GAYATRI VIDYA PARISHAD COLLEGE OF ENGINEERING FOR WOMEN

ELECTRO SPECTRUM 2017

Volume – 2

Vision of the Department	Produce competitive engineers instilled with ethical and social responsibilities to deal with the technological challenges in the field of Electronics and Communication Engineering.	
Mission of the Department		**Mission Statements**
	M1	Facilitate a value-based educational environment that provides updated technical knowledge.
	M2	Provide opportunities for developing creative, innovative and leadership skills.
	M3	Imbue technological and managerial capabilities for a successful career and lifelong learning.

	Program Educational Objectives Statements
PEO1	Analyze and apply the knowledge of Mathematics, Science, and Engineering concepts for solving Electronics and Communication Engineering problems.
PEO2	Solve complex problems in Electronics and Communication Engineering and its allied areas to attain optimum solutions.
PEO3	Excel in chosen career by exhibiting life skills and professional ethics in multidisciplinary fields through continuous learning and research.

	Program Educational Objectives Statements
PSO1	Acquire knowledge required for designing Electronics and Communication systems.
PSO2	Design, simulate and implement essential modules in the areas of Electronic circuits, VLSI, Embedded systems, Communication and Signal processing.

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PRINCIPAL'S MESSAGE:

I am very much delighted and pleased to know that the College is bringing outa Magazine with good and useful information on Engineering and Technologyand also the available infrastructure and facilities provided for the benefit ofstudents and Faculty.

The efforts by the faculty and students to bring out thismagazine with a beautiful getup needs a good word of appreciation.I wish this would continue in future too which certainly upholds theacademic environment and decorum of this campus.Let me thank all the senior teachers and the other faculty who had shared their experiences by their rich and highly informative contributions to the Magazine.

EDITORIAL'S MESSAGE

This is the key motivation behind the launch of this magazine. Gayatri Vidya Parishad College of Engineering for Women was established in 2008 with the primary objective of enhancing quality education and vocational skills amongst women.

Dear students', learning is a continuous activity throughout our lives. We observe, dream, imitate and try to rediscover the things present around us through our learning. College is a place which transforms our dreams and aspirations into reality.

We sincerely hope that the student fraternity receives the first issue enthusiastically and motivate us with their articles for the forthcoming issues.

We wish you a pleasant reading........

COVER STORY

LTE, THE RADIO TECHNOLOGY PATH TOWARDS 4G

ABSTRACT:

Evolved Universal Terrestrial Radio Access (EUTRA), known as the Long-Term Evolution (LTE) technology, brings cellular communication to the fourth generation (4G) era. In this article, we discuss the most important characteristics of LTE; its simplified network architecture which allows ultimate means for adaptation of the radio transmission to the Internet packet traffic flows and to the varying channel states.

LTE radio resource management is based on time–frequency scheduling, fast feedback between the transmitter and receiver, and nearly optimal adaptation of transport formats. Yet, the radio system is simple and cost efficient to manage from the evolved packet core network, having a server architecture with IP tunnels. The mobility states and resource allocation allow power save operation of the User Equipment when not actively communicating. In addition, we brief the key results on the LTE baseline performance for paired and unpaired frequency bands, i.e. the two duplex modes.

INTRODUCTION:

The term “Long Term Evolution” (LTE) stands for the process to generate a novel air interface by the 3rd Generation Partnership Project (3GPP), and for the specified technology. Earlier, the 3GWideband Code Division Multiple Access (WCDMA) provided a new, high capacity, air interface including transport of packet traffic, and the Radio Access Network (RAN) designed to be compatible with the second-generation GSM and GPRS core networks. WCDMA allows multiplexing of voice and variable rate data services, and its evolution to High Speed Packet Access (HSPA) [1,2] further enhances the high rate packet capabilities as a set of new transport channels.

LTE was initiated as a study item and its technical requirements were agreed in June 2005 [3]. The targets of LTE included reduced latency, higher user data rates, improved system capacity and coverage and reduced cost of operation. LTE was required to become a stand-alone system with packet-switched networking.

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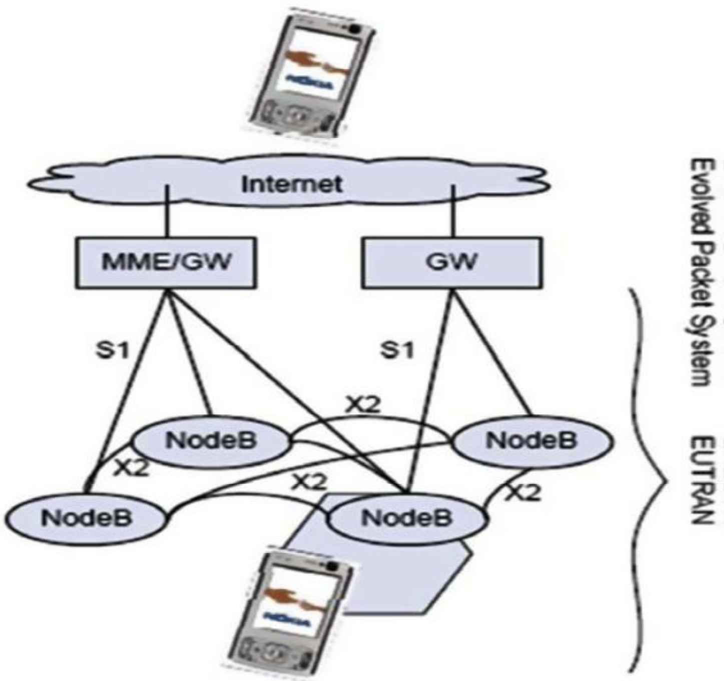


LTE ARCHITECTURE:

In LTE, the UE may operate in two states, the LTE_Idle or the LTE_Active state, in relation to the non-access stratum which connects the UE and the core network. In the radio access network, these correspond to the Radio Resource Control (RRC) states RRC_Idle and RRC_Connected, respectively [1]. The mobility state machine is considerably simplified from 3G/WCDMA UTRAN (with at least four states). Discontinuous transmission and reception modes apply to both states, enabling efficient UE power saving.

In the LTE_Idle state, the location of the UE is not known at cell accuracy. The UE camps on the system at the resolution of a Tracking Area, consisting of a large number of sites, applying the cell_reselection (or cell_change) procedures. UE mobility is controlled by the core network. The UE may initiate activity by a random-access procedure and the network may request UE activity by a paging procedure. The random-access parameters and paging cycles are indicated in a broadcast channel, which is scheduled to allow power saving and appears frequency multiplexed with a shared data channel.

LTE INTERFACES:

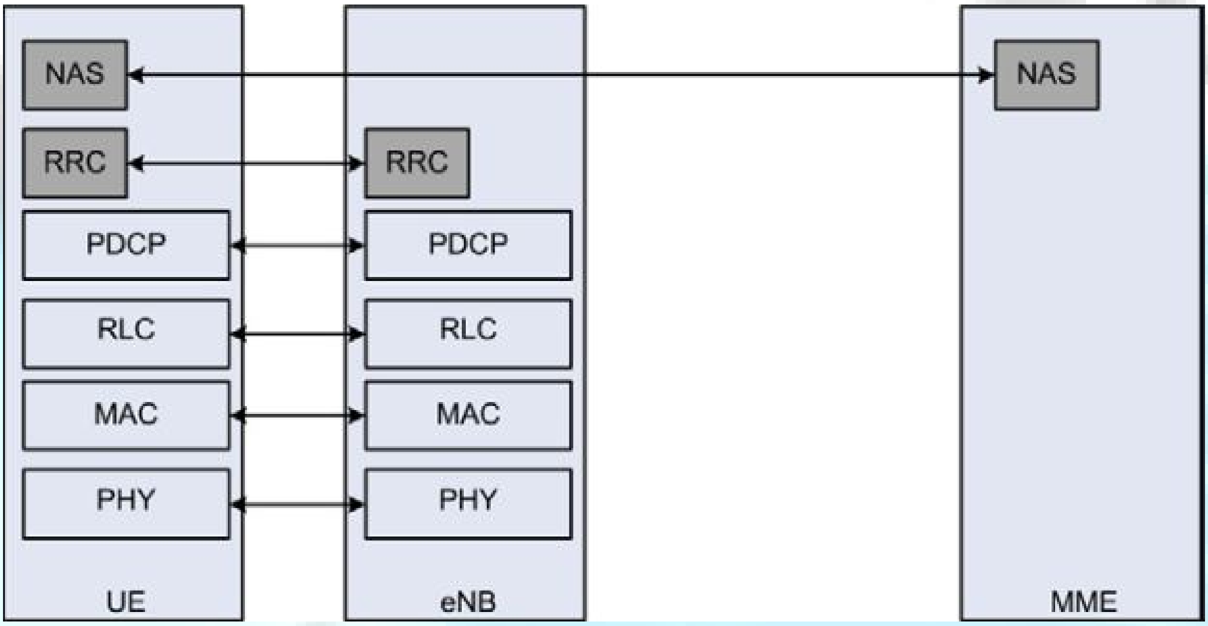
LTE provides a simplified architecture compared to UTRAN, because macro diversity gains are not relevant in EUTRAN, and hence a centralized radio controller is not needed. Thus, all decisions related to communication over the air interface are taken at a transmitting or receiving network node, making ultimate adaptation both to traffic and channel conditions possible. Control plane communication is executed as the application protocol over the S1-interface between the serving eNodeB and the MME. User plane communication is executed as the transport protocol over the S1-interface between the eNodeB and the serving gateway.

In LTE, fast handovers are necessary because of the lack of macro diversity, which may cause the Signal to Interference plus noise ratio (SINR) suddenly decrease due to UE moving at high velocity. Therefore, an interface called X2 is defined between theeNodeBs. An application protocol may be run over the X2 for hand over preparation and execution, and to control transfer of the user plane packet buffers between the eNodeB at handover. Also, Intercell Interference Coordination may be performed over X2. The signalling solution between eNodeB appears much lighter compared to the control and reconfiguration of the transport by a centralized node.

EUTRAN PROTOCOLS:

EUTRAN radio protocols and their peer-to-peer relationship are shown in Fig. 2. EUTRAN architecture includes the Radio Resource Control (RRC) protocol in the control plane for radio resource management functions, see Section 5. In the user plane, EUTRAN includes the Packet Data Convergence Protocol (PDCP) which handles the Internet packet buffers and is terminated in the eNodeB. This architecture allows coupling of the segmentation decisions not only to the packet (SDU) sizes of traffic flows in the Internet but also to the channel state information, short term channel dependent scheduling decisions and transport format adaptation. Flexible segmentation tends to minimize the overhead in providing the best fit of the packet sizes in the queue to the best fit of the transport block size. Transport channel switching (see

UTRA) is neither a problem, because LTE transport resources are shared for all logical channels of a UE. For voice and video packets, segmentation is preferably avoided completely. This creates less protocol overhead and allows strict scheduling that satisfies the packet delay requirements of the real-time transport. For data packets, segmentation is preferably tailored to the amount of detain the transmission buffer rather than to the size of individual packets. This creates less overhead per packet and allows scheduling by greed throughput weighting algorithms. The efficiency of EUTRAN is reached mainly by the protocol architecture and logical channel flow of layer 2, in addition to the advanced physical layer processing. The structure of layer 2processing in the User Equipment is shown in Fig. 3. The physical layer provides signal processing algorithms for the transmitters and receivers, where the computation is executed in the transform domain. Layer 2 protocols enable the presence of channel state information in all critical decisions of segmentation, scheduling, and transport format selection.



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MODULATION AND CHANNEL CODING:

The set of modulation alphabets used is a system design choice due the requirements posed on the implementation of the transmitter– receiver chain. The dynamic range, sensitivity and decoding complexity are key issues as well as requirements for the linearity, Error Vector Magnitude (EVM) and noise figure of the receiver.

In LTE, QPSK, 16QAM and 64QAM modulations may be used both in downlink and uplink. For amplitude modulated multicarrier symbols, the peak power varies depending on the instantaneous choices of modulated symbols. In the eNodeB transmitter, where the linear range of the amplifier can be large, the power limiter cuts the highest power peaks to the wideband noise. The probability of the highest power peaks is fairly small due to a large number of modulated subcarriers; thus, the power-density of the in-band noise remains small, and 64QAM transmissions may be possible.

In the UE transmitter, the linear region of the power amplifier sets constraints for the choice of modulation. In practise, uplink transmissions at least up to 16QAM are feasible. The benefits of 64QAM transmission are disputable, because its coverage-area probability remains small in mobile reception. For short range communications, it however may provide gain.

CONCLUSION:

The LTE process led to rapid research and innovation for the EUTRA technology to radically bring the 3G networks to a new 4G performance era. The technical targets set in [3] required an iterative development process, where simultaneous innovations in the design of the physical layer, radio protocols, resource management algorithms and network architectures support each other. Hence, increasing the cell edge throughput and spectral efficiency had to happen yet reducing the air interface latency, which requires advanced receiver algorithms and efficient signalling protocols. Despite of the high performance at highly aggressive scheduling events, the UE is able to activate its power saving modes for the moments of low activity. This shows as increased battery activity times and yet provide fast transitions to the active state of communications, because the IP connectivity is maintained to the serving gateway on the “always-on” EPS bearer. The cost factors, flexibility and reliability of the network are improved due to the server based distributed architecture and due to the lack of centralized control in the radio access network.

The LTE standard Release 8 (series_36) [1] is complete and several field trials are on-going or planned by the mobile network operators with the mobile device vendors. Targets for launching commercial operations in the near future have been published, and the first openings are expected to begin in year 2010. After the first launches, LTE deployments are expected to increase rapidly, because the network upgrades suit to the existing 3G sites. Also in regions, where 3G is not widely spread, LTE technology is expected to offer the next major upgrade. Hence, LTE will clearly be the future technology for the wide area mobile data coverage in dense traffic areas globally.

In longer term, local access is expected to gain more momentum, because the forecasted increase of traffic volumes cannot fully be satisfied by wide area deployments with large cell ranges. This observation motivates new local area studies e.g. by scaling the LTE technology for small cells and to implement local networking for low cost of operation.

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FACULTY ARTICLE

SPINTRONICS TECHNOLOGY

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ABSTRACT:

Existing semiconductor electronic and photonic devices utilize the charge on electrons and holes in order to perform their specific functionality such as signal processing or light emission. The relatively new field of semiconductor spintronics seeks, in addition, to exploit the spin of charge carriers in new generations of transistors, lasers and integrated magnetic sensors. Spintronics utilizes the electron's spin to create useful sensors, memory and logic devices with properties not possible with charge-based devices. This paper reviews the past successes, and the current and future prospects of spintronic materials and devices. Two and three terminal tunnel-junction based sources of highly spin polarized current are described as one component of possible spintronic logic devices, which have the potential for much low power operation than charge based devices.

INTRODUCTION:

Two of the most successful technologies in existence today have created the Si Integrated Circuit industry and the data storage industry. In the case of ICs, the number of transistors on a chip doubles about every 18 months according to Moore's law. For magnetic hard disk drive technology, a typical desk-top computer drive today has a 40GB per disk capacity, whereas in 1995 this capacity was 1GB per disk. Since 1991, the overall bit density on a magnetic head has increased at an annual rate of 60–100%. The integrated circuits operate by controlling the flow of carriers through the semiconductor by applied electric fields. The key parameter therefore is the charge on the electrons or holes. For the case of magnetic data storage, the key parameter is the spin of the electron, as spin can be thought of as the fundamental origin of magnetic moment.

The characteristics of ICs include high speed signal processing and excellent reliability, but the memory elements are

volatile (the stored information is lost

FIG:sites.google.com

when the power is switched-off, as data is stored as charge in capacitors, i.e DRAMs). A key advantage of magnetic memory technologies is that they are non-volatile since they employ ferromagnetic materials.

The emerging fields of semiconductor spin transfer electronics seeks to exploit the spin of charge carriers in semiconductors. Among this new class of devices are spin transistors operating at very low powers for mobile applications that rely on batteries, optical emitters with encoded information through their polarized light output, fast non-volatile semiconductor memory and integrated magnetic / electronic / photonic devices (‘‘electromagnetism-on-a-chip’’).

From the first prospect, electron spin currents carry and emit no energy and no heat. This strong advantage resolves heat problems in large-scale integration circuits, personal computers, and also any systems loading them. From the second viewpoint, it is a desirable subject for human life to realize devices beyond CMOS FETs, which are approaching its integration and operation limits. Although many materials and technologies have challenged this, it has not yet been realized. Spintronic devices based on some kinds of ideas must realize this. For instance, operation utilizing spin flipping leads to extremely high switching devices (e.g., in Pico-seconds), which overcomes operation speeds of CMOS FETs and LSIs. There are two approaches for spintronics

A. Metal-based spintronics:

After the discovery of giant-magneto resistance (GMR) in magnetic (metal) multilayer’s in 1988, which quickly became the standard technology for read-heads of current hard disk drives, a large tunnel-magneto resistance (TMR) between two magnetic metals separated by a thin insulator was demonstrated at room temperature in 1994. This magnetic tunnel junction (MTJ) is currently the preferred device for a magnetic random-access memory (MRAM) cell. There are challenging device level issues to be solved, however, when MRAM technology is to be pushed beyond Gbit in scale; some of them being resolved by the emergence of the MgO-barrier MTJ. Beyond MRAM, there are schemes to utilize nonvolatility of MRAM not only as a memory but a part of reconfigurable logic-in-memory, which may provide a solution for today's memory bandwidth bottleneck

B. Semiconductor Spintronics

There are several ways to create spin polarization and harness associated spin degree of freedom in semiconductors. One can create spin polarization by the use of circularly polarized light or electrical spin-injection and then utilize it in nonmagnetic semiconductors or when electrons are confined in a quantum dot, the spin-dependent exchange interaction among them becomes important even without magnetic ions. The third approach is to introduce transition metal (magnetic) ions, which gives rise to exchange interaction between band carriers and the electrons localized at the magnetic ions. This has been shown to lead to hole-induced ferromagnetism in the case of InAs and GaAs alloyed with Mn, which made it possible to integrate ferromagnetism with existing nonmagnetic heterostructures, allowing exploration of a new dimension of spin-dependent phenomena in semiconductors. By the use of insulating-gate field-effect transistor structure to modulate carrier concentration, reversible electrical switching of the ferromagnetic phase transition and coercive force has been realized. CIMS has been observed at much lower current density than those in the metallic structures, either in the form of current-induced domain wall motion or in the form of magnetization rotation in Nano-pillars. Because CIMS in semiconductors can be seamlessly. integrated into semiconductor structures, ferromagnetic semiconductors may prove to be useful in developing spintronic devices that combine magnetization switching with other spin-related effects, once the transition temperature of these materials reaches well beyond room temperature.

1. MATERIAL SELECTION

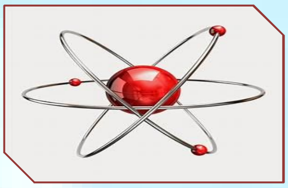
There are two major criteria for selecting the most promising materials for semiconductor spintronics. First, the ferromagnetism should be retained to practical temperatures (i.e. >300 K). Second, it would be a major advantage if there were already an existing technology base for the material in other applications. Most of the work in the past has focused on (Ga, Mn)As and (In, Mn)As. There are indeed major markets for their host materials in infra-red light-emitting diodes and lasers and high speed digital electronics (GaAs) and magnetic sensors (InAs). In samples carefully grown single-phase by molecular beam epitaxy (MBE), the highest Curie temperatures reported are 110 K for (Ga, Mn)As and 35 K for (In, Mn)As For ternary alloys such as (In0.5Ga0.5)0.93Mn0.07As, the Curie temperature is also low 110 K. A tremendous amount of research on these materials systems has led to some surprising results, such as the very long spin lif One of the most effective methods for investigating spin-polarized transport

is by monitoring the polarized electroluminescence output from a quantum well light-emitting diode into which the spin current is injected. Quantum selection rules relating the initial carrier spin polarization and the subsequent polarized optical output can provide a quantitative measure of the injection efficiency. coherence times in GaAs and the ability to achieve spin transfer through a heterointerface, either of semiconductor or metal–semiconductor.

There are a number of essential requirements for achieving practical spintronic devices in addition to the efficient electrical injection of spin-polarized carriers. These include the ability to transport the carriers with high transmission efficiency within the host semiconductor or conducting oxide, the ability to detect or collect the spin-polarized carriers and to be able to control the transport through external means such as biasing of a gate contact on a transistor structure. The observation of spin current-induced switching in magnetic heterostructures is an important step in realizing practical devices. Similarly, spin orbit interaction in a semiconductor quantum well could be controlled by applying a gate voltage. Combined with the expected low power capability of spintronic devices, this should lead to extremely high packing densities for memory elements.

FUNDAMENTALS OF SPINTRONICS:

The rapid decrease in computational power and increase in speed of integrated circuits is supported by the very fast reduction of semiconductor devices feature size. Due to constantly introduced innovative changes in the technological processes, the miniaturization of MOSFETs by Moore’s law successfully continues. Although alternative channel materials with mobility higher than in Si were already investigated, it is believed that Si will still be the main channel

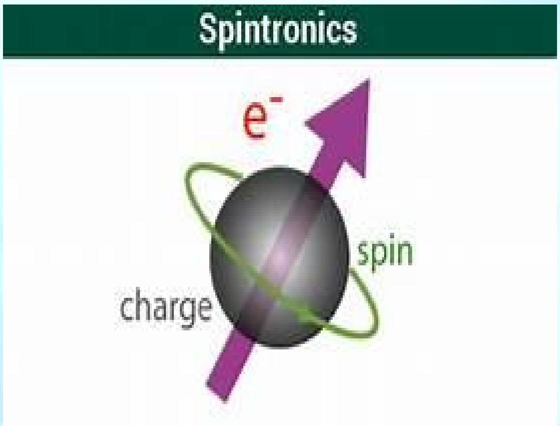


material for MOSFETs beyond the 22-nm technology node.

New engineering solutions and innovative techniques are required to improve CMOS device performance. Strain-induced mobility enhancement is one of the most attractive solutions to increase the device speed, which will certainly maintain its key position among possible technological innovations for future technology generations [25]. In addition, new device architectures based on multi gate structures with better electrostatic channel control and reduced short channel effects will be developed. A multi gate MOSFET architecture is expected to be introduced for the 16-nm technology node. Combined with a high-k dielectric/ metal gate technology and strain engineering, a multi gate MOSFET appears to be the ultimate device for high-speed operation with excellent channel control, reduced leakage currents, and low-power budget

A. Physics of spintronics

Spintronics is also called spin-electronics, where the spin of an electron is controlled by an external magnetic field and polarize the electrons. These polarized electrons are used to control the electric current. The goal of Spintronics is to develop a semiconductor that can manipulate the magnetism. Once we add spin degree of freedom to electronics, it will provide significant versatility and functionality to future electronics products. Magnetic spin properties of electrons are used in many

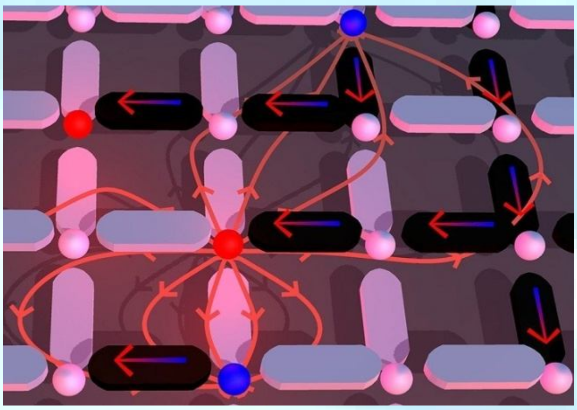


applications such as magnetic memories, magnetic recording (read, write).

The realization of semiconductor of semiconductors that is ferromagnetic. Above room temperature will potentially lead to a new generation of Spintronics devices with revolutionary electrical and optical properties. The field of Spintronics was born in the late 1980s with the discovery of the "giant magneto resistance effect". The giant magneto resistance (GMR) effect occurs when a magnetic field is used to align the spin of electrons in the material, including a large change in the resistance of a material.

In spintronics, information is stored and transmitted using another property of electron, acts like a compass needle, which points either up or down to represent the spin of an electron. Electrons moving through a nonmagnetic material normally have random spins, so the net effect is zero. External magnetic fields can be applied so that the spins are aligned. The effect was first discovered in a device made of multiple layers of electrically conducting materials: alternating magnetic and nonmagnetic layers. The device was known as "spin valve" because when a magnetic field was applied to the device, spin of its electrons went from all up to all down, changing its resistance so that the device acted like a valve to increase or decrease the flow of electrical current, called Spin Valves.

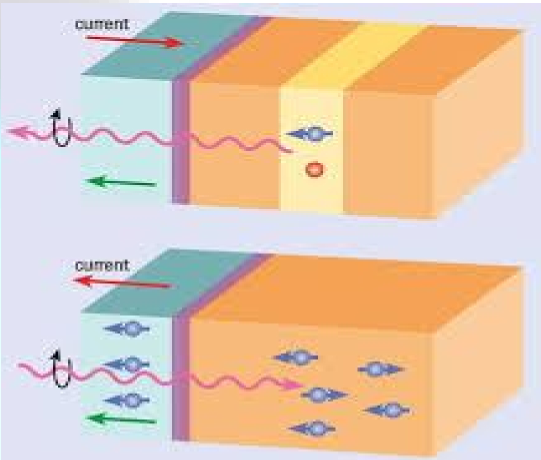
B. Spin Hall Effect



In order to realize spintronics as a fully operational technology, the ability to manipulate spin polarized electrons with in a conductor is necessary. A phenomenon called the spin Hall effect may be the solution. In the regular Hall effect, in a magnetic field is placed perpendicular to the direction of current. The reason for this is the electrons in the current flow in a conductor; a bias voltage will be created perpendicular to both across the conductor

C. Spin Injection into Semiconductors

The goal of spintronics research is to eventually relieve present information technology from solely relying on the charge of electrons. This spin degree of freedom of an electron has shown to be a very viable candidate to save the microelectronics industry from the result of "Moor's Law" which describes a trend of electrical components getting increasingly smaller, eventually reaching atomic scales.



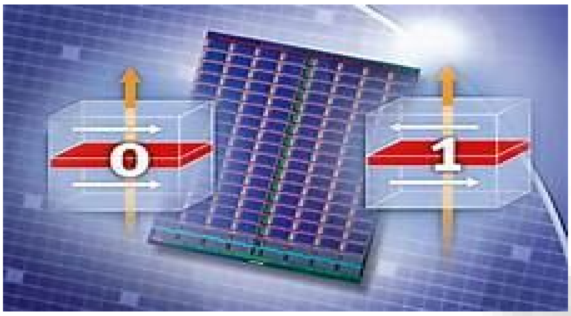
Just recently, researchers have successfully injected spin polarized current into Silicon from ferromagnet. Since Si has no nuclear spin, there are no hyperfine interactions, resulting in very spin preservation for electrons inside the semiconductor

IV. SPINTRONICS DEVICES

Recording devices, such as computer hard disks, already employ the unique properties of the materials. Data are recorded and stored any tiny areas of magnetized iron or chromium oxides. A "read head" can read this information by detecting minute changes in the magnetic field as the disk rotates underneath it. This induces changes in the head's electrical resistance, also known as magnetoresistance

A. Spin Transistor:

The basic idea of spin transistor, as



proposed by Suprio Datt and Biswajit Das, is to control the spin the spin orientation by applying a gate voltage, as shown in fig.3. A spin –FET, as depicted below, consists of ferromagnetic electrodes and semiconductor channels that contain a layer of electrons and a gate electrode attached to the semiconductor. The source and drain electrodes are ferromagnetic (FM) metals. The spin-polarized electrons are injected from the FM source electrode (FMs), and after entering the semiconductor channels they begin to rotate. The rotation can be controlled by an applied electric field through the gate electrode. If the spin orientation of the electron channels is aligned to FM drain (FMd) electrode, electrons are able to flow into the FM drain electrode. However, if the spin orientation is flipped in the electron layer electrons cannot enter the drain electrode. In this way, with the gate electrode the orientation of the electron spin can be controlled.

B. Spin (Magnetic) BJT

In a magnetic transistor, magnetized ferromagnetic layers replace the role of n and p-type semiconductors. Much like in a spin-valve, substantial current can flow through parallel magnetized ferromagnetic layers. However, if say, in a three-layer structure, the middle layer is antiparallel to the two side layers; the current flow would be quite restricted, resulting in a high overall resistance. If two outside layers are pinned and the middle layer allowed to be switched by an external magnetic field, a magnetic transistor could be made, with on and off configurations depending on the orientation of the middle-magnetized layer. Magnetic (spin) transistors are good candidates for logic (spin logic).

C. Spin LED's*:*

Recently, efficient spin injection has been successfully demonstrated in all semiconductor tunnel diode structures by using a spin- polarized DMS as the injector in one case and using a paramagnetic semiconductor under high magnetic field as a spin filter in the other. In such a case, spin- polarized holes and unpolarised electronics are injected from either side and recombine in a quantum well. The polarization of the injected holes can be left-circularly polarizing light in the electroluminescence spectra.

Among such devices the simplest seems to be the concept of a light emitting diode (LED) with one of the contact layers made ferromagnetic by incorporation of transition metal impurities, a so- called spin LED.

CONCLUSION:

To continue the rapid pace of discoveries, considerable advances in our basic understanding of spin interactions in the solid state along with developments in materials science, lithography, miniaturization of optoelectronic elements, and device fabrication are necessary. The progress toward understanding and implementing the spin degree of freedom in metallic multilayers and, more recently, in semiconductors is gaining momentum as more researchers begin to address the relevant challenges from markedly different viewpoints.

This paper presents a summary of Spintronics (spin-based electronics), is new upcoming technology for next generation of microelectronics/nanoelectronics devices with scaling apparently approaching its fundamental limits; the semiconductor industry is facing critical challenges.

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FUTURE COMMUNICATIONS

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ABSTRACT:

One way we might see communication change in the future is through **augmented reality**. In an augmented-reality system, you view the world through a technological overlay. This could take the form of a hand-held device like a smartphone -- there are several augmented-reality applications already available for some phones. Another possible application is through a set of augmented-reality glasses. In either case, you can view the world around you and see real-time digital information about what you're viewing.

The classic example of augmented reality is the restaurant review. You could stand in front of a restaurant and, through an augmented-reality system, read customer reviews or view the daily specials without ever walking inside. But the applications don't have to stop with locations. Augmented-reality systems might extend to people as well. Imagine looking at a stranger and seeing that person's name, Facebook profile, Twitter handle and other information. Clearly, augmented reality systems will raise concerns about privacy and safety, but such systems are already in development.

Then there's video conferencing. While the technology has existed for years, video calls aren't popular in the United States. It might be because the hardware hasn't been compelling or cost-effective enough. But now webcams are starting to appear on televisions and are standard on many laptops. Are we about to enter an era of video conferencing, or is it too much work to make sure you and your house look nice before you order that pizza?

One drawback to video conferencing is that it either requires you to stay in one place for the duration of the call or to hold a device so that you're visible for the whole conversation. We've become used to having a great deal of freedom while on the phone. Will we really adopt a technology that will necessitate that we keep still? Perhaps we'll use video conferencing for special occasions or short conversations.

Language barriers are disappearing as well. Devices that can translate languages in real time are allowing people from different countries and cultures to communicate without the need for an interpreter.

In the distant future, we may be able to communicate by sending our thoughts through a network directly into someone else's brain. We're decades away from such technology, but scientists are working on creating brain-computer interfaces that allow people to transmit thoughts directly to a computer. Perhaps 50 years from now we'll all use an electronic version of telepathy.

The technology of communication evolves at a blistering pace. It may turn out that our predictions don't even scratch the surface. Only time will tell.

Future Cell Phones:

Since the introduction of the iPhone, the cell phone market in the United States has started to shift. Before the iPhone, most smart phone owners in the United States were **enterprise** users. That means they owned a smartphone for business purposes. They'd check e-mail and browse the Web, often while driving, weaving in and out of traffic, and scaring the rest of us.

But the iPhone helped introduce the general consumer to smartphones. Its sleek design and intuitive interface appealed to a wide audience. It didn't hurt that Apple partnered with AT&T, the second-largest cell phone carrier in the United States, for distribution. Soon lots of people were exploring advanced phone features while attempting to navigate through city traffic. Isn't progress wonderful?

In many ways, the iPhone was a game-changing device. It proved that customers in the United States were ready to join the smartphone customer base. Meanwhile, users in Europe and Asia quietly chuckled while they used their own phones to watch television or control their bank accounts.

Today, it seems like it's only a matter of time before the newest smartphone to hit the market is branded as a potential iPhone-killer. The iPhone continues to sell well with each new generation of hardware, but other big names are getting into the game and we may yet see some serious competition rise in the consumer market.

With that in mind, it's time to gaze into the technological crystal ball and take a look at what the future of cell phones will be. Rather than focus on prototypes or unreleased handsets, our list, in no particular order, covers a few phones that manufacturers may one day put in the hands of consumers -- but hopefully not while they're driving.

THE CHANGING FACE OF MOBILE COMMUNICATIONS SERVICES

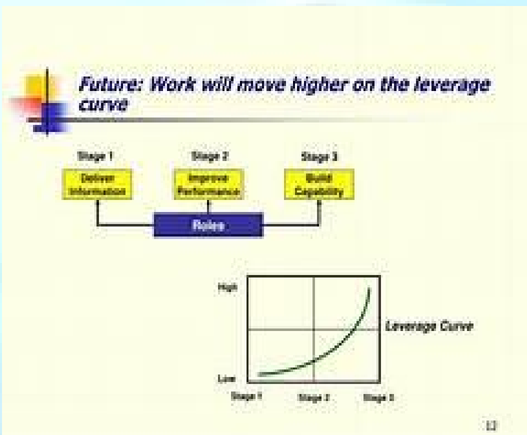
People around the world increasingly rely almost entirely on their mobile phones to communicate with others. Globally, SMS is still the most popular form of messaging, however, Rich IP-based messaging services are becoming increasingly popular. For example, Facebook Messenger and WhatsApp together handle 60 billion messages a day.

THE PUSH FOR AN OPEN AND INTEROPERABLE ECOSYSTEM

In February 2016, mobile operators from around the world, including América Móvil, Bharti Airtel, Deutsche Telekom, Etisalat, Globe Telecom, KPN, Millicom, MTN, Orange, PLAY, Smart Communications, Sprint, Telenor Group, TeliaSonera, Telstra, TIM, Turkcell, VimpelCom, Vodafone, the GSMA, and Google announced the launch of an initiative to enable all operators worldwide to provide an open, consistent, and globally interoperable messaging service across Android devices. Operators have agreed to transition toward a common, universal profile based on the GSMA's RCS specifications in partnership with operators and device makers and Google will provide an own RCS client for Android devices. By aligning on a universal RCS profile, mobile operators worldwide will be able to deploy a consistent RCS implementation, feature set, and configuration. The Android RCS client provided by Google will be based on the universal profile, enabling consumers to access RCS services on their devices. Features such as group chat, high-res photo sharing, read receipts, and more, are set to become part of the operator messaging experience, potentially enhancing the experience of the more than four billion SMS users worldwide. Google plans to also support GSMA RCS advanced calling features in the future. The universal profile and client will enable a consistent and interoperable messaging experience between all Android devices and across all operators worldwide, as well as ease interoperability testing between networks and significantly reduce time to market. “The agreement with Google will broaden the entire ecosystem,” says Enrique Marti del Olmo, Vodafone's global head of communication services. The universal profile can be implemented by other operating systems and will be supported by a formal GSMA accreditation process. Google will also provide an open source version of their client based on the universal profile specification and will provide developer APIs to enhance the RCS client experience. "Today marks an important step forward in bringing a better messaging experience for Android users everywhere," says Nick Fox, vice president of communications products at Google.

NEXT STEPS:

To meet the mounting demand for advanced communications services, mobile operators need to deploy RCS and VoLTE as soon as possible. To support the rollout of RCS, mobile operators can deploy their own IMS infrastructure or they could use a hosted solution. The GSMA's All-IP Business Guide explains in more detail how mobile operators can go about implementing RCS, VoLTE and related services. Once they have deployed advanced communications services, operators should seek to interconnect with services from other operators as soon as possible. Mobile operators also need to consider how they can broaden their communications proposition so that it works on Wi-Fi, as well as across multiple devices, including tablets and PCs. They also need to consider how they can make it easy for businesses to use these services to interact and even transact with their customers: Providing secure and reliable communications enablers to upstream businesses could become an important source of revenue for mobile operators in future.



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STUDENT ARTICLES

HAPTIC TECHNOLOGY

B. L. PRAVALLIKA

15JG1A0416

ABSTRACT:

Users are given the illusion that they are touching or Manipulating a real Physical Object 'Haptics' is a technology that adds the sense of touch to virtual environments.. This seminar discusses the important concepts in Haptics, some of the most commonly used haptics systems like 'Phantom', 'Cyber glove', 'Novint Falcon' and such similar devices. Following this, a description about how sensors and actuators are used for tracking the position and movement of the haptic systems, is provided. The different types of force rendering algorithms are discussed next. The seminar explains the blocks in force rendering. Then a few applications of haptic systems are taken up for discussion.

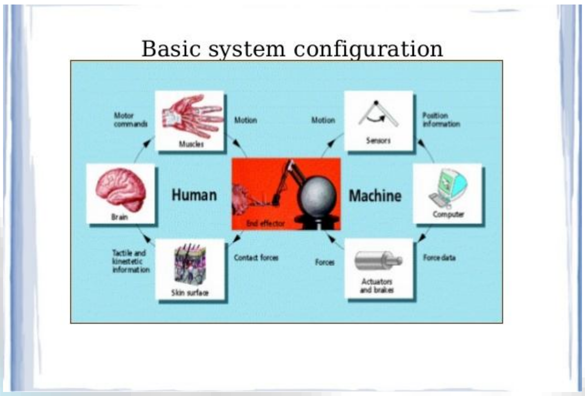
What is 'Haptics'?

Haptic technology refers to technology that interfaces the user with a virtual environment via the sense of touch by applying forces, vibrations, and/or motions to the user. This mechanical stimulation may be used to assist in the creation of virtual objects (objects existing only in a computer simulation), for control of such virtual objects, and to enhance the remote control of machines and devices (teleoperators). This emerging technology promises to have wide reaching applications as it already has in some fields. For example, haptic technology has made it possible to investigate in detail how the human sense of touch works by allowing the creation of carefully controlled haptic virtual objects. These objects are used to systematically probe human haptic capabilities, which would otherwise be difficult to achieve. These new research tools contribute to our understanding of how touch and its underlying brain functions work. Although haptic devices are capable of measuring bulk or reactive forces that are applied by the user, it should not to be confused with touch or tactile sensors that measure the pressure or force exerted by the user to the interface. The term haptic originated from the Greek word meaning pertaining to the sense of touch and comes from the Greek verb meaning to "contact" or "touch.

History of Haptics:

In the early 20th century, psychophysicists introduced the word haptic to label the subfield of their studies that addressed human touch-based perception and manipulation. In the 1970s and 1980s, significant research efforts in a completely different field, robotics also began to focus on manipulation and perception by touch. Initially concerned with building autonomous robots, researchers soon found that building a dexterous robotic hand was much more complex and subtle than their initial naive hopes had suggested. In time these two communities, one that sought to understand the human hand and one that aspired to create devices with dexterity inspired by human abilities found fertile mutual interest in topics such as sensory design and processing, grasp control and manipulation, object representation and haptic information encoding, and grammars for describing physical tasks. In the early 1990s a new usage of the word haptics began to emerge. The confluence of several emerging technologies made virtualized haptics, or computer haptics possible. Much like computer graphics, computer haptics enables the display of simulated objects to humans in an interactive manner. However, computer haptics uses a display technology through which objects can be physically palpated.

WORKING OF HAPTICS:



Basically a haptic system consist of two parts namely the human part and the machine part. In the figure shown above, the human part (left) senses and controls the position of the hand, while the machine part (right) exerts forces from the hand to simulate contact with a virtual object. Also both the systems will be provided with necessary sensors, processors and actuators. In the case of the human system, nerve receptors performs sensing, brain performs processing and muscles performs actuation of the motion performed by the hand while in the case of the machine system, the above mentioned functions are performed by the encoders, computer and motors respectively.

Haptic Information

Basically the haptic information provided by the system will be the combination of

(i) Tactile information

(ii) Kinesthetic information.

Tactile information refers the information acquired by the sensors which are actually connected to the skin of the human body with a particular reference to the spatial distribution of pressure, or more generally, tractions, across the contact area. For example when we handle flexible materials like fabric and paper, we sense the pressure variation across the fingertip. This is actually a sort of tactile information. Tactile sensing is also the basis of complex perceptual tasks like medical palpation, where physicians locate hidden anatomical structures and evaluate tissue properties using their hands. Kinesthetic information refers to the information acquired through the sensors in the joints.

Interaction forces are normally perceived through a combination of these two information's.

CREATION OF VIRTUAL ENVIRONMENT (VIRTUAL REALITY):

Virtual reality is the technology which allows a user to interact with a computersimulated environment, whether that environment is a simulation of the real world or an imaginary world. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special or stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced, haptic systems now include tactile information, generally known as force feedback, in medical and gaming applications. Users can interact with a virtual environment or a virtual artifact (VA) either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a wired glove, the Polhemus boom arm, and omnidirectional treadmill. The simulated environment can be similar to the real world, for example, simulations for pilot or combat training, or it can differ significantly from reality, as in VR games.

Haptic feedback:

Virtual reality (VR) applications strive to simulate real or imaginary scenes with which users can interact and perceive the effects of their actions in real time. Ideally the user interacts with the simulation via all five senses. However, today's typical VR applications rely on a smaller subset, typically vision, hearing, and more recently, touch.

FUTURE VISION:-

As haptics moves beyond the buzzes and thumps of today's video games, technology will enable increasingly believable and complex physical interaction with virtual or remote objects. Already haptically enabled commercial products let designers sculpt digital clay figures to rapidly produce new product geometry, museum goers feel previously inaccessible artifacts, and doctors train for simple procedures without endangering patients.

CONCLUSION:

Finally we shouldn't forget that touch and physical interaction are among the fundamental ways in which we come to understand our world and to effect changes in it. This is true on a developmental as well as an evolutionary level. For early primates to survive in a physical world, as Frank Wilson suggested, "a new physics would eventually have to come into this their brain, a new way of registering and representing the behavior of objects moving and changing under the control of the hand. It is precisely such a representational system—a syntax of cause and effect, of stories, and of experiments, each having a beginning, a middle, and an end— that one finds at the deepest levels of the organization of human language." Our efforts to communicate information by rendering how objects feel through haptic technology, and the excitement in our pursuit, might reflect a deeper desire to speak with an inner, physically based language that has yet to be given a true voice.

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•http://74.125.153.132/search?q=cache:7bpkVLHv4UcJ:science.howstuffworks.com/virtual military.htm/pr

CARBON NANOTUBES FIELD EFFECT TRANSISTORS

A. S. NAVYA BHANU
15JG1A0401

ABSTRACT:

Carbon nanotubes field effect transistors (CNTFETs) are one of the most promising candidates for future nanoelectronics. In this paper, the review of CNTFETs is presented. The structure, operation and the characteristics of carbon-nanotubes, metal-insulator-semiconductor capacitors have been discussed. The operation and *dc* characteristics of CNTFETs have been presented. In future, we expect the performance of CNTFETs will be better by improving CNT quality and on optimizing device structures.

INTRODUCTION:

Over the past few years, critical dimensions of silicon transistor devices have decreased dramatically. Prototype transistors with gate length in 30-nm range have been successfully fabricated and were found to exhibit excellent electrical characteristics[1-4]. While there is still some room for further improvements, the consensus is that alternative concepts will become necessary at some point in future[5]. Since the early 1970s the conventional advancement in technology has followed Moore's law (Moore 1975) whereby the number of transistors incorporated on a memory chip doubles every year and a half. This has resulted from continual improvements in design factors such as interconnectivity efficiency as well as from continual decrease in size. The phenomenal progress signified by Moore's law has been achieved through scaling of the metal-oxide-semiconductor field effect transistor (MOSFET) from larger physical dimensions to smaller physical dimensions, thereby gaining speed and density. Shrinking the conventional MOSFET beyond the 50 nm-technology node requires innovations to circumvent barriers due to fundamental physics that constrains the conventional MOSFET.

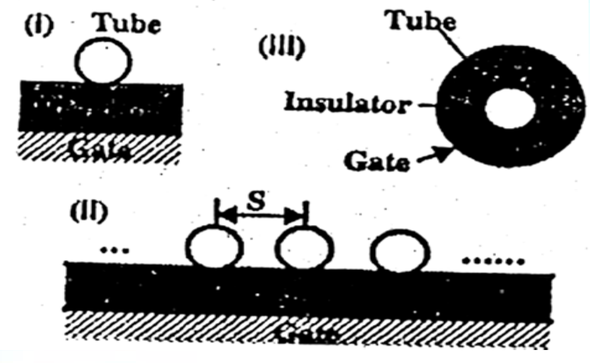
With the end of silicon transistors scaling, a great deal of research activity is currently focused on identifying alternatives which would enable continued improvements in the density and performance of electronics information systems. Other alternatives for more density and performance of electronics

information systems are high dielectric constant (high-k) gate dielectric, metal gate electrode, double- gate FET, and strained-Si FET. High dielectric-constant materials are useful as gate insulators as they can provide efficient charge injection into transistor channels and reduce direct tunneling leakage currents. Of the various materials systems and structures being investigated carbon nanotubes have shown the promising characteristics. Carbon nanotubes are hollow seamless cylinders that can be envisioned as being formed by rolling up a finite sized piece of graphite sheet. Depending on how the roll-up of the graphite sheet occurs during the growth process, carbon nanotubes can exhibit semiconducting as well as metallic character[6]. Moreover, the band gap of the semiconducting tubes scales inversely with the tube diameter[7]. The growth process can be tuned such that fine control of the tube diameter is achieved thereby forming semiconducting tubes with very similar electrical properties. Growth conditions giving the best yield produce carbon nanotubes with a diameter of around 1.4 nm [Ref. 8] resulting for semi-conducting tubes in an energy gap of 0.6eV.

With respect to electronics applications the small tube size implies that a high packing density of tubes in an array can be achieved in principle. On the other hand, the existence of metallic as well as semiconducting nanotubes points towards a fully carbon nanotubes-based electronics where metallic tubes act as interconnecting wires and semi-conducting tubes work as active device elements. However, the most important aspect in view of the electrical properties of carbon nanotubes is their one- dimensional (1 dim) character. Because of the confinement of carriers on the cylinder mantle of the tube, a strong quantization of electron and hole states occurs and charge transport in only one 1 dim-sub band (two counting the bands at k_F independently) becomes feasible in this material class even at room temperature. This has an important impact on scattering in these systems. The reduced phase space for scattering events reduces the probability of backscattering and manifests itself in a high conductivity of carbon nanotubes.

Carbon nanotubes MIS capacitors

Some transistors on current, an important performance parameter, is the product of charge induced by gate and the average carrier velocity, so that first step is to understand the gate-controlled electrostatics of a carbon nanotubes metal-insulators-semiconductor (MIS) capacitor. Theoretical studies of carbon nanotubes electrostatics have focused on two-terminal devices and the electrostatics along the nanotubes direction. In this section, MIS electrostatics of carbon nanotubes capacitors in three different geometries can be analyzed by solving the two-dimensional Poisson equation self-consistently with carrier statistics of nanotubes. The results show that for the densely packed array of nanotubes on a planar insulator, the capacitance per tube is reduced due to the screening of the charge on the gate plane by neighboring nanotubes. In contrast to silicon, planar MOS capacitors, the capacitance is strongly influenced by relative to the middle of the energy gap (we assume the intrinsic nanotube), and V_{CNT} is the average potential of the nanotube. A semi-classical approach can be adopted in which the effect of gate voltage is to move the sub-bands of the nanotube rigidly up and down without changing the $D(E)$,then nanotube DOS.



This assumption is valid for the co-axial geometry because the cylindrical symmetry produces the same potential for each carbon atom. But for a planar geometry, potential drops across the nanotube can perturb its hard structure. As long as the potential variation across a~1 nm diameter nanotube is below
0.8 V, the effect is small, so use of a 0.4 V power supply, as required for high-density digital systems, suggests that band structure perturbations will be small in this case.

The charge on the nanotube for an assumed potential, the corresponding gate voltage is

$V'_G \equiv V_G - V_{fb} = V_{CNT} - Q_L/C_{ins},$

where C_{ins} is the gate to nanotube insulator capacitance (a constant independent of gate voltage), V_G, the gate voltage, and V_{fb}, the flat band voltage as determined by the gate metal to nanotube work function difference and any insulator nanotube work function difference and any insulator nanotube surface states. Because V_{fb} depends on species of experimental conditions, all results can be plotted as a function of V'_G except otherwise specified. By solving Eqs (1) and (2) self-consistently, the Q_L (V_G) relation is obtained and the gate capacitance is C_G $= -dQ_L/dV_G$. This procedure is analogous to the one commonly used to compute MOS C_G versus V_G characteristics. Before the C_G versus V_G characteristics can be evaluated, the insulator capacitance must be specified. There is a simple, analytical expression for the coaxial geometry, but planar capacitors require a numerical solution of two-dimensional Poisson equations because two different dielectric constants above the metal plate (the insulator and air) invalidate the simple, analytical expression. The numerical solution was first evaluated for a classical conducting cylinder on the top of an infinite conducting plane with a uniform dielectric material between them, and the result agreed well with the exact analytical solutions. The single nanotube planar geometry, which has two dielectric materials [case (i) in Fig. 1] was then simulated. Two limits were considered

1. a classical distribution of charge in the nanotube, which assumes the charge redistribute itself to establish an equal potential over the nanotube like a classical metal
2. a single sub-band quantum distribution, which assumes that the charge distributes symmetrical

The significant difference between the classical and quantum limits occurs because the quantum charge distribution (the center of the nanotube) is located further from the metal than is the classical charge centroid, and the nanotube diameter is comparable to t_m. Note that in most of the experimental planar nanotube capacitors explored to date the difference between the classical and quantum limits will be small because the nanotube diameter (typically ~ 1 nm) is much smaller than insulator thickness (typically ~ 100 nm). The difference may become important, however, for the very thin insulators that will be used near the scaling limit.

Figure 2 shows the insulator capacitance of an array of parallel nanotubes [case (ii) in Fig. 1] versus the nanotube density, ρ= 1/*S*, where *S* is the spacing between neighboring nanotubes. For small packing densities, the capacitance per unit area is proportional to the packing density. The largest capacitance per unit area (still 20%-50% below C_{ins} of the planar silicon MOS capacitor) is achieved when the tubes are closely packed, but increasing the normalized packing density above 0.5, does not result in the proportional increase of capacitance.

TOP-GATEDCNTFET

The Top-gated carbon nanotube field-effect transistors (CNTFETs) have the structure similar to that of conventional silicon metal-oxide semiconductor field-effect transistors(MOSFETs) with gate electrodes above the conduction channel separated from the channel by a thin (15-20 nm) SiO_2dielectric, as shown schematically in Fig. 5 (a). This geometry allows for operation at low gate voltage, and it also allows for the switching of individual devices on the same substrate.

Most CNTFETs reported use of the conductive substrate as a back-gate electrode, usually with gate dielectrics of considerable thickness (~100 nm or more). As a result, high gate voltage is required to switch the devices on. In addition, use of the substrate as a gate implies that all devices are turned on as a gate implies that all devices are turned on

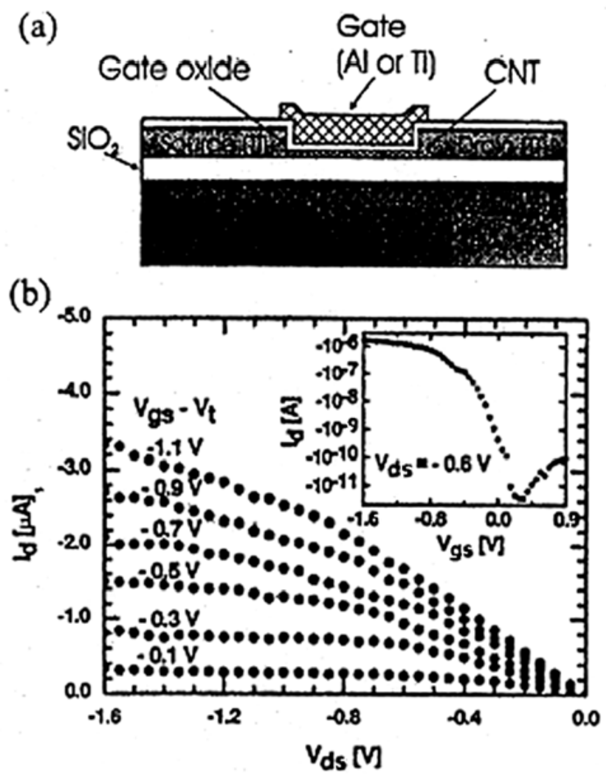


Fig. 5(a)□Schematic cross-section of top gate CNTFET showing the gate and source and drain electrodes (b) Output characteristic of top gate p-type CNTEFT with a Ti gate oxide thickness of 15 nm. The gate and gate voltage values range from □0.1 to □1.1 V above the threshold voltage, which is □0.5 V. Inset: Transfer characteristic of the CNTFET for V_{ds} = -0.6V.

simultaneously, precluding operation of all but the most basic circuits. Recently, Batchold *et al.*[10]reported an improved back-gate structure with a very thin (~2-5 nm) gate dielectric and with individual field effect transistor (FET) gating. Those devices did show low gate voltage operation and individual switch ability. However, the bottom gate structure used in that work, as well as in other previously published CNTFET studies[11-14] has open geometry in which the CNT is exposed to air. This presents electrostatic disadvantages in that the gate insulator capacitance is diluted by the lower dielectric constant of the air surrounding the CNT, the contrast in the top gate geometry the CNT is completely embedded within the gate insulator, offering the full advantage of the gate dielectric. A further disadvantage of the open geometry is that exposure of CNTs to air leads to *p*-type characteristics. Top-gate CNT, on the other hand, allows the fabrication of both *n*-type as well as p-type devices these features make the devices presented in this paper the most technologically relevant CNT transistors fabricated so far, and they only allow for a more direct comparison with mainstream silicon-based MOSFETs. Device fabrication is described else- where[15]by Derycke *et.al*[15] Single-crystal Si substrates (either *p*-type or *n*-type), with resistivities of 0.005- 0.01Ω cm, were cleaned and coated with 120 nm of thermal SiO_2. Single wall nanotubes (SWNTs) produced by laser ablation were dispersed from a 1, 2- dichloroethane solution by spinning onto the substrates after mild sonication.

CONCLUSION:

The review of carbon nanotubes metal-insulator- semiconductor capacitors are presented. The *V-I* characteristic top-gated CNTFETs are also described. These top-gate devices exhibit excellent electrical characteristics. These electrical characteristics of top- gate CNTFETs also compared to state-of-art silicon devices. For low-voltage, digital applications, the CNTFET with a planar gate geometry provides an on- current that is comparable to that expected for a ballistic MOSFET. Significantly better performance, however, could be achieved with high gate capacitance structures. Therefore, it can be concluded that CNTFETs are one of the most promising candidates for future Nano electronics.

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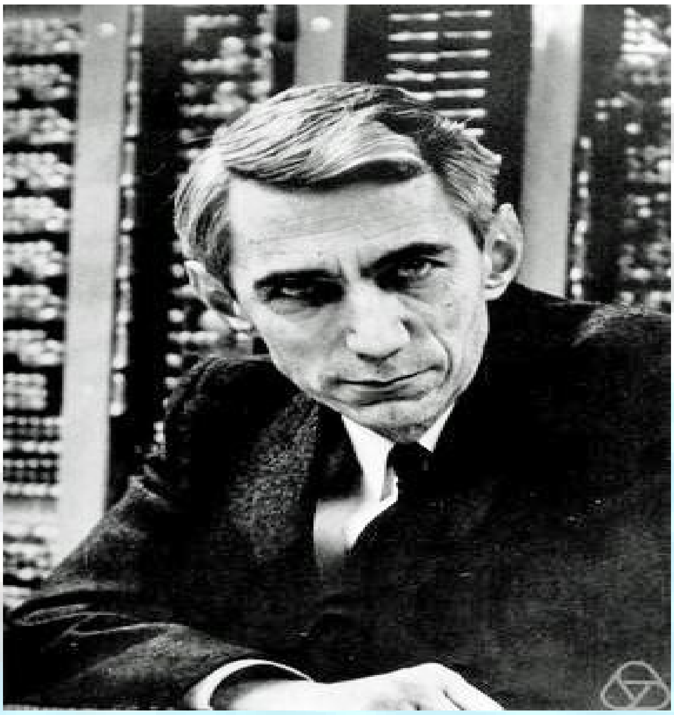
KNOW A SCIENTIST

CLAUDE SHANNON

Claude Elwood Shannon (April 30, 1916 – February 24, 2001) was an American mathematician, electrical engineer, and cryptographer known as "the father of information theory".[1][2] Shannon is noted for having founded information theory with a landmark paper, "A Mathematical Theory of Communication", that he published in 1948.



He is also well known for founding digital circuit design theory in 1937, when—as a 21-year-old master's degree student at the Massachusetts Institute of Technology (MIT)—he wrote his thesis demonstrating that electrical applications of Boolean algebra could construct any logical numerical relationship. [3] Shannon contributed to the field of cryptanalysis for national defence during World War II, including his fundamental work on codebreaking and secure telecommunications.

WARTIME RESEARCH:

Shannon then joined Bell Labs to work on fire-control systems and cryptography during World War II, under a contract with section D-2 (Control Systems section) of the National Defence Research Committee (NDRC).

Shannon is credited with the invention of signal-flow graphs, in 1942. He discovered the topological gain formula while investigating the functional operation of an analog computer.

For two months early in 1943, Shannon came into contact with the leading British mathematician Alan Turing. Turing had been posted to Washington to share with the U.S. Navy's cryptanalytic service the methods used by the British Government Code and Cypher School at Bletchley Park to break the ciphers used by the Kriegsmarine U-boats in the north Atlantic Ocean. He was also interested in the encipherment of speech and to this end spent time at Bell Labs. Shannon and Turing met at teatime in the cafeteria. Turing showed Shannon his 1936 paper that defined what is now known as the "Universal Turing machine". This impressed Shannon, as many of its ideas complemented his own.

INFORMATION THEORY:

In 1948, the promised memorandum appeared as "A Mathematical Theory of Communication", an article in two parts in the July and October issues of the Bell System Technical Journal. This work focuses on the problem of how best to encode the information a sender wants to transmit. In this fundamental work, he used tools in probability theory, developed by Norbert Wiener, which were in their nascent stages of being applied to communication theory at that time. Shannon developed information entropy as a measure of the information content in a message, which is a measure of uncertainty reduced by the message, while essentially inventing the field of information theory. In 1949 Claude Shannon and Robert Fano devised a systematic way to assign code words based on probabilities of blocks. [23] This technique, known as Shannon-Fano coding, was first proposed in the 1948 article.

The book, co-authored with Warren Weaver, The Mathematical Theory of Communication, reprints Shannon's 1948 article and Weaver's popularization of it, which is accessible to the non-specialist. Warren Weaver pointed out that the word "information" in communication theory is not related to what you do say, but to what you could say. That is, information is a measure of one's freedom of choice when one selects a message. Shannon's concepts were also popularized, subject to his own proofreading, in John Robinson Pierce's Symbols, Signals, and Noise.

Information theory's fundamental contribution to natural language processing and computational linguistics was further established in 1951, in his article "Prediction and Entropy of Printed English", showing upper and lower bounds of entropy on the statistics of English – giving a statistical foundation to language analysis. In addition, he proved that treating whitespace as the 27th letter of the alphabet actually lowers uncertainty in written language, providing a clear quantifiable link between cultural practice and probabilistic cognition.

AWARDS AND HONOUR LIST:

Alfred Noble Prize, 1939 (award of civil engineering societies in the US)

Morris Liebmann Memorial Prize of the Institute of Radio Engineers, 1949[57]

Yale University (Master of Science), 1954

Stuart Ballantine Medal of the Franklin Institute, 1955

United States National Academy of Sciences, 1956[58]

Research Corporation Award, 1956

University of Michigan, honorary doctorate, 1961

Rice University Medal of Honor, 1962

SELECTED WORKS:

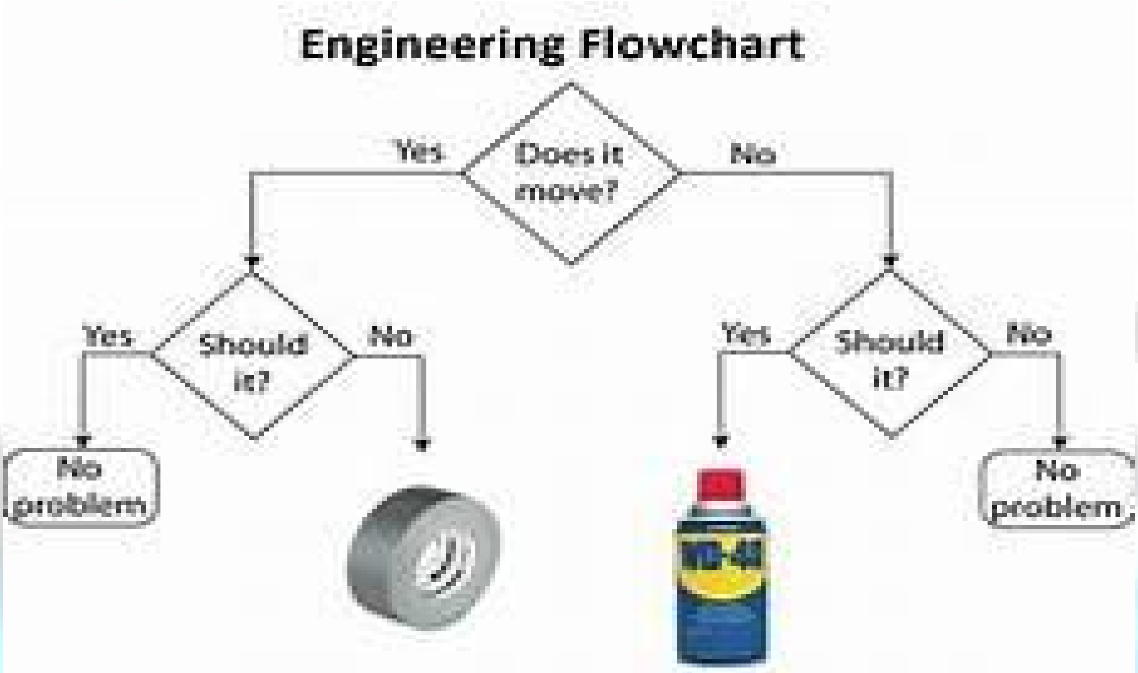
Claude E. Shannon: A Symbolic Analysis of Relay and Switching Circuits, master's thesis, MIT, 1937.

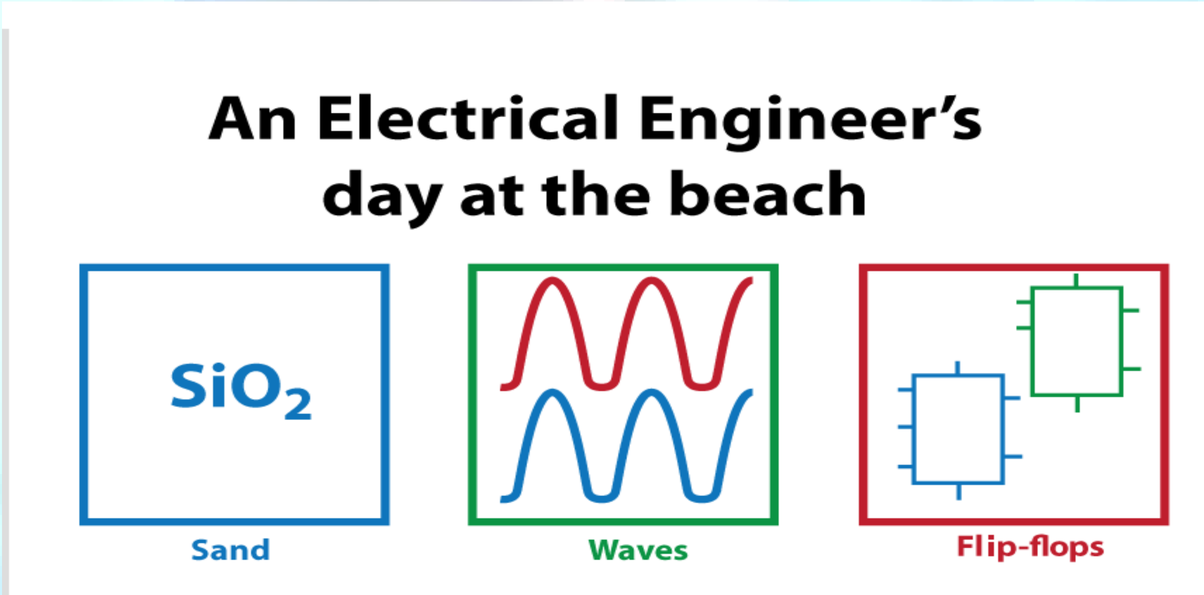
Claude E. Shannon: "A Mathematical Theory of Communication", Bell System Technical Journal, Vol. 27, pp. 379–423, 623–656, 1948 (abstract).

Claude E. Shannon and Warren Weaver: The Mathematical Theory of Communication. The University of Illinois Press, Urbana, Illinois, 1949. ISBN 0-252-72548-4

STUDENT CORNER

JOKES:





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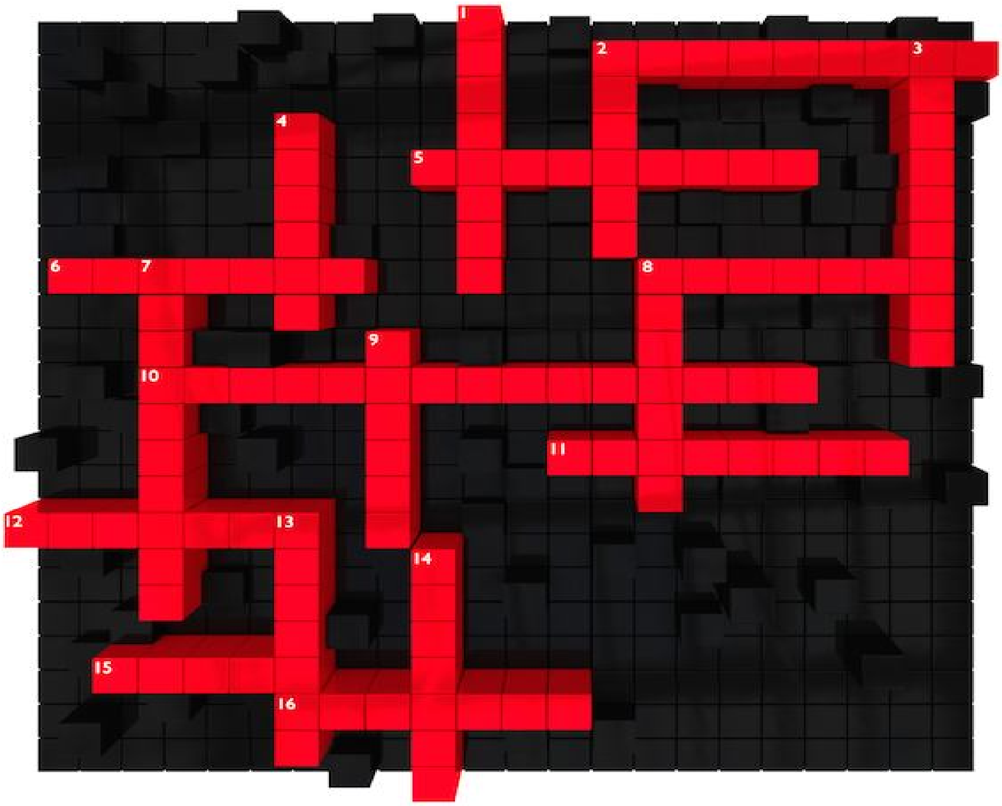


Across

2. A diagram that shows the electrical connections of the electronic components
5. Current is considered to be the movement of ________.
6. A voltage source that converts chemical energy to electrical energy
8. A flow of electric charge
10. A characteristic of a secondary cell
11. A material that is composed of a mixture of elements
12. The term used to designate electrical pressure
15. A short circuit will have a ________ current flow.
16. The part of an atom that has no electric charge

Down

1. A voltmeter is used in ________ with the circuit.
2. A device that opens or completes an electrical path
3. A material that opposes the movement of free electrons
4. One coulomb passing a point in one second
7. A resistive component that is designed to be temperature sensitive
8. A unit of charge that contains 6.25 × 10^18 electrons
9. An atom's atomic number is determined by its number of _________.
13. A substance that is found only in its pure form
14. It is used to measure current.

DEPARTMENT ACTIVITIES

GUEST LECTURE:

[1] SUBJECT NAME: SENSORS

RESOURCE PERSON : DR.D.V. RAMA KOTI REDDY ,SECRETARY,IETE VSP CENTER

DATE: 31-08-2017

DESCRIPTION: Through This Guest Lecture Students Came To Know About The Different Type Of Sensors And How They Work, Later They Had An Interactive Session With The Guest Lecturer

[2] SUBJECT NAME: INDUSTRY EXPECTATIONS AND NEEDED SKILLS

RESOURCE PERSON : Mr.Aniruddha S Dasu, Global HR, Virtuesa Software Solutions

DATE: 01-09-2017

DESCRIPTION: Through This Guest Lecture Students Came To Know About The Real Working Of Industries And How The Work Flow Goes In Real Time,The Session Is Made More Exciting By Interaction Session With The Students

[3]] SUBJECT NAME: ON THE OCCASION OF BIRTH ANNIVERSARY OF J.C.BOSE

RESOURCE PERSON : PROF.N.BALA SUBRAMANYAM, HOD ECE, GVPCEW

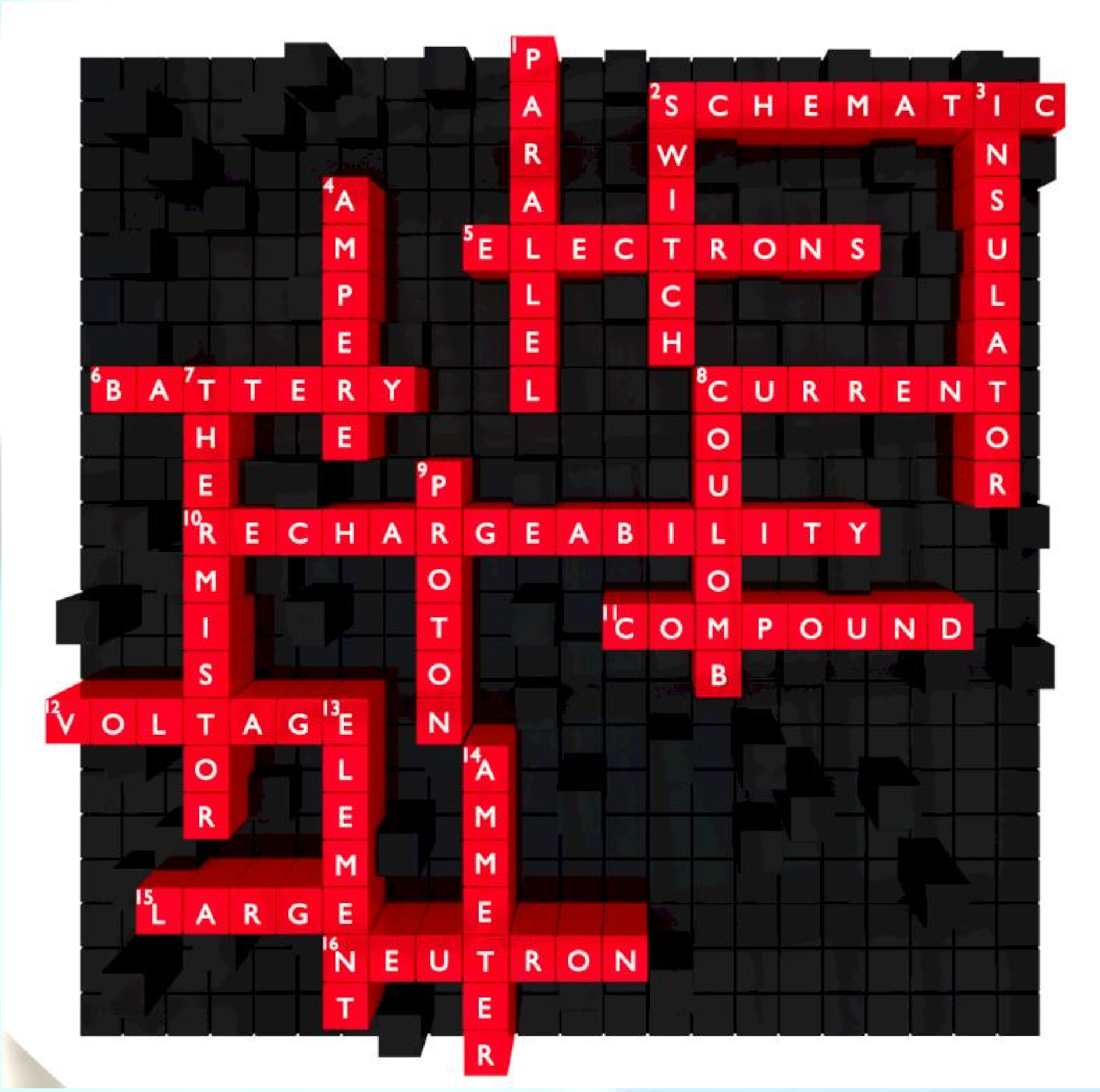
DATE: 30-11-2017

TECHNICAL EVENT:

[4]SUBJECT NAME:POSTER PRESENTATIONS ON WIRELESS COMMUNICATIONS

DATE: 12-12-2017

ANSWER:


1 PARALLEL
2 SCHEMATIC
2 SWITCH
3 INSULATOR
4 AMPERE
5 ELECTRONS
6 BATTERY
7 THERMISTOR
8 CURRENT
8 COULOMB
9 PROTON
10 RECHARGEABILITY
11 COMPOUND
12 VOLTAGE
13 ELEMENT
14 AMMETER
15 LARGE
16 NEUTRON

Vision of the Department	**Produce competitive engineers instilled with ethical and social responsibilities to deal with the technological challenges in the field of Electronics and Communication Engineering.**	
Mission of the Department		**Mission Statements**
	M1	**Facilitate a value-based educational environment that provides updated technical knowledge.**
	M2	**Provide opportunities for developing creative, innovative and leadership skills.**
	M3	**Imbue technological and managerial capabilities for a successful career and lifelong learning.**

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