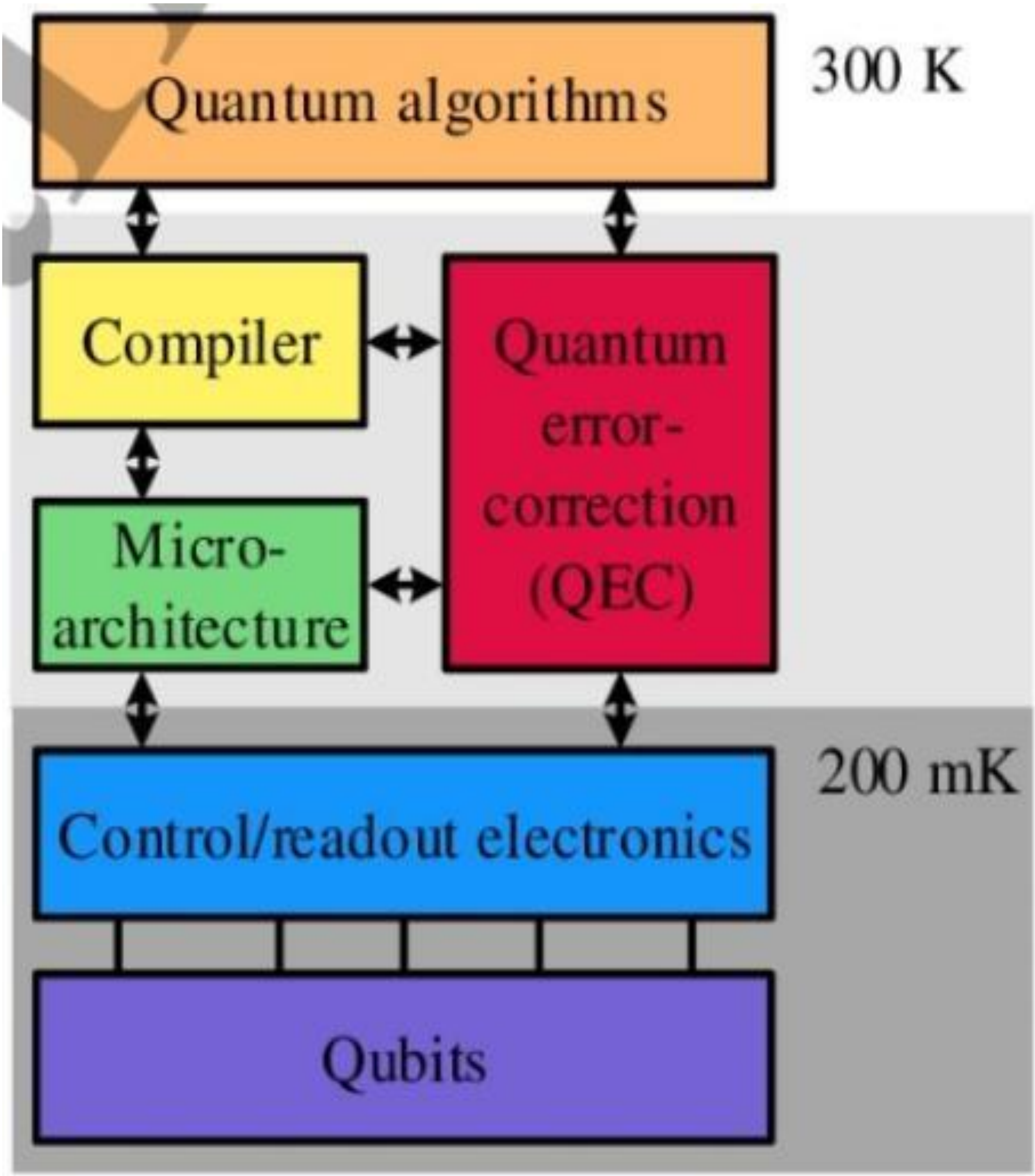
FINDING ALTERNATIVES

This article explores the application of quantum computing to transistor replacement.

Quantum teleportation is a method of transferring mixed states and quantum information from one place to another. By bringing or placing two or more unique particles together into a common quantum state, entanglement forces statistical connections between physically different systems. Quantum teleportation is an example of quantum entanglement, often referred to as "spooky action at a distance," as Albert Einstein once called it.

No matter how far apart they are, the two quantum objects involved are bound to each other in such a way that changing one immediately changes the other. One of these particles can change its quantum state simply by observing which also changes state regardless of the distance between them.

According to Popular Mechanics, even if they are light years apart, in theory, when we observe one, it immediately changes the other. Just as any classical computation can be broken down into a series of classical logic gates that operate on just a few classical bits at a time, so can any quantum. The computation can be broken down into a series of quantum logic gates that affect only a few qubits at a time.



Block diagram (source:researchgate.net)

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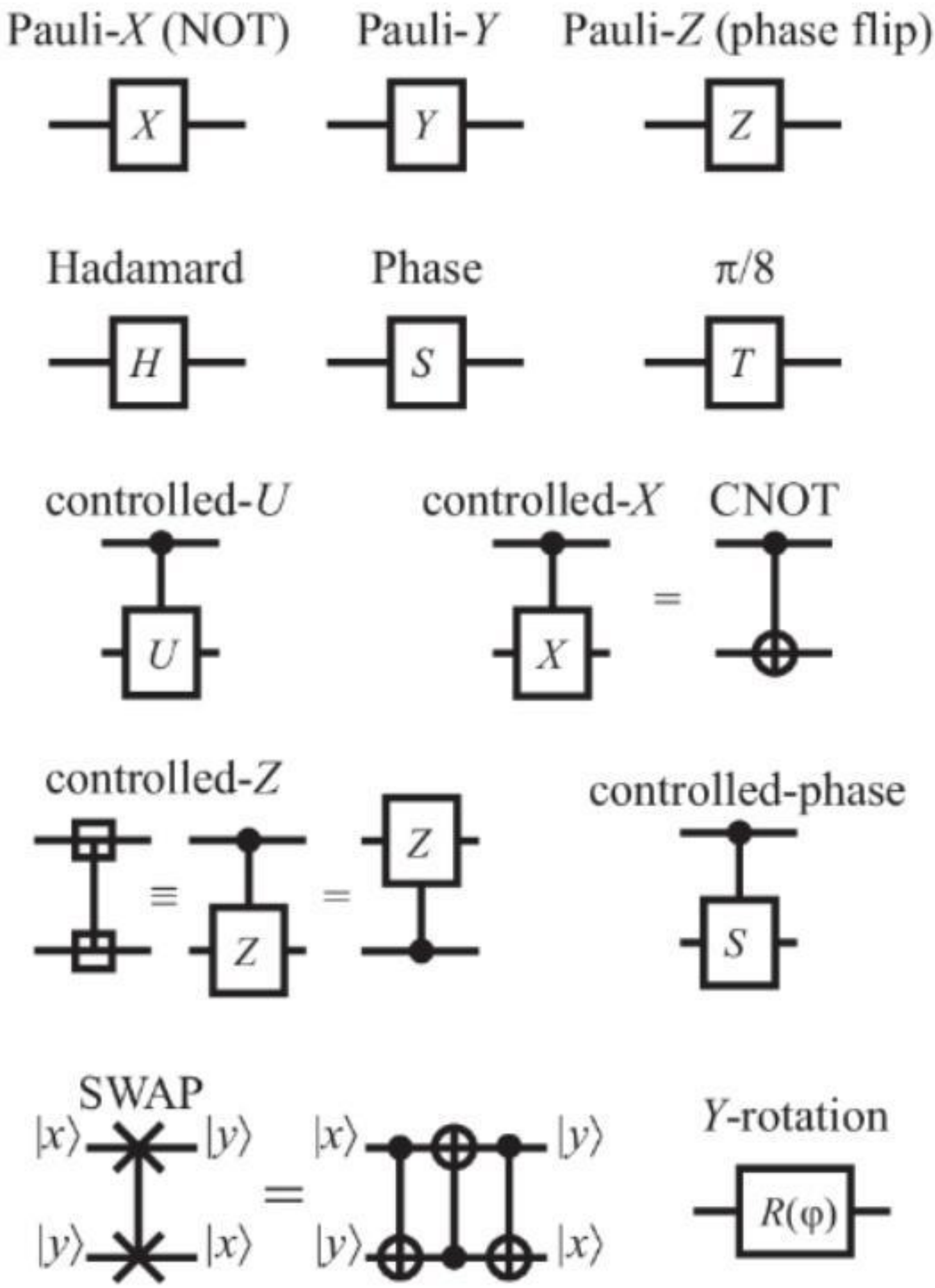
(fig.) Quantum logic gates (source:researchgate.net)



Quantum bits, or qubits, have the unique ability to be both zero and one at the same time. Quantum bits can be both on and off at the same time, unlike a classical computer, which can only be turned on or off with a light switch. Basically, a quantum computer allows us to do many calculations at the same time. Quantum bits (qubits) exponentially increase storage space.

• The power of a digital computer doubles when a quantum computer goes from 32 bits to 64 bits, which doubles its power with each qubit added.

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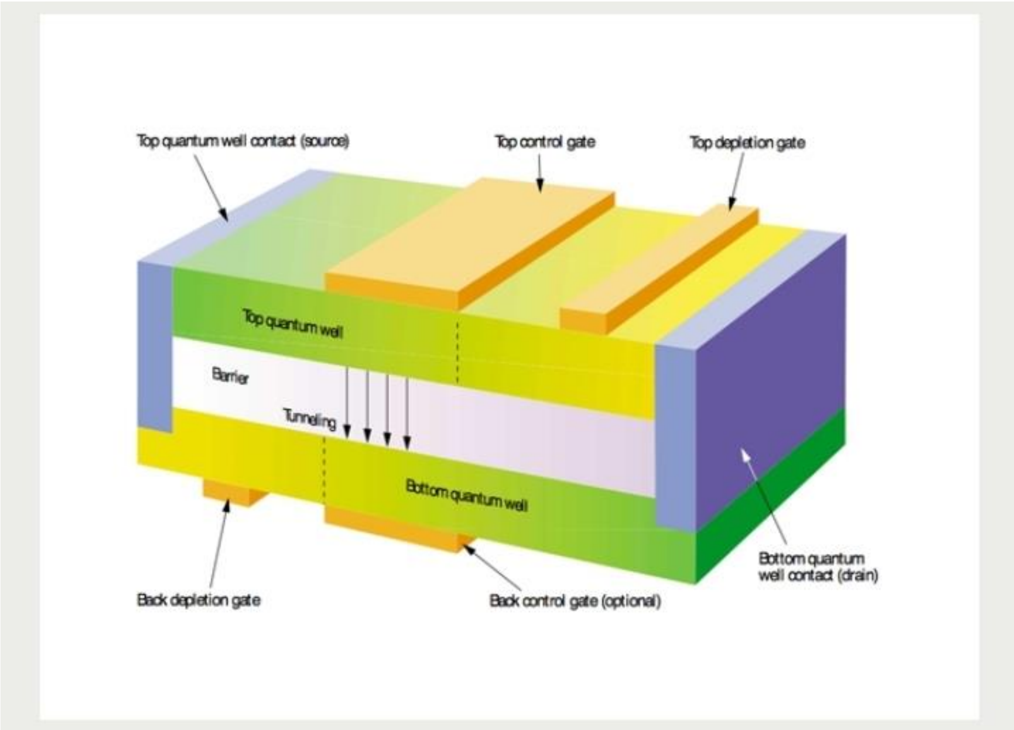
• The power of a quantum computer by doubled changing from 32 to 33 qubits.

QUANTUM TRANSISTORS

The planar double-layer tunnel transistor, or Deltt, consists of two 15 nm thick quantum holes separated by a 12.5 nm thick barrier.
The voltage applied to the upper control gate and the voltage deviation between the wells regulate the electron atmosphere between them. The upper well and lower well are in contact with the source and drain terminals, respectively. The top drain gate ensures that the drain contacts only the bottom quantum well, removing electrons from the top quantum well near the sink (yellow shaded area).
The same is achieved with a source terminal with an opposite drain port. Although quantum transistors are a novelty today, they are needed when the classical field-effect transistor (FET) cannot be made smaller, an event already on the radar screens of engineers.
Tunneling is probably the most amazing quantum phenomenon in transistor-like devices. The phrase refers to a particle breaking through a wall that would be insurmountable in the classical universe. Deltt, developed at Sandia, uses the mechanism as a basis. .
For the performance of devices like the Deltt, which has two terminals instead of three, developers are basing their efforts on high speed, even if they are still in the early stages of research. They have been shown to oscillate at frequencies up to 700 GHz and are known as resonant tunneling diodes.
Deltts are also suitable for mass production. They are built using a planar method and traditional semiconductor coating. It is possible to control the

(fig.) quantum transistor (source:ieee.org)



landing with an accuracy of a few tenths of a nanometer. The discrete energy levels allowed for electrons in a well depend on the size of the well and the height of the barrier (defined as the energy required for an electron to move through it). Only if the energy and momentum of the electron are in the plane can an electron tunnel through the barrier. In other words, an electron tunneling can happen only if the energy state of the quantum well on the other side of the barrier is the same as its originally occupied energy state and momentum for both energies.
Normally, the device is turned off when no voltage is applied because the two wells do not have matching spaces.

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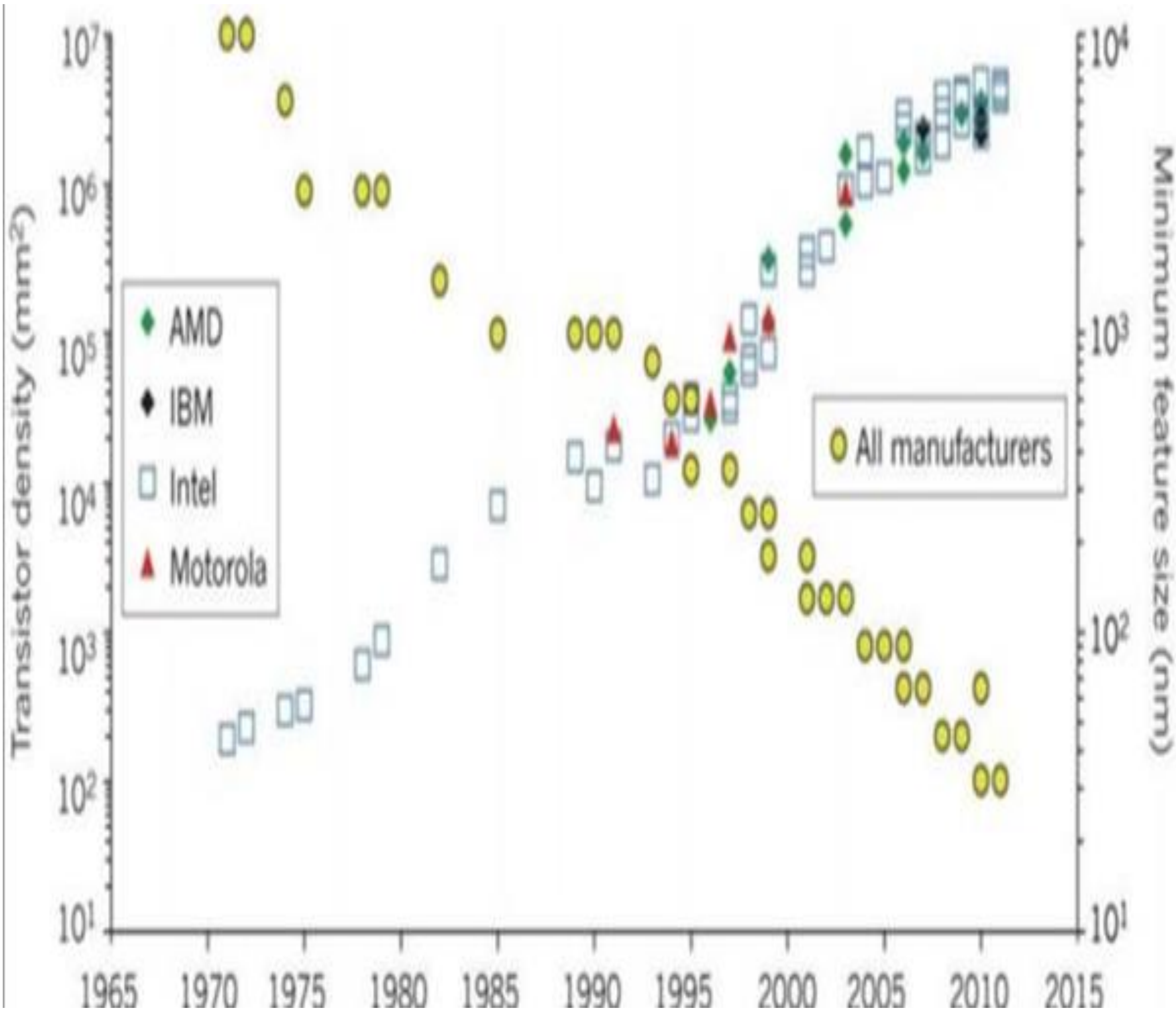
However, if the energy level of the electrons in one well is properly changed, the energy states oppose each other and tunneling occurs - this state is called resonance. Applying voltage to the control gate or tilting one well relative to the other transfers energies. In practice, both voltages are used when using Delta.

A delta can be turned on or off by applying a voltage to the gate with a certain source-drain bias, analogous to conventional transistor switching. However, there is one important difference. The current increases as the gate or drain voltage is increased in a typical transistor. However, in deltas, raising the voltage above the resonance point causes the current to break. In other words, the differential resistance, which is the difference in voltage from the change in current, can decrease. This feature allows additional circuits to be built using a single type of transistor instead of the n-type and p-type transistors required for CMOS circuits.



(fig.)Comparing feature sizes of classical and quantum transistors (source: researchgate.net)

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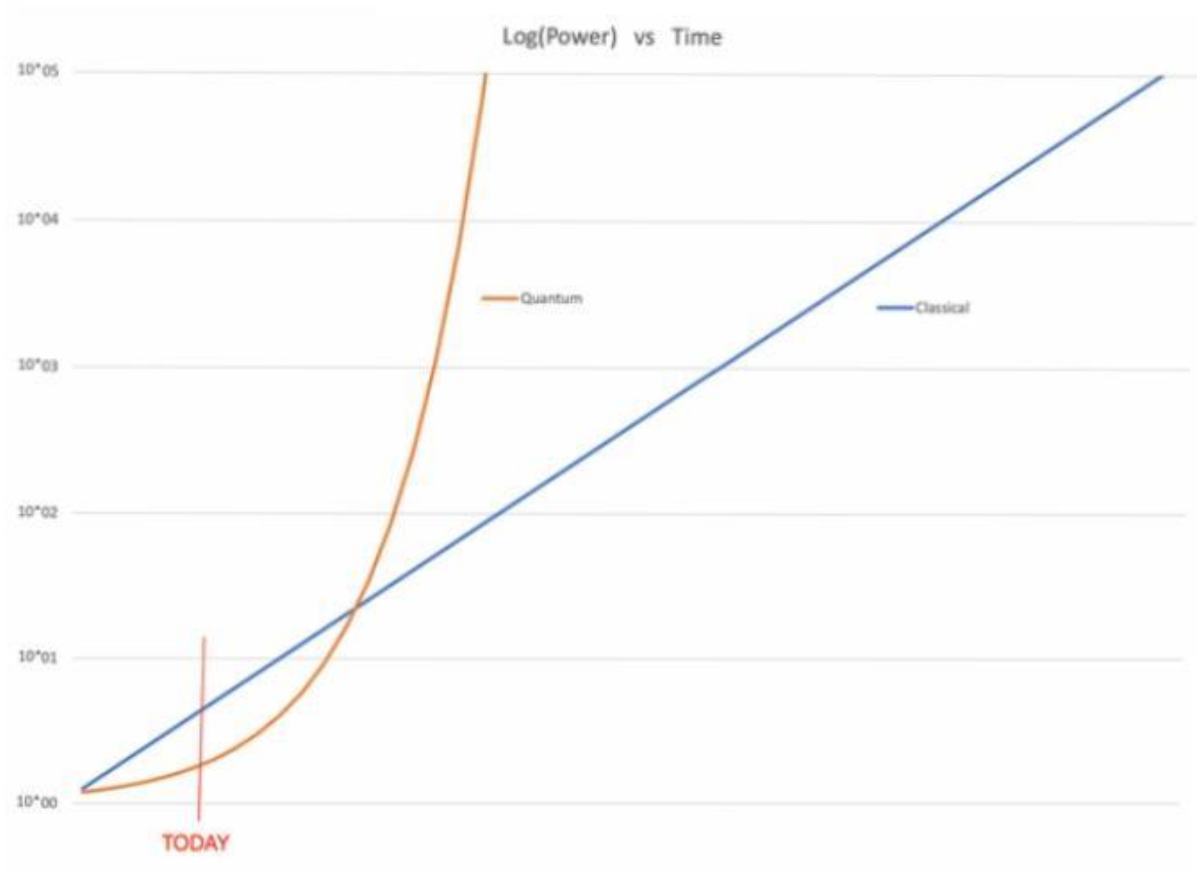
Whether we rise to the stars or not depends on how far we can push the error rate. Small improvements in error rate lead to huge improvements in computational efficiency.
(source: nickyoder.com)



Current quantum machines (1/100 error) are vaguely useful for some toy problems. With an error rate of 1 in 10,000, these machines could revolutionize medical research, materials engineering and cryptography.

CONCLUSION

We might draw the conclusion from this that the classical approach is based on the turning on and off of electrical circuits, whereas quantum computing is framed on concepts of superposition and quantum entanglement, which allow for the existence of several states simultaneously. CMOS and quantum transistors are employed in classical and quantum processing, respectively.
The use of traditional computing methods is well-known. It's cheap and doesn't require any special equipment. It is quick and deterministic for some problems.
Traditional physics and the absence of parallel processing are, however, its limitations.
Quantum computing has the capability of massively parallel processing, which may speed up the resolution of some issues.
It works for some kinds of problems and is non-deterministic in nature. Therefore, it overcomes the shortcomings of traditional computing in some way.
There have not yet been any published actual demonstrations or performance descriptions; At press conferences, some quantum devices have only been mentioned.

Notwithstanding, quantum figuring requires the utilization of specific equipment, for example, cryogenic contraption to keep the qubits at incredibly low temperatures and particular control hardware to work the qubits. They are also expensive and prone to interference from outside sources. How far we can move the Mistake Rate will decide if we rise towards the stars.
Even modest reductions in error rates will significantly advance computing.

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