BEES Magazine

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K S R Institute for Engineering and Technology

Department of Electrical and Electronics Engineering

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Together We Make Difference

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Editorial Board

5 G

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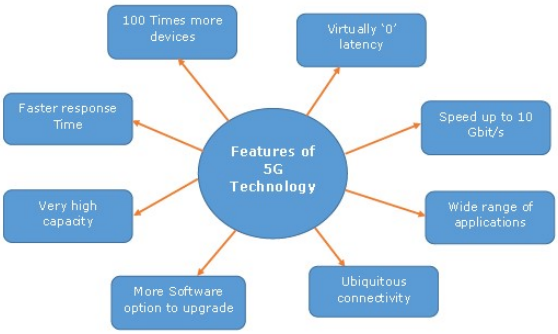
Introduction

Radio technologies have evidenced a rapid and multidirectional evolution with the launch of the analogue cellular systems in 1980s. Thereafter, digital wireless communication systems are consistently on a mission to fulfil the growing need of human beings (1G, …4G, or now 5G).

Salient Features of 5G

5th Generation Mobile Network or simply 5G is the forthcoming revolution of mobile technology. The features and its usability are much beyond the expectation of a normal human being. With its ultra-high speed, it is potential enough to change the meaning of a cell phone usability.



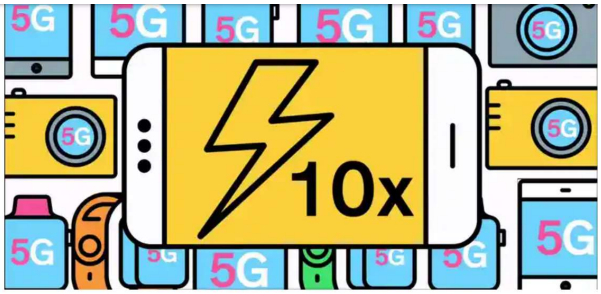
With a huge array of innovative features, now your smart phone would be more parallel to the laptop. You can use broadband internet connection; other significant features that fascinate people are more gaming options, wider multimedia options, connectivity everywhere, zero latency, faster response time, and high quality sound and HD video can be transferred on other cell phone without compromising with the quality of audio and video. G technology is the next generation of wireless communications. It is expected to provide Internet connections that are least 40 times faster than 4G LTE. 5G technology may use a variety of spectrum bands, including millimeter wave (mmWave) radio spectrum, which can carry very large amounts of data a short distance. The drawback of the higher frequencies is that they are more easily obstructed by the walls of buildings, trees and other foliage, and even inclement weather.

The forthcoming 5G technology will come from various vendors and will be composed of solutions designed to provide very fast download speeds and low latency. Today—in advance of 5G's expected debut around 2020—companies such as Verizon, AT&T, Samsung, and Ericsson are testing new advances in signal processing, chips, and antenna technologies that will enable the next generation of mobile connectivity.

But when you dig deeper into the 5G evolution, you'll find an array of 5G technology that will underpin future wireless communications.

Data centers for 5G need to be low latency, highly flexible, and support automation and cloud

technology. Learn how QCT QxStack with Cloud Native Platform is built with the 5G data center in mind.



Source: IEEE Spectrum

The 5G Technology That Will Make Everything HappenAs the 5G technology market comes into focus, we're seeing a number of technologies emerge as vital to the 5G experience. These include the aforementioned mmWave technology; small cells; massive multiple input, multiple output (MIMO); full duplex; software-defined networking (SDN); and beamforming.

Millimeter wave: Millimeter waves are broadcast at frequencies between 30 GHz and 300 GHz, compared with the bands below 6 GHz used for 4G LTE. The new 5G networks will be able to transmit very large amounts of data—but only a few blocks at a time. Although the 5G standard will offer the greatest benefits over these higher frequencies, it will also work in low frequencies as well as unlicensed frequencies that WiFi currently uses, without creating conflicts with existing WiFi networks. For this reason, 5G networks will use small cells to complement traditional cellular towers.

Small cells: Small cells are low-powered portable base stations that can be placed throughout cities. Carriers can install many small cells to form a dense, multifaceted infrastructure. Small cells' low-profile antennas make them unobtrusive, but their sheer numbers make them difficult to set up in rural areas. As 5G technology matures, consumers should expect to see ubiquitous 5G antennas, even in their own homes.

Massive MIMO: 5G technology enables base stations to support many more antennas than 4G base stations. With MIMO, both the source (transmitter) and the destination (receiver) have multiple antennas, thus maximizing efficiency and speed. MIMO also introduces interference potential, leading to the necessity of beamforming. Beamforming: Beamforming is a 5G technology that finds the most efficient data-delivery route to individual users. Higher-frequency antennas enable the steering of narrower transmission beams. This user-specific beamforming allows transmissions both vertically and horizontally. Beam direction can change several times per millisecond. Beamforming can help massive MIMO arrays make more efficient use of the spectrum around them.

Full duplex: Full duplex communication is a way to potentially double the speed of wireless communication. By employing a 5G full duplex scheme on a single channel, only one channel is needed to transmit data to and from the base station, rather than two. A potential drawback of full duplex is that it can create signal interference.

SDN: SDN and network functions virtualization (NFV) are considered the foundation for how 5G will be deployed.

5G Technology Is Rampant

This assemblage of 5G technology—along with much more that's still evolving through vendor cooperation—will power the wireless networks of the future, enabling such use cases as interactive television, high-definition and 3-D video, social gaming, virtual reality (VR) and augmented reality (AR), robotics, automated vehicles, advanced manufacturing, healthcare imaging and diagnostics, and more.

5G Replace WiFi?

The 5G standard promises to embody a mobile-connectivity revolution, providing enhanced broadband connectivity and speed for a wide swath of customers. As we approach that future, an increasing number of people are debating whether the 5G standard will replace WiFi — through the sheer force of its strength and ubiquity — or otherwise cause problems with WiFi networks.

This 5G WiFi debate depends on the supposition that the two technologies will somehow merge onto the same track as the industry coalescences into next-gen communications. But in reality, many experts believe that 5G and WiFi will continue along their current, differentiated paths for the foreseeable future.

There are many reasons why 5G will continue the 4G interoperability methodology. First, from a consumer point of view, billions of existing and forthcoming WiFi-only devices such as tablets, entertainment systems, and computer peripherals will not be going anywhere soon. As for business cases, enterprises will continue to value the availability of WiFi connections as part of a multi-connectivity scenario for services such as Software-Defined Wide Area Network (SD-WAN).

Here are some other reasons by WiFi will continue to thrive even with the launch of 5G: The Wi-Fi market is growing, not shrinking. According to a MarketsandMarkets report, the global WiFi market will be worth 33.6 billion by 2020. WiFi traffic, from both mobile and WiFi-only devices, will account for more than 50 percent of total IP traffic by that time.

WiFi understands dense deployments. The 5G future is dense. Grids will be composed of small cells and ubiquitous antenna to enhance capacity and coverage—a scenario that WiFi already understands.

Regenerative Braking

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Introduction

Regenerative braking systems (RBSs) are a type of kinetic energy recovery system that transfers the kinetic energy of an object in motion into potential or stored energy to slow the vehicle down, and as a result increases fuel efficiency.These systems are also called kinetic energy recovery systems. There are multiple methods of energy conversion in RBSs including spring, flywheel, electromagnetic and hydraulic. More recently, an electromagnetic-flywheel hybrid RBS has emerged as well. Each type of RBS utilizes a different energy conversion or storage method, giving varying efficiency and applications for each type.

RBSs are installed along the drive train or fitted to the drive wheels of a vehicle where they inhibit the motion of the wheels using magnetic fields or mechanical torque. These methods of motion inhibition allow energy to be generated under braking, as opposed to friction brakes which simply waste away energy to slow the vehicle by turning the kinetic energy into thermal energy. Due to the maximum charging rate of the energy storage mechanisms, the braking force from a RBS is limited. Therefore, a traditional friction brake system is required to maintain the safe operation of a vehicle when heavy braking is necessary. RBS can improve fuel consumption and reduce the overall braking load taken on by the vehicles friction brakes, reducing the wear on the brake pads.

RBSs are used in almost every electric vehicles and hybrid electric vehicles. In addition, public transportation such as buses and bullet trains make use of RBSs to decrease the environmental impacts of the transportation fleet and save money.

History

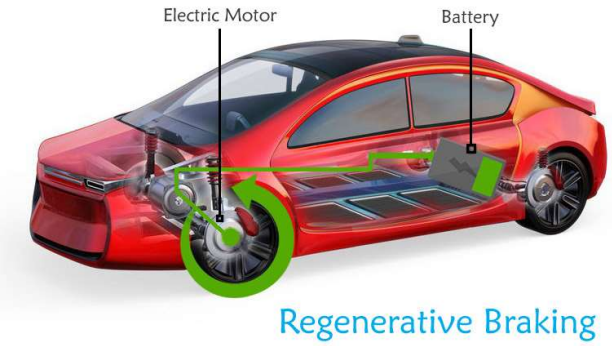
The idea of a brake that could take the kinetic energy it absorbs and turn it into potential energy for later use has been around since the late 1800s. Some of the early attempts of this technology were to install spring type RBS on front wheel drive bicycles or horse-drawn cabs.

The Baku-Tbilisi-Batumi railway started applying RBS in the early 1930s. This is one example of early using of this technology in railway system.

In the 1950s, Swiss company Oerlikon developed the gyrobus, which utilized flywheel as its energy storage method. The effects of gyroscopic motion on the bus soon resulted in it being discontinued.

In 1967, the American Motor Car Company (AMC) created an electrical energy regeneration brake for their concept electric car, the AMC Amitron. Toyota was the first car manufacturer to commercialize RBS technology in their Prius series hybrid cars.

Since then, RBSs have evolved to be used in almost all electric and hybrid cars, as well as some gas-powered vehicles.



Methods of Energy Conversion and Storage

There are multiple methods of energy conversion in RBS including spring, flywheel, electromagnetic and hydraulic. More recently, an electromagnetic-flywheel hybrid RBS has emerged as well. Each type of RBS utilizes a different energy conversion or storage method, giving varying efficiency and applications for each type. Currently, the most commonly used type is the electromagnetic system.[8]

Electromagnetic

In electromagnetic system, the drive shaft of the vehicles is connected to an electric generator, which uses magnetic fields to restrict the rotation of the drive shaft, slowing the vehicle and generating electricity. In the case of electric and hybrid vehicles, the electricity generated is sent to the batteries, giving them a recharge. In gas powered vehicles, the electricity can be used to power the cars electronics or sent to a battery where it can later used to give the vehicle an extra boost of power. This technique is currently used in some Le Mans Prototype racing cars.

Flywheel

In flywheel RBS, the system collects the kinetic energy of the vehicle to spin a flywheel that is connected to the drive shaft through a transmission and gear box. The spinning flywheel can then provide torque to the drive shaft, giving the vehicle a power boost.

Electromagnetic-flywheel

Electro flywheel regenerative brake is a hybrid model of electromagnetic and flywheel RBSs. It shares the basic power generation methods with the electromagnetic system; however, the energy is stored in a flywheel rather than in batteries. In this sense, the flywheel serves as a mechanical battery, where electrical energy can be stored and recovered.[10] Due to the longevity of flywheel batteries compared to lithium-ion batteries, electric flywheel RBS is the more cost effective electricity storage method.

Spring

The spring loaded regenerative braking system is typically used on human powered vehicles, such as bicycles or wheelchairs. In spring RBS, a coil or spring is winded around a cone during braking to

store energy in the form of elastic potential. The potential can then be returned to assist the driver while going up hill or over rough terrain.

Hydraulic

The hydraulic RBS slows the vehicle by generating electricity which is then used to compress a fluid. Nitrogen gas is often chosen as the working fluid. Hydraulic RBSs have the longest energy storage capability of any system, as compressed fluid does not dissipate energy over time. However, compressing gas with a pump is a slow process and severely limits the power of the hydraulic RBS.

Applications

Hybrid and Electric Cars

Modern hybrid and electric cars both utilize an electric engine to power the car which makes applying regenerative braking very simple and efficient. In the vast majority of these cars, the transmission of the car is set up such that when the driver applies the brakes, the electric motor reverses itself and applies a resistance to the wheels rather than power. The resistance applied to the wheels is then put through the electric motor where it is used to recharge the batteries.

In high performance electric cars, improving the feel of the car is very important to car manufacturers. Many customers support electric super-cars but are against purchasing them because of the lack of high performance feel. One important aspect of this feel is engine braking. In a standard internal combustion engine, once power is not being applied to the engine, the natural friction inside the engine works to slow the vehicle down. In electric cars, this friction force does not apply;

Auto Racing

In 2009, Formula 1 (a common type of race car) introduced a regenerative braking system called the Kinetic Energy Recovery System (KERS). The uptake of the system was slow at first and had no teams using it in the 2010 season; however, improvements to the system in the 2011 season made it extremely beneficial to cars and almost all teams adopted some form of the system. Formula one cars use either a four flywheel or electric generator system to store energy under braking. This stored energy can then be utilized by the driver by pushing a button on thier steering wheel. The FIA restricts the use to 6.67 seconds per lap during which the system gives the car an extra 81 hp.

Limitations

Due to the maximum recharging rate of the circuit and the capacity of battery, the braking force from an electromagnetic type RBS is always limited. Therefore, a traditional friction brake system is required to convert the excess energy from the vehicle. The friction brake can also prevent the loss of braking ability in the case of RBS failure.

RBS can only be installed on driving wheels since a drive train is required for energy recovery. The waste heat is not significantly reduced unless the vehicle is an all wheel drive model.

Adding a RBS to a vehicle means to increase the curb weight of it. Although RBS can improve fuel economy under start-and-stop driving conditions, it may have negative effect on fuel consumption during highway cruising.

3D Integrated Circuits

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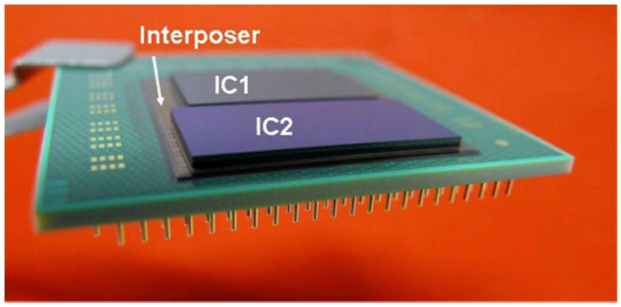
Introduction

n the world of semiconductors and microelectronics, a trend to vertically stack integrated circuits (ICs) or circuitry has emerged as a viable solution for meeting electronic device requirements such as higher performance, increased functionality, lower power consumption, and a smaller footprint. The various methods and processes used to achieve this are called 3D integration technologies.

In general, 3D integration is a broad term that includes such technologies as 3D wafer-level packaging; 2.5D and 3D interposer-based integration; 3D stacked ICs (3D-SICs), monolithic 3D ICs; 3D heterogeneous integration; and 3D systems integration.

3D Packaging

3D packaging refers to 3D integration schemes that rely on traditional methods of interconnect at the package level such as wire bonding and flip chip to achieve vertical stacks.



Examples of 3D packages include package-on-package (PoP) where individual die are packaged, and the packages are stacked and interconnected with wire bonds or flip chip processes; and 3D wafer-level packaging (3D WLP) that uses redistribution layers (RDL) and bumping processes to form interconnects.

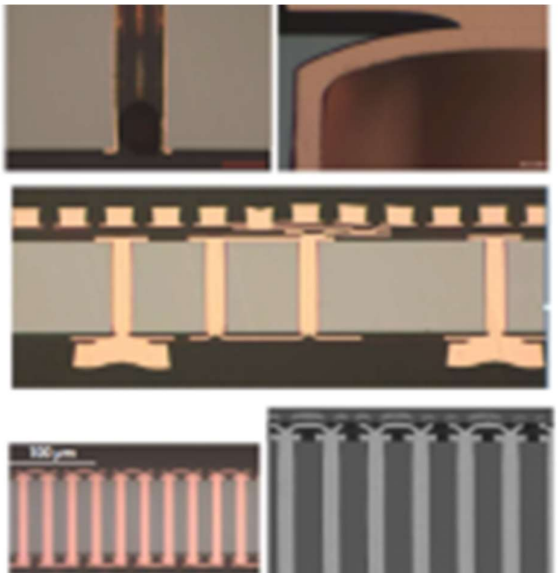
2.5D interposer is a configuration where dies are mounted side-by-side on a silicon, glass, or organic interposer using through silicon vias (TSVs) through the interposer. (When glass or organic laminate is used as the interposer substrate, the vias are called through glass vias (TGV) and through substrate via (TSV) respectively.) Communication between the dies takes place via circuitry fabricated on the interposer.

CMOS image sensors (CIS) have TSVs as backside vias to form interconnects, eliminate wire bonds, and allow for reduced form factor and higher-density interconnects. In all types of 3D packaging, chips in the package communicate using off-chip signaling, much as if they were mounted in separate package on a normal circuit board.

3D ICs can be divided into 3D Stacked ICs (3D-SICs), which refers to stacking IC chips and interconnecting them with TSVs; and true 3D ICs, which use fab processes to stack multiple device layers on a single chip, which may or may not use very-fine-pitch TSVs to form the interconnect.

Through Silicon Vias

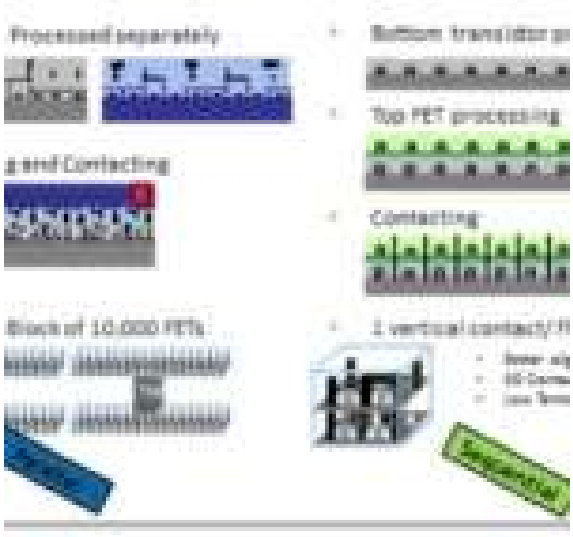
Through silicon vias (TSVs) are holes created in a silicon wafer using an etch process. Interconnects are formed by filling TSVs with a conductive material, such as copper, tungsten, or polysilicon.



The main advantage of TSV interconnects is the shortened path for the signal to travel from one chip to the next, or one layer of circuitry to the next. This allows for reduced power, and the ability to increase interconnect density, thereby increasing functionality and performance. TSVs are not 3D ICs all by themselves. Rather, they are the building blocks that enable 3D ICs. Backside vias are also used in other devices such as image sensors, microelectromechanical systems (MEMS) and compound semiconductors.

monolithic 3D ICs

Rather than stacking wafers or die to create 3D ICs,monolithic 3D ICs begin with a base wafer onto which additional layers of crystallized silicon, metalized layers and active as well as passive circuitry are added using traditional fab equipment



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The vertical interconnects are formed between layers rather than chips, using vias in the nanometer rather than micron range; as is the case with TSVs. There are several different approaches being developed, targeting mainly memory applications. Monolithic 3D is also sometimes called Sequential 3D.

3D memory

There are a number of approaches being developed to stack memory vertically for both non-volatile (NAND Flash) and volatile (DRAM) memory devices. DRAM approaches include high-bandwidth memory (HBM), Micron's Hybrid Memory Cube, and Tezzaron's disintegrated RAM (DiRAM). All of these are based on 3D ICs using TSVs (Figure 3).

Samsung, Toshiba and a number of other companies are developing 3D NAND Flash, based on monolithic 3D approaches.

2.5D technology was first developed to be a bridge technology to 3D ICs, and has grown to be a package platform that is expected to co-exist alongside 3D ICs. Unlike in 3D-ICs, only the interposer, and not the dies themselves, needs TSVs to connect active die with package substrates. This allows for the use of existing die designs.

Main technology drivers for 3D integration

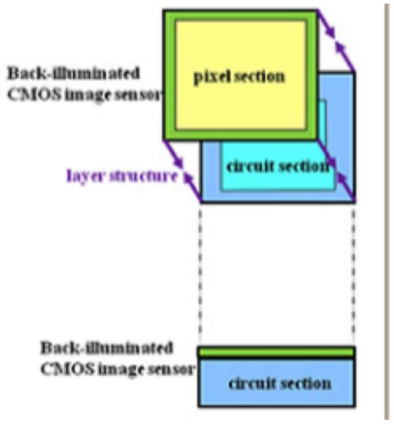
The increased costs of lithography steps and wafer processing in general at the next-generation silicon nodes are driving the industry to find alternatives to improve the performance and functionality of our electronic devices, lower the cost. Additionally, the need to integrate disparate technologies (logic, memory, RF, sensors, etc) in small form factors is driving the industry to 3D integration as a solution.

What are the market drivers for 3D integration

The market drivers for 3D integration begin with high-end computing, servers and data centers, military and aerospace, and medical devices, because they have the greatest need and can bear the cost of current 3D integration technologies. Tablets, smartphones and gaming devices are also driving the technology.

Challenges being faced by 3D ICs

While many claim there are no remaining technology challenges—and that those that are left can be easily engineered out—certain process steps still need better solutions, namely, design tools for planning, implementing and verifying 2.5D and 3D ICs, thin wafer handling, thermal management, and test. The main challenge is unit cost at the current, low volumes and implementation risk, due to a slowly maturing ecosystem. Efforts are underway to reduce process costs and streamline industry-wide cooperation. Yield improvements will enable cost reduction. However, many 3D experts believe that implementing 3D ICs will reduce system costs considerably, and that the remaining challenge is educating the system-level engineers about the benefits of designing 3D ICs into their systems.



CMOS Image Sensors (CIS) were the first devices to implement via-last backside vias at high volumes. CIS with backside illumination (BSI) is now in production, and as the CIS is stacked on top of the IC, it is a 3D IC device (Figure 2). Xilinx introduced 2.5D interposer designs in 2011 with their Virtex-7 family of all programmable FPGAs.

Tezzaron has delivered DiRAMs in lower volumes for the past few years.
In late 2014, Micron and Samsung are expected to begin production of the hybrid memory cube (HMC), which is a 3D DRAM stack on top of a logic device. SK Hynix will offer HMC and High Bandwidth Memory (HBM) at the same time. The high-volume production of these 3D integrated memory devices is expected for 2014 /15 and will continue with logic stacks and heterogeneous devices over the next few years.

Digital Light Processing

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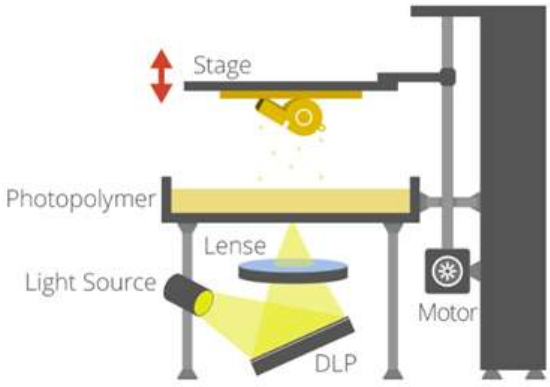
Introduction

DLP (Digital Light Processing) is a similar process to stereolithography in that it is a 3D printing process that works with photopolymers. The major difference is the light source. DLP uses a more conventional light source, such as an arc lamp with a liquid crystal display panel, which is applied to the entire surface of the vat of photopolymer resin in a single pass, generally making it faster than SL. Also like SL, DLP produces highly accurate parts with excellent resolution, but its similarities also include the same requirements for support structures and post-curing. However, one advantage of DLP over SL is that only a shallow vat of resin is required to facilitate the process, which generally results in less waste and lower running costs.



In this process, once the 3D model is sent to the printer, a vat of liquid polymer is exposed to light from a DLP projector under safelight conditions.

The DLP projector displays the image of the 3D model onto the liquid polymer. The exposed liquid polymer hardens and the build plate moves down and the liquid polymer is once more exposed to light. The process is repeated until the 3D model is complete and the vat is drained of liquid, revealing the solidified model. DLP 3D printing is faster and can print objects with a higher resolution.

Because of the nature of the SL process, it requires support structures for some parts, specifically those with overhangs or undercuts. These structures need to be manually removed. In terms of other post processing steps, many objects 3D printed using SL need to be cleaned and cured. Curing involves subjecting the part to intense light in an oven-like machine to fully harden the resin.

The process

Objects are built in a container filled with liquid photopolymer, which is a plastic which reacts to light. An adjustable building platform is initially placed in its highest position, submerged in a thin layer of liquid photopolymer. A procector cobined wiht an angled mirror projects a series of projectins across the entire platform to solidify the complete cross section.

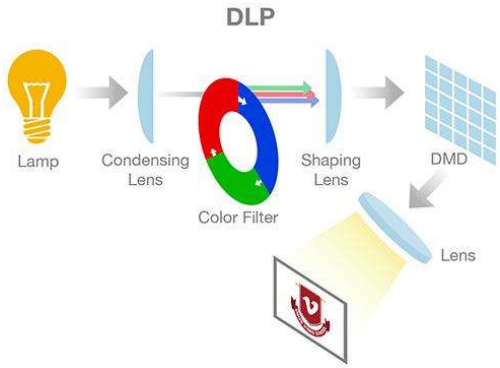
The platform is lowered so that the previous layer is now covered by a new, thin layer of liquid. The DLP projector solidifies a new layer which sticks to the previous layer.

Support structures can be created if needed, if the liquid cannot support the weight of the overhanging parts of the component. The process is repeated until the object is completed and the finished part is usually cleaned by ultrasound and alcohol.

Digital Light Processing Projector

Digital light processing is a display device based on optical micro-electro-mechanical technology. In simple words, it is the device which is used inside the projectors used for showing films in theatres.

Components



- Lamp
- Condensing lens
- Colour Filter
- Shaping Lens
- DMD (digital micromirror device)

Working of the Projector

Lamp:

The lamp is generally a Xenon arch lamp which is ignited by a 5000 - 20,000 volt pulse from a current-regulating ballast to initiate an arc between two electrodes in the quartz tube.

Condensing Lens :

The light passes through the condensing lens which converges light on the colour wheel.

Colour Wheel :

Now let's understand what this colour wheel is. You can see in the diagram given above that there is a chip (DMD) which sends light to the screen. All that the chip can do is either send or not send light – making it black-and-white only. To create colour images, projector manufacturers include a colour wheel which rotates in synchronization over the DLP chip. As it rotates between red, blue and green, the DLP chip sends the correct pattern of light. Because the images go on and off the screen so quickly, the brain puts them together into one full-colour image. It gives us a sense of a continuous motion picture going on, a phenomenon known as Persistence.

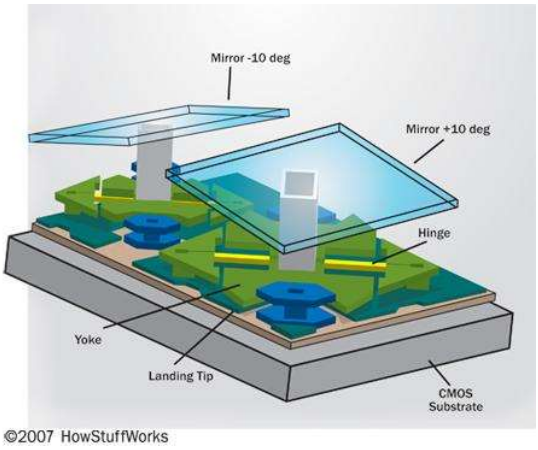
DMD Chip :

After passing through colour wheel light falls on the DMD chip. A DMD chip has on its surface several hundred thousand microscopic mirrors arranged in a rectangular array which correspond to the pixels in the image to be displayed. The mirrors

can be individually rotated ±10-12°, to an on or off state. In the on state, light from the projector bulb is reflected into the lens making the pixel appear bright on the screen. In the off state, the light is directed elsewhere (usually onto a heatsink), making the pixel appear dark.

Working of the DMD chip

The working mechanisms of a DMD chip is a very interesting combination of application of mechanical, electrical and optical engineering.



The DMD chip has millions of small mirrors. Before any of the mirrors in the DMD chip switch to their on or off positions, the chip will rapidly decode a bit-streamed image code that enters through the semiconductor. It then converts the data from interlaced to progressive, allowing the picture to fade in. Next, the chip sizes the picture to fit the screen and makes any necessary adjustments to the picture, including brightness, sharpness and colour quality. Finally, it relays all the information to the mirrors, completing the whole process in just 16 microseconds.

The mirrors are mounted on tiny mechanical hinges that enable them to tilt either toward the light source (ON) or away from it (OFF) up to +/- 12°, and as often as 5,000 times per second. When a mirror is switched on more than off, it creates a light gray pixel. Conversely, if a mirror is off more than on, the pixel will be a dark gray. Now combining this with the colour wheel, we can get all the colours we want. In simple words, the proportion of time the mirror is ON decides the intensity of the color which is sent to it by the color wheel.

Lens

Finally all the data (pixels) obtained from the DMD chip is projected on screen after passing the light through a diverging lens and thus we get the desired visual output on the screen.

Quantum Computing

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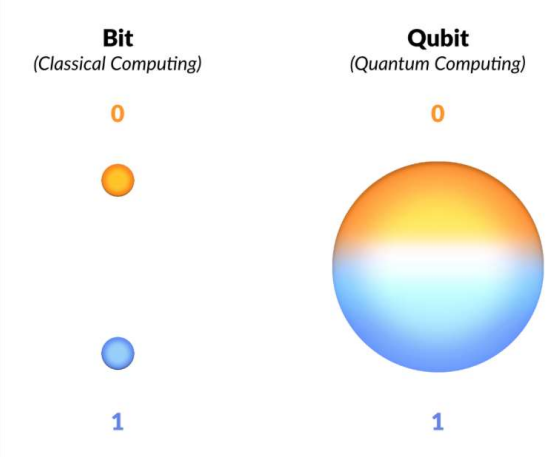
Introduction

With quantum computing we can harness the super powers superposition and entanglement to solve complex problems that our classical computers cannot do. **Thus a quantum computer uses the quantum phenomena of subatomic particles to compute complex mathematical problems.**

A quantum computer uses qubits to supply information and communicate through the system. Its encoded with quantum information in both states of **0 and 1** instead of classical bits which can only be **0 or 1**. This means a qubit can be in multiple places at once due to superposition.



Imagine the following example, I write an X on a random page in a random book in a library with 1 million books and tell a quantum and classical computer to find the X. For a classical computer, it would have to sort through every page of every book one by one to find the X which would consume a lot of time. For a quantum computer, a qubit in superposition can be in a multiple places at once so it can analyze every page at the same time and find the X instantly.

Superposition and entanglement in a quantum computer:

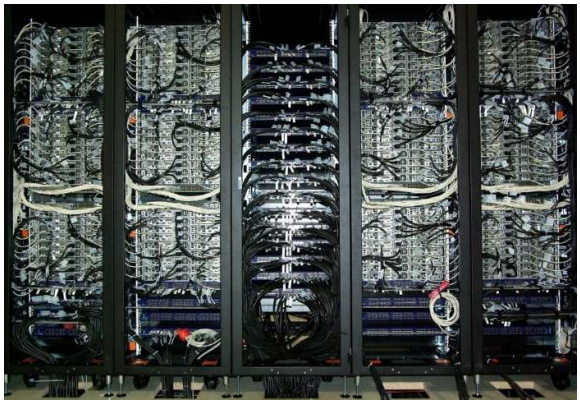
- qubits unlike classical computers can be in a superposition of both 0 and 1
- a complex system of qubits can be in many superpositions at once, example 5 qubits can be in a superposition of 32 states (2^n)
- 2 entangled qubits are correlated with one another, information on one qubit will reveal information about the other unknown qubit

At about 50 qubits, many say a quantum computer could achieve "quantum supremacy" ~ John Preskill

Together both properties of superposition and entanglement will enable qubits to compute huge amounts of data simultaneously and solve complex problems such as optimization which classical computers would take millions of years to calculate.

Importance of optimization problem

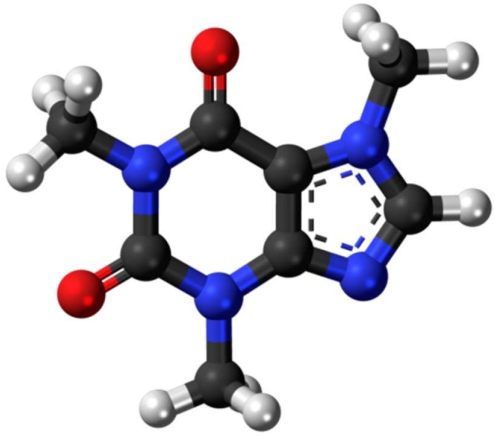
An optimization problem is essentially finding the best solution to a problem from endless number of possibilities.



Classical computers would have to configure and sort through every possible solution one at a time,

on a large scale problem this could take millions of years.

Quantum computers can find all possible variants at the same time using superposition and entanglement and sift through large amounts of data in a significantly small amount of time.



One problem we have now is simulating possible chemical compositions of different compounds due to complex structures that involve a lot of combinations of electron repulsion and attraction. It is another type of optimization problem with countless possibilities for bonds and shapes of molecules.

With quantum computing this problem is easily scalable with enough qubits to configure all possibilities for the structure of a molecule. It can be revolutionary for drug discovery in the pharmaceutical industry for classification of millions of drugs and optimizing for the best possible ones for a certain disease. This can be a game changer for personalized medicine, genomics, and being able to fully scale our DNA.

One company using this cutting edge technology is Biogen with Accenture labs and 1QBit to completely change the way of traditional drug discovery.

The process of computing on a quantum computer is very different from a classical computer. To solve optimization problems there are set algorithms used and qubits function a lot differently to reach the optimal value. The process is explained below in a very simple manner but in reality it is a lot more complex.

The Process of Utilizing Quantum Algorithms:

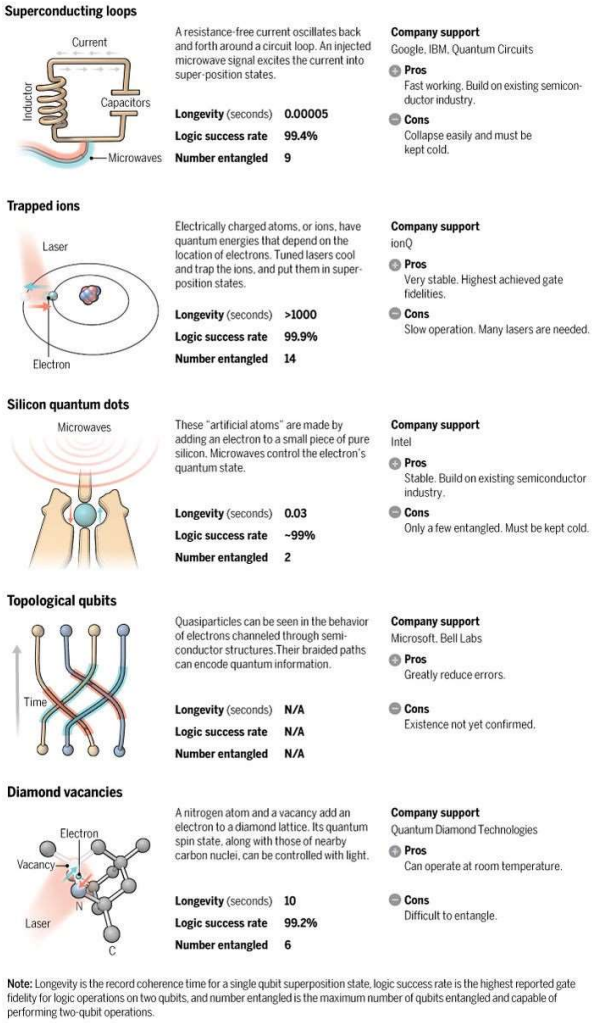
1. Activate qubits to reach a superpositions of all possible states
2. Encode the optimization problem by applying a phase on each superposition state
3. Use methods of interference to cancel or add phases to optimize for the correct answer and shrink the wrong answers (like noise canceling in headphones)

However its not very easy getting qubits to cooperate with a system. As more number of qubits are added to a system the higher the error rates. To have a working computational quantum computer your system must satisfy these properties:

- Initialize all of your qubits to a known state
- Rotate individual qubits.
- Measure individual qubits.
- Perform an operation that entangles pairs of qubits.
- Stay free of outside interference (decoherence) for as long as it takes to finish a computation.

For a quantum computer to be functional it must have qubits that can harness quantum properties and have all possible measures must be taken to reduce error rates. Qubits are prone to instability and error which is why the system needs to be

cooled down as close to 0 kelvin degrees and all accounts of error must be calculated to have a decoherent environment.



Types of qubits

The Canadian based quantum computer company D-Wave Systems Inc. has a 2000 qubit quantum computer on the market for $15 million. Pretty decent price I would say for a machine that can do math on just a couple atoms. It uses superconducting loops to create functional qubits. The other possible methods are being explored by large tech companies like Google, IBM, Intel, Microsoft, etc. Everyone is in the race to reach **"quantum supremacy." This is the point where quantum computers will outperform classical supercomputers.** 2018 is another year for many future breakthroughs in quantum computers, there is no way to tell how soon we will reach quantum supremacy.

Quantum computers are in their early stage of development much like the classical computers back in the 50's. No doubt with the classical computers came revolutionary technology such as the internet so imagine the applications of quantum computers for the future. *Who back in the 50's could predict such a thing as social media and the concept of being connected to millions of people through transmitting signals?*

Future Applications of quantum computers:

- Better online security with development in quantum encryption
- Significantly improve AI technology
- Drug research and discovery
- More accurate weather predictions
- Optimizing traffic control

Quantum mechanics are the laws of subatomic particles with phenomenas such as quantum tunnelling, superposition and entanglement. Quantum computers will use qubits to encode quantum information and calculate complex mathematical problems using superposition and entanglement. Quantum computers can solve optimization problems which can revolutionize drug discovery and many more industries. Qubits are unstable and very susceptible to environmental changes, only work with 0 outside interference due to fragile system Many types of qubits being used today to create the world's best functional quantum computer Lots of research still needed to create a quantum computer that can defeat our classical supercomputers

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Organic Light Emitting Diode

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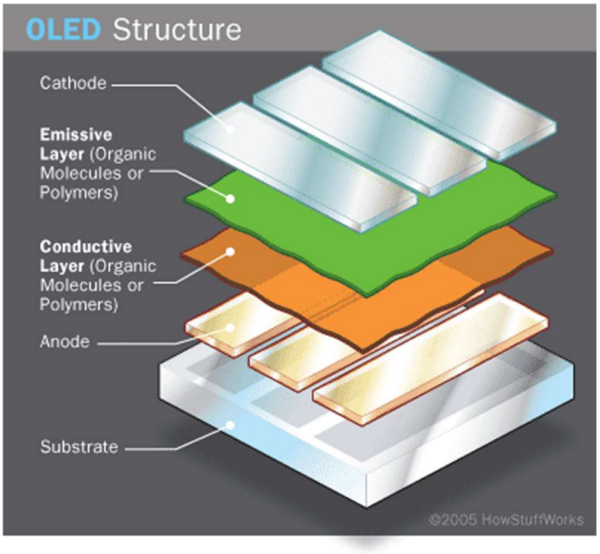
Introduction

Organic Light Emitting Diode OLED is a solid-state semiconductor device that is 100 to 500 nanometers thick or about 200 times smaller than a human hair. OLEDs can have either two layers or three layers of organic material; in the latter design, the third layer helps transport electrons from the cathode to the emissive layer. In this article, we'll be focusing on the two-layer design.



An OLED consists of the following parts:
Substrate (clear plastic, glass, foil) - The substrate supports the OLED.
Anode (transparent) - The anode removes electrons (adds electron "holes") when a current flows through the device.
Organic layers - These layers are made of organic molecules or polymers.
Conducting layer - This layer is made of organic plastic molecules that transport "holes" from the anode. One conducting polymer used in OLEDs is polyaniline.
Emissive layer - This layer is made of organic plastic molecules (different ones from the conducting layer) that transport electrons from the cathode; this is where light is made. One polymer used in the emissive layer is polyfluorene.
Cathode (may or may not be transparent depending on the type of OLED) - The cathode injects electrons when a current flows through the device.
The biggest part of manufacturing OLEDs is applying the organic layers to the substrate. This can be done in three ways:

Vacuum deposition or vacuum thermal evaporation (VTE) - In a vacuum chamber, the organic molecules are gently heated (evaporated) and allowed to condense as thin films onto cooled substrates. This process is expensive and inefficient.

Organic vapor phase deposition (OVPD) - In a low-pressure, hot-walled reactor chamber, a carrier gas transports evaporated organic molecules onto cooled substrates, where they condense into thin films. Using a carrier gas increases the efficiency and reduces the cost of making OLEDs.

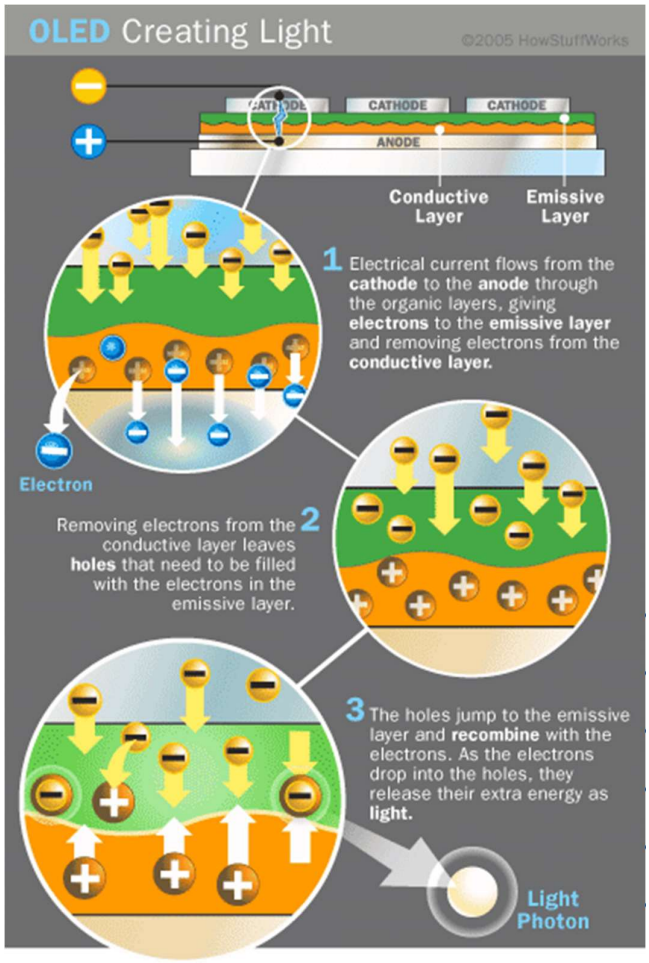
Inkjet printing - With inkjet technology, OLEDs are sprayed onto substrates just like inks are sprayed onto paper during printing. Inkjet technology greatly reduces the cost of OLED manufacturing and allows OLEDs to be printed onto very large films for large displays like 80-inch TV screens or electronic billboards.

Working of OLED

OLEDs emit light in a similar manner to LEDs, through a process called **electrophosphorescence**.

The process is as follows:

The battery or power supply of the device containing the OLED applies a voltage across the OLED.



An electrical current flows from the cathode to the anode through the organic layers (an electrical current is a flow of electrons). The cathode gives electrons to the emissive layer of organic molecules. The anode removes electrons from the conductive layer of organic molecules. (This is the equivalent to giving electron holes to the conductive layer.)

At the boundary between the emissive and the conductive layers, electrons find electron holes. When an electron finds an electron hole, the electron fills the hole (it falls into an energy level of the atom that's missing an electron). When this happens, the electron gives up energy in the form of a photon of light (see How Light Works).

The OLED emits light.

The color of the light depends on the type of organic molecule in the emissive layer. Manufacturers place several types of organic films on the same OLED to make color displays.

The intensity or brightness of the light depends on the amount of electrical current applied: the more current, the brighter the light.

There are several types of OLEDs:

Passive-matrix OLED

Active-matrix OLED

Transparent OLED

Top-emitting OLED

Foldable OLED

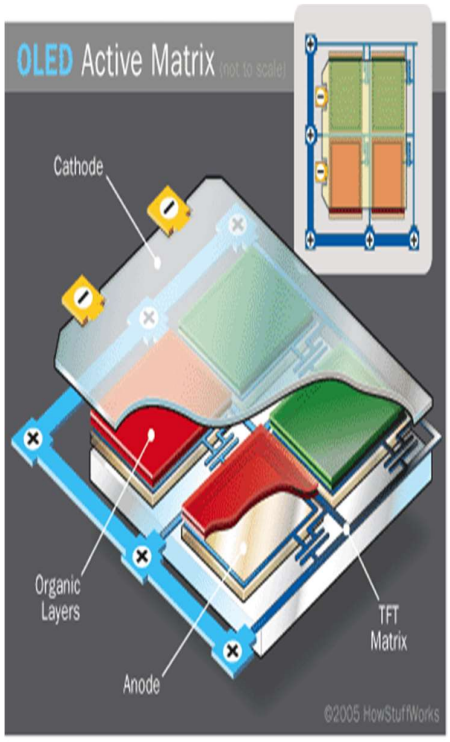
White OLED

Each type has different uses. In the following sections, we'll discuss each type of OLED. Let's start with passive-matrix and active-matrix OLEDs.

Passive-matrix OLED (PMOLED)

PMOLEDs have strips of cathode, organic layers and strips of anode. The anode strips are arranged perpendicular to the cathode strips. The intersections of the cathode and anode make up the **pixels** where light is emitted. External circuitry applies current to selected strips of anode and cathode, determining which pixels get turned on and which pixels remain off. Again, the brightness of each pixel is proportional to the amount of applied current.

PMOLEDs are easy to make, but they consume more power than other types of OLED, mainly due to the power needed for the external circuitry. PMOLEDs are most efficient for text and icons and are best suited for small screens (2- to 3-inch diagonal) such as those you find in cell phones, PDAs and MP3 players. Even with the external circuitry, passive-matrix OLEDs consume less battery power than the LCDs that currently power these devices.



Active-matrix OLED (AMOLED)

AMOLEDs have full layers of cathode, organic molecules and anode, but the anode layer overlays a thin film transistor (TFT) array that forms a matrix. The TFT array itself is the circuitry that determines which pixels get turned on to form an image.

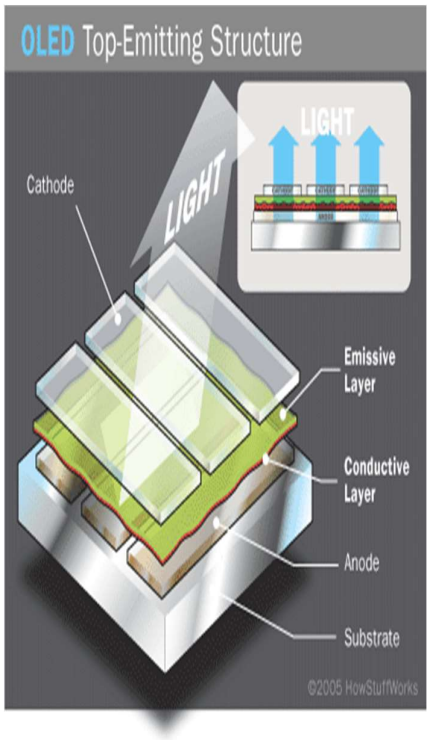
AMOLEDs consume less power than PMOLEDs because the TFT array requires less power than external circuitry, so they are efficient for large displays. AMOLEDs also have faster refresh rates suitable for video. The best uses for AMOLEDs are computer monitors, large-screen TVs and electronic signs or billboards.

Transparent OLED

Transparent OLEDs have only transparent components (substrate, cathode and anode) and, when turned off, are up to 85 percent as transparent as their substrate. When a transparent OLED display is turned on, it allows light to pass in both directions. A transparent OLED display can be either active- or passive-matrix. This technology can be used for heads-up displays.

Top-emitting OLED

Top-emitting OLEDs have a substrate that is either opaque or reflective. They are best suited to active-matrix design. Manufacturers may use top-emitting OLED displays in smart cards.



Foldable OLED

Foldable OLEDs have substrates made of ver flexible metallic foils or plastics. Foldable OLEDs ar very lightweight and durable. Their use in device such as cell phones and PDAs can reduce breakage, major cause for return or repair. Potentially, foldabl OLED displays can be attached to fabrics to creat "smart" clothing, such as outdoor survival clothin with an integrated computer chip, cell phone, GP receiver and OLED display sewn into it.

White OLED

White OLEDs emit white light that is brighter, mor uniform and more energy efficient than that emitte by fluorescent lights. White OLEDs also have th true-color qualities of incandescent lighting. Becaus OLEDs can be made in large sheets, they can replac fluorescent lights that are currently used in homes an buildings. Their use could potentially reduce energ costs for lighting.

In the next section, we'll discuss the pros and cons o OLED technology and how it compares to regula LED and LCD technology.

OLED Advantages and Disadvantages

The LCD is currently the display of choice in sma devices and is also popular in large-screen TVs Regular LEDs often form the digits on digital clock and other electronic devices. OLEDs offer man advantages over both LCDs and LEDs:

The plastic, organic layers of an OLED are **thinner, lighter and more flexible** than the crystalline layers in an LED or LCD.

- Because the light-emitting layers of an OLED are lighter, the substrate of an OLED can be **flexible** instead of rigid. OLED substrates can be plastic rather than the glass used for LEDs and LCDs.
- OLEDs are **brighter** than LEDs. Because the organic layers of an OLED are much thinner than the corresponding inorganic crystal layers of an LED, the conductive and emissive layers of an OLED can be multi-layered. Also, LEDs and LCDs require glass for support, and glass absorbs some light. OLEDs do not require glass.
- OLEDs do not require backlighting like LCDs (see How LCDs Work). LCDs work by selectively blocking areas of the backlight to make the images that you see, while OLEDs generate light themselves. Because OLEDs do not require backlighting, they **consume much less power** than LCDs (most of the LCD power goes to the backlighting). This is especially important for battery-operated devices such as cell phones.
- OLEDs are easier to produce and can be made to larger sizes. Because OLEDs are essentially plastics, they can be made into large, thin sheets. It is much more difficult to grow and lay down so many liquid crystals.
- OLEDs have **large fields of view**, about 170 degrees. Because LCDs work by blocking light, they have an inherent viewing obstacle from certain angles. OLEDs produce their own light, so they have a much wider viewing range.

Digital Marketing

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Introduction

Digital marketing is a combination of two words i.e. digital and marketing. In simple words, **Digital** means anything that you can see or hear from an electronics device such as TV, mobile phone, radio. **Marketing** means to understand the needs of the consumer and provide the products or services accordingly.

Digital Marketing is done in order to reach a targeted audience to analyze their demands, to promote product and services and to create brand awareness using different digital platforms present online. It is mainly done on the Internet.

Example – Sending an E-mail for the marketing various food offers like the ones which Zomato, Swiggy normally do.

Marketing can also be done using conventional methods such as TV advertisements, billboards, visiting cards, hoardings. But these methods need huge investment, are not so cost-effective, and it's very difficult to analyze the return on investment(ROI) on them.

Therefore, marketers have found new ways to connect with the audience using the Internet. Nowadays marketers use digital platforms (Search Engines & Social Media Websites) such as LinkedIn, Twitter, Facebook, Whatsapp, Google, Yahoo, Bing to gain access to promote brands at a very low cost.

User of Digital Marketing

Anyone in any field can use Digital Marketing. Most of the people implement it to create awareness. Students who are determined can also use it to earn money out of their college or school life. Business professionals can use it to run any campaign for their products. Entrepreneurs to share their business ideas and to ask for funding, marketing professionals to do a survey or to increase the website's ranking.

- It is complicated.
- It's a vast subject, it is not only about product and services but more than that.
- Unlike marketing it does not generates direct sales.
- You should have a proper understanding of the basic concepts used in digital marketing.
- In-depth knowledge of the subject requires hard work and patience.

Traditional Marketing vs Digital Marketing

Since traditional marketing is not a new concept similarly, digital marketing was also there since the beginning of the internet but they differ from each other.

- Online/digital marketing is done using electronic gadgets such as mobile, desktops in different platforms like Google, Facebook, LinkedIn, Twitter, WhatsApp, etc, whereas traditional marketing revolves around TVs, newspaper, radio, etc.
- You can select your target audience in digital marketing at a very economical price, which is not possible with traditional marketing.
- Digital Marketing provides a better user experience as compared to traditional marketing.

Important Digital Marketing Terms

- **PPC**– Pay per click, we use this term for paid advertisements.
- **CTR-** Click through rate, this term issues to know the percentage of clicks at a link.
- **SEO**– Search engine optimization, we use this term to improve the website's ranking.
- **SMM**– Social media marketing, we use this term for marketing on platforms like facebook, twitter, LinkedIn, etc.
- **SEM**– Search engine marketing, this term revolves around search engines like Google, Bing, etc
- **SERP**– **Search engine result page,** pages that display on any search engine's list with a specific keyword

Components of Digital Marketing

Search Engine Optimization (SEO)

SEO (Search Engine Optimization) is a process to change and modify the website's content/data to improve the website's ranking in Search Engine.

Pay Per Click (PPC)

It's a practice to attract online traffic towards their website by paying some amount of money to advertisement publisher (search engine).

E-mail Marketing

It's a simple and direct technique of digital marketing to reach end customers by sending them an email containing some valuable information.

Affiliate Marketing

In this type of digital marketing, the promoter pays commission to affiliate marketers to promote their brands on different platforms.

Content Marketing

Contents like text, videos, graphics, images, etc are used to connect with the targeted audiences to communicate with them.

Advantages of Digital Marketing

- It is easy to measure and provides better feedback.
- It gives a smooth construction experience.
- Also, it is very cost effective and economical as compared to traditional marketing.
- It provides flexibility.
- It helps in connecting with a larger group of audience.

Social Media Marketing

Social media marketing is an easy, familiar and friendly way of digital marketing. Now every social media website has its own specific ideology for

promotion and audience interaction. For example, in Instagram and Pinterest, one can put images of a food recipe and promote their restaurant or cookery show.

Facebook also has its own specific product called 'facebook businesses'. So, the Facebook business allows you to run a business campaign, sell products online, extract personal information, create brand awareness, brand recall at a very economical price. Many business organizations use this platform.

Twitter allows you to share a text message of 280 characters with images and videos. Similarly, business professionals use LinkedIn to share their business ideas, work experience, job openings, etc.

Best Digital Marketing Tools

Facebook Business

It is a part of Facebook which emphases on creating different campaigns namely sales campaign, awareness campaign, lead generation campaign etc.

MailChimp

It's a very common platform which we use for e-mail marketing. It helps in sending bulk e-mails.

Canva

It's a website which acts as a photo editor. It has a huge collection of photographs that can be made in collage in so many ways.

Google analytics

It's a commonly used search engine analytical tool which helps the user to measure current performances going on in a website.

Word press

It's a free website building tool. It's user-friendly and easy to use.

In today's world, technology lies in everybody's fingertip so it has become trouble-free and hassle less to get access to digital platforms. Digital marketing has provided several options to increase business and job opportunities. It is also cost effective and economical as compared to old and traditional ways of marketing. It not only allows the user to connect with different people around the world but also provide a path to cater to one's business. The world is becoming digital and so is everyone therefore; it is important to master yourself in this field to keep up the pace with the digital world.

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GI-FI

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Introduction

GI-FI or gigabit wireless is the world's first transceiver integrated on a single chip that operates at 60GHz on the cmos process. It will allow wireless transfer of audio and video data at up to 5gigabits per second, ten times the current maximum wireless transfer rate, at one- tenth the cost. NICTA researchers have chosen to develop this technology in the 57-64GHz unlicensed frequency band as the millimeter-wave range of the spectrum makes possible high component on-chip integration as well as allowing for the integration of very small high gain arrays.

The available 7GHz of spectrum results in very high data rates, up to 5 gigabits per second to users within an indoor environment, usually within a range of 10 meters .It satisfies the standards of IEEE 802.15.3C .

A new silicon chip developed in Melbourne is predicted to revolutionize the way household gadgets like televisions, phones and DVD players talk to each other. The tiny five- millimeter-a-side chip can transmit data through a wireless connection at a breakthrough five gigabits per second over distances of up to 10 meters.

An entire high-definition movie could be transmitted to a mobile phone in a few seconds, and the phone could then upload the movie to a home computer or screen at the same speed. This means his team is ahead and stood in front of the competition in terms of price and power demand. His chip uses only a tiny one-millimeter-wide antenna and less than two watts of power, and would cost less than $10 to manufacture.

Technologies Used

This mmWave WPAN will operate in the new and clear band including 57-64 GHz unlicensed band defined by FCC 47 CFR 15.255. 2 types.

(i). Multiple Input Multiple Outputs

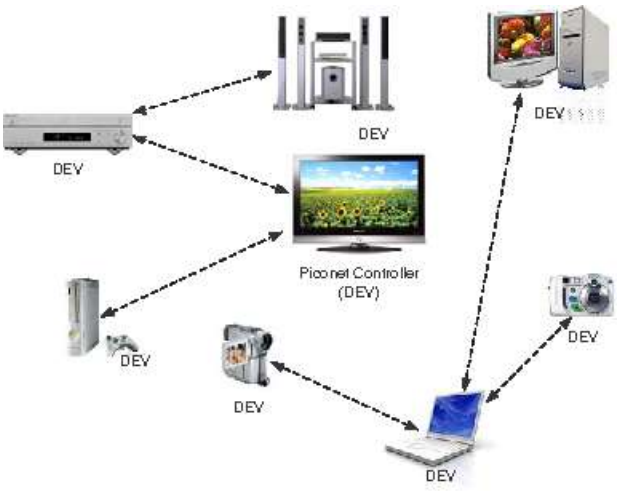
MIMO wireless is an emerging cost effective technology that offers substantial leverages in making 1Gbps wireless links a reality. We can in principle, meet the 1Gbps data rate requirement if the product of bandwidth (measured in Hz) and spectral efficiency (measured in bps/Hz) equals 10^9. MIMO wireless constitutes a technological breakthrough that will allow Gbps speeds in NLOS wireless networks. The performance improvements resulting from the use of MIMO systems are due to

- Array gain
- Diversity gain

- Spatial Multiplexing Gain
- Interference Reduction
- System-On-A-Package

SOP approach for the next-generation wireless solution is a more feasible option than SOC. Recent development of materials and processes in packaging area makes it possible to bring the concept of SOP into the RF world to meet the stringent needs in wireless communication area.

Wireless devices implementing complex functionality require a large amount of circuitry and consequently, require a large conventional package or MCM real estate. SOP goes one step beyond Multi Chip Module (MCM) by enhancing overall performances and adding more functionality



Advantages of Gi-Fi

Removing Cables

For many years cables ruled the world. Optical fibers played a dominant role for its higher bit rates and faster transmission. But the installation of cables caused a greater difficulty and thus led to wireless access. The foremost of this is Bluetooth which can cover 9-10mts. Wi-Fi followed it having coverage area of 91mts. The standard's original limitations for data exchange rate and range and high cost of the infrastructures have not yet made it possible for WiFi to become a good replace for the cables. Gi-Fi technology Removes need for cables to connect consumer electronics devices and all the devices in the range of 10 meters can be connected in order to transmit the data wirelessly.

Low Cost Chip

Gi-Fi's chip uses only a tiny one-millimeter-wide antenna and less than 2mili watts of power. Low-cost chip allows technology to be readily incorporated into multiple devices. The chip in Gi- fi would likely cost about $10 or less to build. This and a small design would allow cell phones and other small devices to add the technology without significantly drive up the price, according to the company. GI-FI is based on an open, international standard. Mass adoption of the standard, and the use of low-cost, mass-produced chipsets, will drive costs down dramatically, which is very less in compare to present technologies.

Security

Among the factors that have held back enterprise uptake of wireless LANs outside green field sites have been security fears and lack of performance compared to wire line Ethernet. About 70 per cent of firms have deployed their WLAN in a secure firewall zone but are still using the old WEP protocol, which does not protect the application layer effectively, so better encryption is urgently needed. Secure encryption technology in GI-FI ensures privacy and security of content.

Simplicity

One of the problems with wire connections and cables is complexity for connecting, but in the Gigabit wireless technology simplicity is one of the features. Simple connection improves the consumer experience. The new gigabit wireless system provides Multi-gigabit wireless technology that removes the need for cables between consumer electronic devices and is More than 100 times faster than current short-range wireless technologies such as Bluetooth and Wi-Fi. This technology with high level of frequency re-use can satisfy the communication needs of multiple customers within a small geographic region.

Future Scope

A completely integrated single chip transceiver has been fabricated, tested and demonstrated in GI-FI chip and a transceiver with integrated phased array antenna on 65nm CMOS technology has been sent for fabrication. GI-FI technology demonstrates the world's first fully integrated transceiver on CMOS technology operating at 60 GHz and provides new technique for integrating antennas on CMOS. The GI-FI team is looking for partners interested in commercializing its 60GHz chips and with growing consumer adoption of High-Definition (HD) television, low cost chip and other interesting features of this new technology it can be predicted that the anticipated worldwide market for this technology is vast. Within next few years, we expect GI-FI to be the dominant technology for wireless networking. By providing low-cost, high broadband access, with very high speed large files swapped within seconds it could develop wireless home and office of future.

As the integrated transceiver is extremely small, it can be embedded into devices. The breakthrough will mean the networking of office and home equipment without wires will finally become a reality. The GI-FI integrated transceiver chip may be launched by the starting of next year by NICTA. Due to the less cost of chip so many companies are coming forward to launch the chip. The potential of microwave Companies like Intel, LG, Panasonic, Samsung, Sony & Toshiba to form wireless HD. Specifically wireless HD has a stated goal of enabling wireless connectivity for streaming high definition content between source devices and high definition devices.

Program Outcomes (POs)

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, and engineering fundamentals to solve the complex electrical engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex Electrical and Electronics Engineering problems enabling attainment of conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of Solutions:** Design solutions, components or process for complex Electrical Engineering problems to meet the specified needs considering public health, safety and environmental considerations.
PO4	**Conduct Investigations of complex problems:** Exercise research knowledge and technical methodology for design, analysis and interpretation of data to converge to a suitable solution.
PO5	**Modern Tool Usage**: Use modern engineering tools, softwares and equipments to predict, analyze and model engineering problems.
PO6	**The Engineer & Society:** Apply reasoning skills to assess societal, health, safety, legal and cultural issues relevant to the professional engineering practice and take consequent responsibilities in the society
PO7	**Environment and Sustainability:** Realize the impact of the professional engineering solutions and demonstrate the knowledge for sustainable development in environmental context
PO8	**Ethics:** Apply and realize the professional ethics and responsibilities in Electrical engineering practice.
PO9	**Individual and Team Work:** Exhibit Individuality, Leadership and Team spirit in multidisciplinary settings.
PO10	**Communication:** Communicate, comprehend, write reports, design documentation and presentation effectively on complex engineering activities
PO11	**Project Management & Finance:** Demonstrate the Electrical engineering and management principles adhering to financial strategies to manage projects as a member or leader in a team
PO12	**Life Long Learning:** Inculcate independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO 1: Electrical drives and control: Graduates will Analyze, design and provide Engineering solutions in the field of Power Electronics and Drives

PSO 2: Embedded system: Graduates will Simulate, experiment and solve complex problems in Embedded System.

KSR INSTITUTE FOR ENGINEERING AND TECHNOLOGY

VISION

To become a globally recognized Institution in Engineering Education, Research and Entrepreneurship.

MISSION

- Accomplish quality education through improved teaching learning process.
- Enrich technical skills with state of the art laboratories and facilities.
- Enhance research and entrepreneurship activities to meet the industrial and societal needs.

Department of EEE

VISION

To produce world class Electrical and Electronics Technocrats and Entrepreneurs with social responsibilities.

MISSION

- Impart quality education in the field of Electrical and Electronics Engineering through state of the art learning ambience.
- Enrich interdisciplinary skills and promote research through continuous learning.
- Enhance professional ethics, entrepreneurship skills and social responsibilities to serve the nation.

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