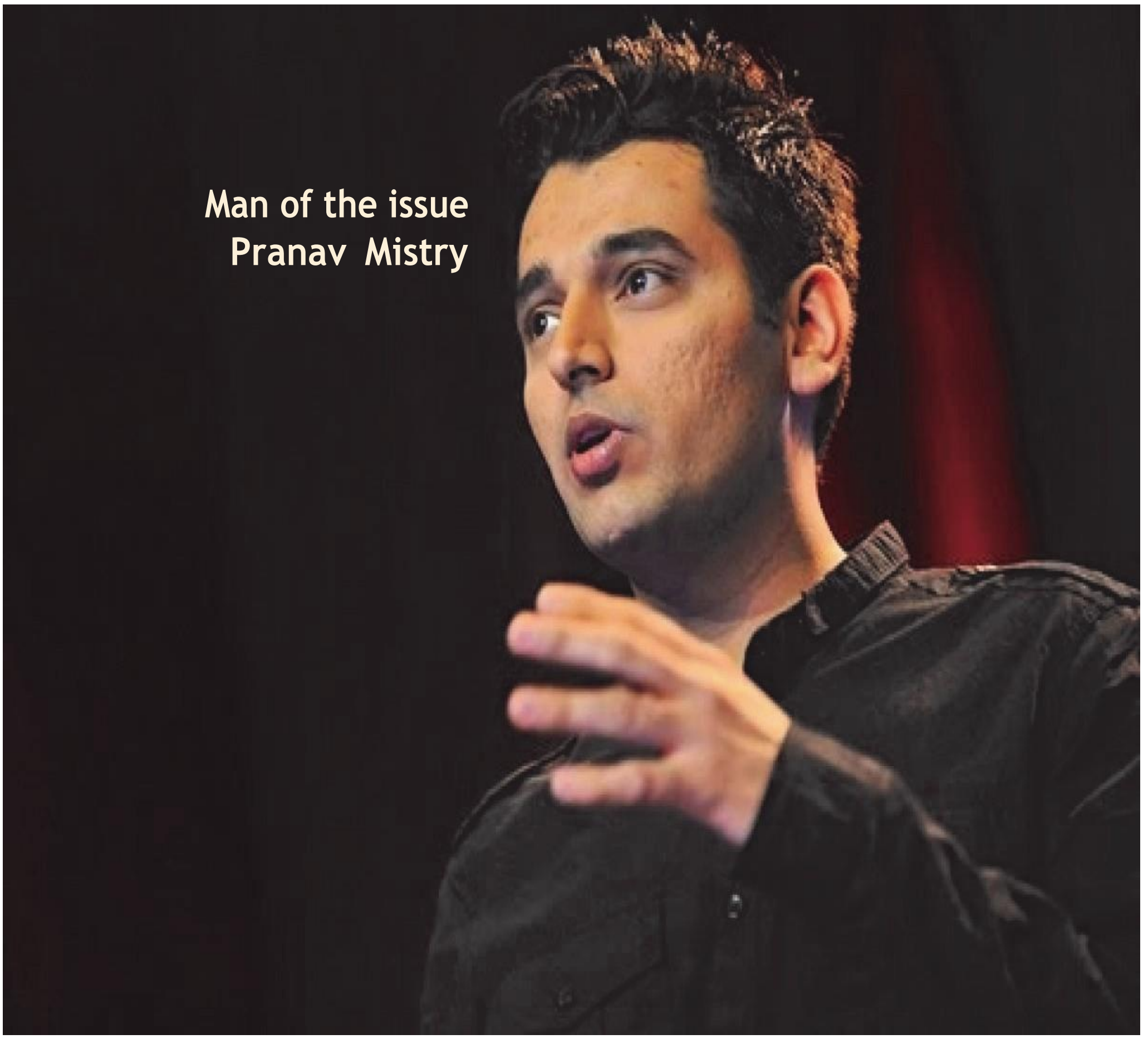
E-TARANG

KIET ECE E-MAGAZINE

Vol. II, Issue. I 2019-20



Department of Electronics and Communication Engineering
KIET Group of Institutions, Ghaziabad
(NAAC 'A' Grade, NBA Accredited and ISO 9001-2000)

KIET Group of Institutions, Ghaziabad, U.P.

Department of Electronics & Communication Engineering

VISION AND MISSION OF THE INSTITUTE

Vision statement

To become a leading institution nationally in the area of professional education, research & innovation for serving the global community.

Mission statements

- To impart quality professional education, skills and values through outcome-based innovative teaching learning process in all spheres.
- To undertake collaborative interdisciplinary research as a co-requisite for professional education and simultaneously solve problems faced by society and industry.
- To create an ambience of innovation, entrepreneurship and consultancy for future leaders and innovators.
- To keep faculty members enthusiastic by continuous professional development and positive working environment.

KIET Group of Institutions, Ghaziabad, U.P.

Department of Electronics & Communication Engineering

VISION AND MI SSION OF THE DEPARTMENT

Vision:

To become a leading center of excellence in the technical education of Electronics & Communication Engineering and create competent professionals in thrust areas for the development of society and nation.

Mission:

- To educate the students with the state of the art technologies through innovative teaching-learning process.
- To enable the graduates to develop the skills required to solve complex real time problems using tools and techniques of Electronics & Communication Engineering practice.
- To develop the spirit of innovation and creativity by collaborating with industries and research establishments to fulfill the needs of society.
- To practice high standards of human values, professional ethics and accountability.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) OF B.TECH. (ELECTRONICS & COMMUNICATION ENGINEERING)

Graduates of the program will:

I. Acquire fundamental knowledge of Electronics & Communication Engineering to become employable and capable of pursuing higher studies.

II. Have sound foundation required to develop hardware & software solutions necessary for analysis, design and implementation of modern Electronics & Communication Engineering systems

III. Develop effective communication skills and interpersonal behavior to become a cooperative team member and able leader.

IV. Provide quality and worthy service towards their profession with societal and ethical values.

V. Inculcate the habit of life -long learning needed for higher studies and research and continue to develop new methodologies and technologies.

KIET Group of Institutions, Ghaziabad, U.P.

Department of Electronics & Communication Engineering

PROGRAMME OUTCOMES (POs) and (PSOs) OF B.TECH. (ELECTRONICS & COMMUNICATION ENGINEERING)

Program Outcomes (POs)

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2: Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the

engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: Formulate the real-life problems and apply the concepts of semiconductor technology, signal processing and communication systems, VLSI etc., in the design and development of application-oriented engineering systems.

PSO2: Ability to identify, formulate and analyze complex problems in the field of Electronics and Communication Engineering using modern engineering tools, along with analytical and managerial skills either independently or as team.

KIET Group of Institutions, Ghaziabad, U.P.

Department of Electronics & Communication Engineering

GRADUATE ATTRIBUTES

The Graduate Attributes of Engineering Programs as identified by NBA are:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

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3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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Dr. A Garg

Message

I am delighted to note that the Department of Electronics and Communication Engineering, KIET Group of Institutions, Ghaziabad is publishing (Online) Volume. II Issue I, of KIET ECE E-Magazine, "E-TARANG".

I appreciate the efforts on the part of the Editorial Committee in bringing out Volume. II Issue I, of E-TARANG on various domains of Electronics & Communication Engineering.

I understand that the articles contributed for publication in the Volume. 1 Issue I, of are on almost all the current aspects of Communication Systems, Electronics systems and several others.

I have great pleasure in congratulating the Editors of KIET ECE E-Magazine, "E-TARANG" for their untiring efforts in bringing out this Volume.1 Issue I, of E-TARANG which will be a valued treasure for all researchers, students and faculty in Communications, Networking, Microwave and Electronics Engineering areas.

Let me close with warmest regards

Dr. A Garg
President
KIET ECE E-Magazine, "E-TARANG"

FROM EDITOR'S DESK

It gives me immense pleasure in writing this foreword for the first issue of the KIET ECE E-Magazine, "E-TARANG" being publishedby the Department of Electronics and Communication Engineering, KIET Group of Institutions, Ghaziabad.

This magazine is targeted towards researchers, professionals, educators and students to share innovative ideas, issues, recent trends and future directions in the field of Electronics and Communication Engineering. Furthermore, it will enable the students in the various domains to foster the exchange of concepts, prototypes, research ideas and the results of research work which could contribute to the academic arena and also benefit business and industrial community.

I am sure that this magazine would greatly benefit researchers, students and faculty. Young students and technocrats will find the contents of the magazine helpful to set roadmaps for their future endeavors.

Dr. Sanjay Sharma
Professor & Head, ECE DepartmentKIET Group of Institutions

CONTENTS

NEWS

Japan's robo-astronaut takes 'one small step...'

The wide-eyed and bootie-wearing "Kirobo"—roughly the size of a chihuahua—broadcast a message from inside the International Space Station, greeting citizens of Earth and paying cheeky tribute toNeil Armstrong. "On August 21, 2013, a robot took one small step toward a brighter future for all," Kirobo said in a video that showed the humanoid creation drifting weightlessly on-board the ISS, as it moved its legs in the air. The images made their global debut as part of Tokyo's bid for the 2020 Games during a presentation ahead of a meeting of the International Olympic Committee. "Goodmorning to everyone on Earth. This is Kirobo. I am the world's first talking robot astronaut. Nice to meet you," it said in Japanese. The humanoid was created jointly by advertising firm Dentsu, the University of Tokyo, robot developer Robo Garage and Toyota. The robot stands just 34 centimetres (13.4 inches) tall and weighs about one kilogram (2.2 pounds). It left Earth on August 4 on a cargo- carrying rocket that was also delivering supplies to the ISS. Kirobo is programmed to communicate in Japanese and keep records of its conversations with Koichi Wakata, the first Japanese astronaut to command the ISS. The robot is part of a study aimed at seeing how a non-human companion can provide emotional support for people isolated over long periods.

Dash Robotics crowd funding 'origami' runner you can assemble at home

A team of Berkeley PhD engineers who worked in the school's lab explored animal locomotion strategies and shared an interest in prototypes made quickly and cheaply, particularly fast robotic runners that could be affordable and easy to explore. People found them appealing and started askingif the robots were for sale. Idea think origami. The team worked out a novel way to manufacture new fast-running robot prototypes quickly and cheaply. The team, Nick Kohut, Paul Birkmeyer, Andrew Gillies and Kevin Peterson, dedicated to the spirit of a maker movement, have embarked on a mission to commercially offer robot kits for less than $70 and have made their goal a crowd funding campaign. They plan on having the robots shipped in a flat pack as a kit and then folded out and assembled by the user at home, complete with tabs and slots to guide the way. Simple electronics for controlling the robots are included with the kit.

"With this campaign, we're funding the beta development of Dash, and we need your help. We're only producing one thousand robots, so get your Dash before we run out!" they announced on the crowd funding site. "When you back us, you'll be getting more than just an awesome robot. You'll be participating in the beta development of our product," they said. "With your help, we can bring Dash out of the lab and into everyone's hands."

Nick Kohut, chief executive officer and co-founder of Dash Robotics, hopes their fast runners will make a difference in the price barriers that turn a lot of parents and hobbyists away from educational robots that could provide fun and learning experiences for youths.

"Most educational robots today cost hundreds of dollars – that's not realistic for most families," said Kohut. The team, now as a company called Dash Robotics, announced Thursday that they will deliver their first robots through the crowd funding Dragon Innovation. The latter is a crowd funding platform, aimed at backing makers and their projects. The campaign will help the team move their robots from research prototype to the "beta" product phase, in anticipation of launching Dash commercially next year. Dash, as they hope, will carry the distinction of being the world's fold-able, programmable, origami robot that more people can afford.

New connection between stacked solar cells can handle energy of 70,000 suns

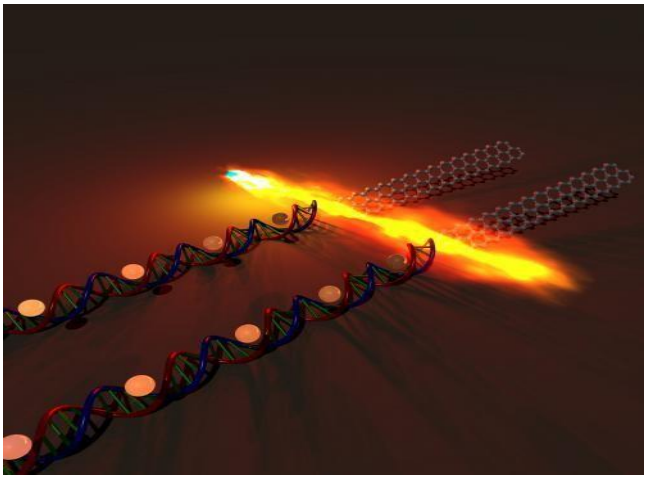
Stacked solar cells

North Carolina State University researchers have come up with a new technique for improving the connections between stacked solar cells, which should improve the overall efficiency of solar energy devices and reduce the cost of solar energy production. The new connections can allow these cells to operate at solar concentrations of 70,000 suns worth of energy without losing much voltage as "wasted energy" or heat. Stacked solar cells consist of several solar cells that are stacked on top of

one another. Stacked cells are currently the most efficient cells on the market, converting up to 45 percent of the solar energy they absorb into electricity. But to be effective, solar cell designers need to ensure the connecting junctions between these stacked cells do not absorb any of the solar energy and do not siphon off the voltage the cells produce—effectively wasting that energy as heat. "We have discovered that by inserting a very thin film of gallium arsenide into the connecting junction of stacked cells we can virtually eliminate voltage loss without blocking any of the solar energy," saysDr. Salah Bedair, a professor of electrical engineering at NC State and senior author of a paper describing the work. This work is important because photovoltaic energy companies are interested in using lenses to concentrate solar energy, from one sun (no lens) to 4,000 suns or more. But if thesolar energy is significantly intensified—to 700 suns or more—the connecting junctions used in existing stacked cells begin losing voltage. And the more intense the solar energy, the more voltage those junctions lose—thereby reducing the conversion efficiency. "Now we have created a connecting junction that loses almost no voltage, even when the stacked solar cell is exposed to 70,000 suns of solar energy," Bedair says. "And that is more than sufficient for practical purposes, since concentrating lenses are unlikely to create more than 4,000 or 5,000 suns worth of energy. This discovery means that solar cell manufacturers can now create stacked cells that can handle these high-intensity solar energies without losing voltage at the connecting junctions, thus potentially improving conversion efficiency. "This should reduce overall costs for the energy industry because, rather than creating large, expensive solar cells, you can use much smaller cells that produce just as much electricity by absorbing intensified solar energy from concentrating lenses. And concentrating lenses are relatively inexpensive," Bedair says.

Priyansh Shankhdhar

Scientists use DNA to assemble a transistor from grapheme



To the right is a honeycomb of graphene atoms. To the left is a double strand of DNA.

Graphene is a sheet of carbon atoms arrayed in a honeycomb pattern, just a single atom thick. It could be a better semiconductor than silicon – if we could fashion it into ribbons 20 to 50 atoms wide. Could DNA help? DNA is the blueprint for life. Could it also become the template for making a new generation of computer chips based not on silicon, but on an experimental material known as graphene? That's the theory behind a process that Stanford chemical engineering professor ZhenanBao reveals in *Nature Communications*. Bao and her co-authors, former post-doctoral fellows AnatoliySokolov and Fung Ling Yap, hope to solve a problem clouding the future of electronics: consumers expect silicon chips to continue getting smaller, faster and cheaper, but engineers fear that this virtuous cycle could grind to a halt.Why has to do with how silicon chips work. Everything starts with the notion of the semiconductor, a type of material that can be induced to either conduct or stop the flow of electricity. Silicon has long been the most popular semiconductor material used to make chips. The basic working unit on a chip is the transistor. Transistors are tiny gates that switch electricity on or off, creating the zeroes and ones that run software. To build more powerful chips, designers have done two things at the same time: they've shrunk transistors in size and also swung those gates open and shut faster and faster. The net result of these actions has been to concentrate more electricity in a diminishing space. So far that has produced small, faster, cheaper chips. But at a certain point, heat and other forms of interference could disrupt the inner workings of silicon chips. "We need a material that will let us build smaller transistors that operate faster using less power,"

Bao said. Graphene has the physical and electrical properties to become a next-generation semiconductor material – if researchers can figure out how to mass-produce it. Graphene is a single layer of carbon atoms arranged in a honeycomb pattern. Visually it resembles chicken wire. Electrically this lattice of carbon atoms is an extremely efficient conductor.

Priyansh Shankhdhar

E- PRODUCTS

Sous-Vide SDV delivers a more accurate cooking experience

I know that for many of us who spend time in the kitchen whipping up dishes from time to time, cooking does involve a fair bit of skill as well as intuition. The thing is, all of this intuition comes with plenty of experience, but if you are just starting out, it would be highly advisable for you to obtain the relevant number of tools to help you get going, starting off on the right foot. The $99.99 Sous-Vide SDV is definitely such a device that would eliminate any kind of guesswork, as it capable of maintaining water temperature within 1 degree F of precision, and works well with your slow cooker or rice cooker. Not only that, I guess you can say that this is an affordable introduction to sous vide cooking. It might even propel you to star chef status in your home, as your meals start to taste even better than ever before, without you ending up serving the rest of your guests under or over-cooked meat. Perhaps that elusive (so far) perfect steak is no longer a distant dream, eh? The Sous-Vide SDV will involve a technique that immerses a vacuum packed sachet of meat into precisely temperature- controlled water, where the water would slowly bring the internal temperature of the food evenly up to a point without scorching it. With the Sous-Vide SDV, it will be placed between your slow-cooker (crock pot) or rice-cooker and the wall outlet, where the wired probe remains in the center of your water bath, and using its sophisticated computer brain, will control the cooker so that the water bath remains within 1 degree F of the desired temperature. Isn't this neat?

Samsung Galaxy Gear smartwatch set to rock and roll

Are you thinking about getting a new timepiece to adorn your wrist? If you have answered in the affirmative, then you would surely want to check out the Samsung Galaxy Gear which was just announced at IFA 2013 earlier yesterday. In fact, the smartwatch might be the new trend when it comes to portable devices – remember how the tablet exploded overnight with the introduction of the Apple iPad, creating a new niche market? Perhaps the smartwatch might be the next ―tablet‖, so to speak, and here we are with more details about the Samsung Galaxy Gear that is set to arrive in store shelves from September 25th onwards.

TouchTone portable Bluetooth wireless speaker and speakerphone makes life easier

I am quite sure that many of us have heard of id Software before, as they are the ones behind the classic Wolfenstein 3D FPS which was followed up by the Doom series, and just when you thought that things could not get any better, along came the fully 3D Quake and its subsequent sequels. Having saidthat, what about id America?id America is no gaming house, but rather, they are a premium manufacturer of fashion-forward digital accessories, and their latest announcement would come inthe form of the TouchTone. The TouchTone happens to be a portable Bluetooth wireless speaker and speakerphone, where it was specially designed for stylish sound connoisseurs without sacrificing on performance of course.

LG sports a new 77-Inch Ultra HD curved OLED TV to wow the masses

Just how much larger do you think that TVs in the living room will get eventually that having a projector around is redundant just for screen size alone? We are not quite sure where the glass ceiling is set in terms of measurements, but one thing is for sure – LG has just edged closer to a new

record. In fact, their latest offering comes in the form of a 77‖ Ultra HD curved OLED TV that might just set the tone for the next-generation TV market. You might get a sense of deja vu out of reading this, but that is because the South Korean consumer electronics giant rolled out a 55‖ curved OLED TV earlier this year at CES, leaving this 77‖ monster to debut at IFA 2013 instead.

Plasma-Treated Nano Filters Help Purify World Water Supply

Aug. 21, 2013 — Access to safe drinking water is a step closer to being a reality for those in developing countries, thanks to new research published today in *Nature Communications*.

The study paves the way for the next generation of portable water purification devices, which could provide relief to the 780 million people around the world who face every day without access to a clean water supply.

An international team of researchers -- led by Associate Professor Hui Ying Yang from Singapore University of Technology and Design -- showed that water purification membranes enhanced by plasma-treated carbon nanotubes are ideal for removing contaminants and brine from water.

The team included Dr Zhaojun Han and Professor Kostya (Ken) Ostrikov from CSIRO's world-leading Plasma Nanoscience Laboratories.

The study paves the way for the next generation of portable water purification devices, which could provide relief to the 780 million people around the world who face every day without access to a clean water supply.

According to Dr Han, these membranes could be integrated into portable water purification devices the size of a tea pot that would be rechargeable, inexpensive and more effective than many existing filtration methods. Contaminated water would go in one end, and clean drinkable water would comeout the other.

"Small portable purification devices are increasingly recognised as the best way to meet the needs of clean water and sanitation in developing countries and in remote locations, minimising the risk of many serious diseases," Dr Han says.

"The large industrialised purification plants we see in other parts of the world are just not practical -- they consume a large amount of energy and have high labour costs, making them very expensive to run."

Dr Han acknowledges that some smaller portable devices do already exist. However, because they rely on reverse osmosis and thermal processes, they are able to remove salt ions but are unable to filter out organic contaminants from the briny water found in some river and lake systems.

"For people in remote locations, briny water can sometimes be the only available water source," he says. "That's why it's important to not only be able to remove salts from water, but to also be able to put it through a process of purification."

"Our study showed that carbon nanotube membranes were able to filter out ions of vastly different sizes -- meaning they were able to remove salt, along with other impurities," he says.

According to Professor Ostrikov, the other downside of existing portable devices is that they require a continuous power supply to operate their thermal processes. "On the other hand, the new membranes could be operated as a rechargeable device."

Professor Ostrikov attributes the success of the new membranes to the unique properties of plasma treated carbon nanotubes.

"Firstly, ultralong nanotubes have a very large surface area that is ideal for filtration. Secondly, nanotubes are easy to modify, which allows us to tailor their surface properties through localised nanoscale plasma treatment," he says.

Now that the researchers have proven the effectiveness of the method, they plan to extend their research to investigate the filtration properties of other nanomaterials. They will begin by looking at graphene, which has similar properties to carbon nanotubes, but could be made considerably denser and stronger.

The study 'Carbon nanotube membranes with ultrahigh specific capacity for water desalination and purification' is a collaborative work between Singapore University of Technology and Design, CSIRO, Massachusetts Institute of Technology (MIT), the University of Sydney, and Hong Kong Polytechnic University.

Ankit Srivastava

WEB PULSE

Artificial intelligence meets the real World

There is no end to the applications of robotics, evoking a lot of interest across different sectors of the economy. At the same time, there are fears of robots taking over humanity. It's time you get more familiar with this science in its early stages, today and in future.

Laser welding by a robot

The word ‗robot' originates from the Czech word for forced labour or serf. It was introduced by playwright Karel Capek, whose ficional robotic inventions were much like Dr Frankenstein's monsters—creatures created by chemical and biological methods rather than mechanical. But the current mechanical robots of popular culture are not much different from these fictional biological creations.

The International Standards Organization (ISO) defines a robot as an automatically-controlled, re-programmable, multi-purpose and manipulative machine, with or without locomotion, for use in industrial automation applications. Robotics is a field of multi-discipline engineering that deals with design, development and application of robots and the use of computer for their manipulation and processing.

Evolution of robotics

The history of robotics can be traced back to ancient Greece. According to Greek mythology, the Greek god of fire and forge—Hephaestus—was served by mechanical robots. Another historical record suggests an ancient Egypt origin for robotics, where priests used steam-activated mechanisms to open the doors of their temple.

Before the first electrician was born, the earliest reference to a robot was in ancient China, in the form of an organic robot given by an artificer called Yan Shi to King Mu of Zhou around 1000 BC. The

robot was made of leather and glue with actual human organs, and it ceased functioning when the organs were removed. It was around 350 BC when veteran Greek mathematician Archytas constructed a mechanical bird named ‗pigeon'—a robot powered by steam, which could fly. It was the first recorded model airplane and a milestone in the history of robotics.Between 1500 and 1800, odd mechanical marvels were springing up all over Europe. Leonardo Da Vinci was the next known robot designer after the ancient period. He invented a mechanical man in knight's armour. John Dee of England invented a flying wooden beetle during the Elizabethan era. Another machine was Vaucanson's ‗digesting duck' in 1739, which was able to annoy real ducks, quack, eat grain and produce fake faeces. The duck was even referred to by Voltaire, albeit rather cryptically: —Without the duck of Vaucanson you have nothing to remind you of the glory of France.‖ Isaac asimov's laws of robotics

Law zero. A robot may not injure humanity or, through inaction, allow humanity to come to harm. ***First law***. A robot may not injure a human being or, through inaction, allow a human being to come toharm. ***Second law***. A robot must obey orders given by human beings, except where such orders would conflict with the first law.
Third law. A robot must protect its own existence as long as such protection does not conflict with the firs tor second law.

Basic requirements of a robotic system
Some basic features of a robot include: *Mobility.* It possesses some form of mobility.

Programmability. It implies computational or symbol-manipulative capabilities that a designer can combine as desired. So the robot is basically a computer, which can be programmed to accomplish a large variety of tasks. After being programmed, it operates automatically.

Sensors. Sensors sense the environment and give useful feedback to the device.

Mechanical capability. Robots act according to the environment rather than merely functioning as data processing or computational device.

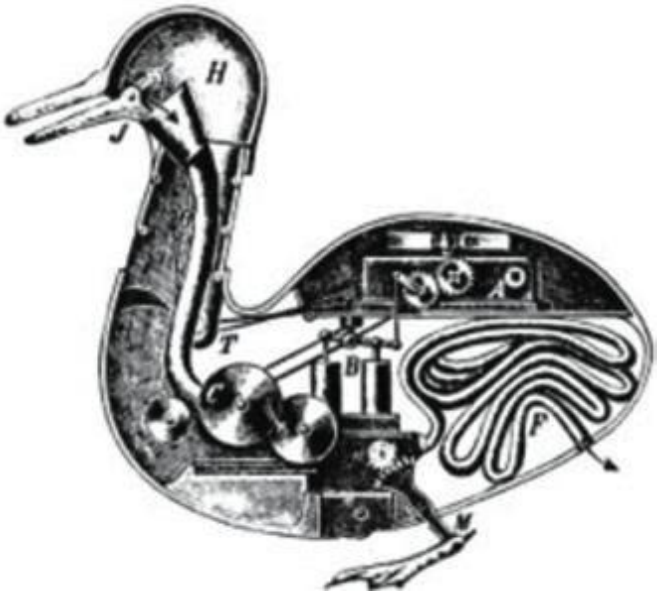
Flexibility. Robots operate with a range of programs and manipulate and transport materials in a variety of ways.

Robotics, then and now

1801 A punch-card-controlled textile machine called Jacquard loom
1890 First autonomous vehicles (Tesla)
1922 First reference to ‗robot' in Capek's play Rossum's Universal Robots
1938 Pollard and Roselund devised programmable paint sprayer
1946 DeVol—a general-purpose magnetic playback device for controlling machines
1946 Eckert &Mauchly devised ENIAC electronic computer
1948 MIT Prof. Wiener published Cybernetics
1952 First numerical control machine built at MIT
1954 Duvoll designed first programmable robot (Unimation—first robot company)
1959 Planet Corporation marketed the first commercially available robot
1962 GM installed first industrial robot on an assembly line
1964 Artificial Intelligence labs opened at MIT and SRI
1967 Mark II robot imported to Japan for paint spraying
1968 SRI built Shakey—first mobile robot operated using AI techniques
1970 First robot arm developed at Stanford
1973 T#—first minicomputer-controlled industrial robot (used extensively in the industry)
1976 Robot arms used on Viking 1 and 2 space probes
1977 ASEA (Europe) built first microcomputer-controlled robot
1980 s and on Rapid growth in the robot industry (Japan becomes the biggest player)
Source: http://www.cs.binghamton.edu

Scope of robotics

Robotics requires the application of mechanical engineering, electrical/electronic engineering, computer-based integrated manufacturing, biological mechanics and software engineering.



Vaucanson's digesting duck developed in 1739

A good depth in following major subjects is required to deal with robotics technology:

1	Artificial intelligence
2	Engineering physics (mechanics)
3	Computer-aided design and computer-aided manufacturing
4	Computational geometry and simulation
5	Robot motion and path planning/detection
6	Electronic control, communication and navigation systems
7	Material science and technology
8	Optical engineering

Robots are being used in industries, nuclear science, sea-exploration, servicing of electric signals transmission, designing of bio-medical equipment, etc. The interdisciplinary field of robotics also finds applications to pursue research in various sectors. A good background in mechanics, control and algorithms is the primary requirement for doing any work in robotics. In addition to this, if one would like to get involved in aerial robotics such as unmanned aircrafts, the basic knowledge of aerodynamics and aircraft mechanics is essential. Robotics can be broadly divided into mechanical design and control algorithms. There is lot of research happening to improve the motion of robots through a good structural design and enhance their efficiency and adaptability through better control design, computer vision and artificial intelligence.

Challenges

Standardisation is a major hurdle. As no standard operating systems and software are currently in use, there exists diversity in the possible configurations in which a robot can be built and also in the hardware used. It is often necessary to write programming codes from scratch when dealing with new robots. Other issues such as concurrency, cost, compliance control, robot locomotion (particularly for legged, amphibious and flying robots), humancomputer interactions and cognitive computer vision are also facing a great deal of scrutiny with considerable research going on in each area.

TABLE I
Engineering Institutes Offering Courses in Robotics in India

Institute	Course offered
Centre for Robotics and Mechatronics at IIT Kanpur	M.Tech in robotics engineering
University of Hyderabad	M.Tech in artificial intelligence and robotics
University College of Engineering, under the Osmania University, Hyderabad	ME/M.Tech in automaton and robotics
MS University, Baroda	Master's programme with specialisation in automatic control and robotics
Institute of Technology, Banaras Hindu University	M.Tech in production engineering/industrial management engineering with robotics and automation as electives
The Birla Institute of Technology and Science (BITS), Pilani	ME in computer science with robotics as a subject
Department of Engineering Design, IIT Madras	Dual degree programme in engineering design and automotive engineering
Sri Sathya Sai Institute of Higher Learning, Prasanthinilayam, Andhra Pradesh	M.Tech in computer science with specialisation in artificial intelligence
The PSG College of Technology, Coimbatore	M.Tech in mechanical engineering with robotics as an elective subject
SRM University, Chennai	M.Tech in robotics
Cochin University of Science and Technology (CUSAT), Kerala	M.Sc in electronic science with specialisation in artificial intelligence and robotics
Defence Institute of Advanced Technology (DIAT), Pune	M.Tech in automotive engineering

A high level of specialisation is required to work on any particular aspect of robotics. Hence there are not too many options for taking up robotics as a degree itself, especially at the undergraduate level. Robotics still remains a popular course as an elective subject for engineering students.

Opportunities in India

Innovation coupled with consolidated research and development in robot technology has catapulted India's scientific position to a level that equals other advanced countries in recent years. It is, however, a known fact that robots are not widely used by Indian companies. Out of 600 to 700 robots widely used in India, most are used in engineering institutes and research organisations (see Tables I and II).

Robotics education is taking shape and many universities are introducing courses in robotics and automation at the postgraduate level as main or elective subjects. Seminars, workshops and conferences are also conducted by universities and institutes at regular intervals to project the recent developments in robotics technologies at national and international levels. These activities have inspired a notable number of under-graduate students to pursue higher studies in the field of robotics and automation in India and abroad. Students' participation in various robotics contests, meets and expos at international level has also increased marginally in recent years from India. Private institutes play a big role in robotics training for participation in these events.

Research on robotics and related technologies is being carried out at various centres to explore the possible applications of robotics in various fields (refer Table II)

TABLE II
Robotics Research Centres in India

Governing body	Centres	Applications
IIT Kanpur	Centre for Robotics & Mechatronics	Surgical robots and humanoid robots
NIT Rourkela	Centre for Industrial Electronics & Robotics	Industrial robots
Sathyabama University	Centre for Robotics	Robotics design
IIIT, Hyderabad	Robotics Research Lab	Robotics vision
IIT Madras	Department of Design Engineering	Underwater and medical robotics
Defence Research Development Organization (DRDO)	Centre for Artificial Intelligence & Robotics, Bangalore CVRDE, Chennai VRDE, Ahmednagar R & D E (E), Pune ADE, Bengaluru NSTL, Vizag NPOL, Kochi	Mini/micro robots Unmanned ground vehicles Autonomous surveillance vehicles Remotely operated underwater vehicles Unmanned aerial vehicles Autonomous underwater vehicles Underwater surveillance robots
Council of Scientific & Industrial Research (CSIR)	CSIO, Chandigarh CEERI, Pillani	Automation Industrial automation
Department of Atomic Energy (DAE)	BARC Mumbai	Laser-based robot for mapping
Ministry of Earth Sciences	NIOT, Chennai	Remote-operated boats

In India, studies related to robot technology and its implications are supported by the Department of Science and Technology (DST) and Department of Scientific and Industrial Research. The DST, Department of Information Technology and Ministry of Earth Sciences (formerly Department of Ocean Development), facilitates R&D in various areas of national interest.

Future of robotics

There is no limit to the applications of robotics technology. These range from household to deep sea,

space to classroom, and medical to communication. Humanoid robots will impact various aspects of our lives from our workplace to healthcare. In the near future, robots with artificial cognition may develop a will of their own and potentially turn against people spontaneously. To produce intelligent human-like robots that are able to have their own thoughts and take independent actions, technology has to incorporate into the machines a stable and conscientious mindset.

For serving the society in the form of a teaching tool, one may consider a robo-teacher. Incorporating more knowledge at the university level, there might be a robo-professor, who would possibly complete a teaching module from a remote place via the Internet.

In the future, we may even order a robot-replica that speaks, reacts, responds and behaves just like us, preserving our essence in artificial form for eternity. But robotics research is still in infancy and many targets need to be met before all this becomes a reality. So we can follow the saying: ―The Roadto success is always under construction.‖

Communication: From 1G to 4G

Mobile communications technology has come a long way since the initial analogue phones. Read this article to understand the evolution from 1G to 4G with technologies behind this phenomenal growth and important developments along the way.

Any radio telephone capable of operating while moving at any speed, battery operated and small enough to be carried by a person comes under the mobile communication systems. These communication systems may have different facilities. The different types of mobile communication systems are mobile two-way radio, public land radio, mobile telephone and amateur (HAM) radio.

Mobile two-way radios are one-to-many communication systems that operate in half-duplex mode, i.e., push to talk. The most common among this type is citizen band (CB) radio, which uses amplitude modulation (AM). It operates in the frequency range of 26-27.1 MHz having 40 channels of 10 kHz. It is a non-commercial service that uses a press-to-talk switch. It can be amplitude-modulated having double-sideband suppressed carrier or single-sideband suppressed carrier.

Public land mobile radio is a two way FM radio system, used in police, fire and municipal agencies. It is limited to small geographical areas. Mobile telephones offer full-duplex transmission. These are one- to-one systems that permit two simultaneous transmissions. For privacy, each mobile unit carries a unique telephone number.
Amateur (HAM) radios cover a broad frequency band from 1.8 MHz to above 30 MHz. These include continuous wave (CW), AM, FM, radio teleprinter, HF slow-scan still picture TV, VHF or UHF slow-scan or fast-scan TV, facsimile, frequency-shift keying and amplitude-shift keying.

Present and past of mobile communications

Before I narrate the journey from 1G to 4G, let me explain the important technologies behind the phenomenal growth of mobile communication systems. Since the commercial introduction of advanced mobile phone system (AMPS) service in 1983, mobile communication systems have witnessed an explosive growth. The most important breakthrough was the cellular concept.

Cellular concept. The advent of cellular operation brought frequency reuse capabilities. Advances in wireless access, digital signal processing, integrated circuits, increased battery life, etc led to exponential growth of personal communication services.

Cellular system works as follows: An available frequency spectrum is divided into discrete channels, which are assigned in groups to geographic cells covering a service area. The discrete channels are capable of being reused in different cells with diameters ranging from 2 to 50 km. The service area is allotted a radio frequency (RF) transmitter, whereas adjacent cells operate on different frequenciesto avoid interference.

Cellular telephones began as a simple two-way analogue communication system using frequency modulation for voice and frequency-shift keying for transporting control and signalling information. Other cellular systems are digital cellular system, cordless telephony, and satellite mobile and paging. Analogue cellular systems fall in the first-generation (1G) category and digital cellular low-power wireless fall in the second-generation (2G) category.

Analogue cellular phone. In 1970, Bell Labs in New Jersey proposed a cellular telephone concept as advanced mobile telephony system (AMPS). AMPS is a standard cellular telephone service placed into operation on October 13, 1983 by Illinois Bell. It uses narrow-band FM with a usable audio frequency band of 300-3 kHz and maximum frequency deviation of ±12 kHz for 100 per cent modulation. According to Carson's rule, this corresponds to 30 kHz.

AMPS uses frequency-division multiple access (FDMA), where transmissions are separated in the frequency domain. Subscribers are assigned a pair of voice channels (forward and reverse) for the

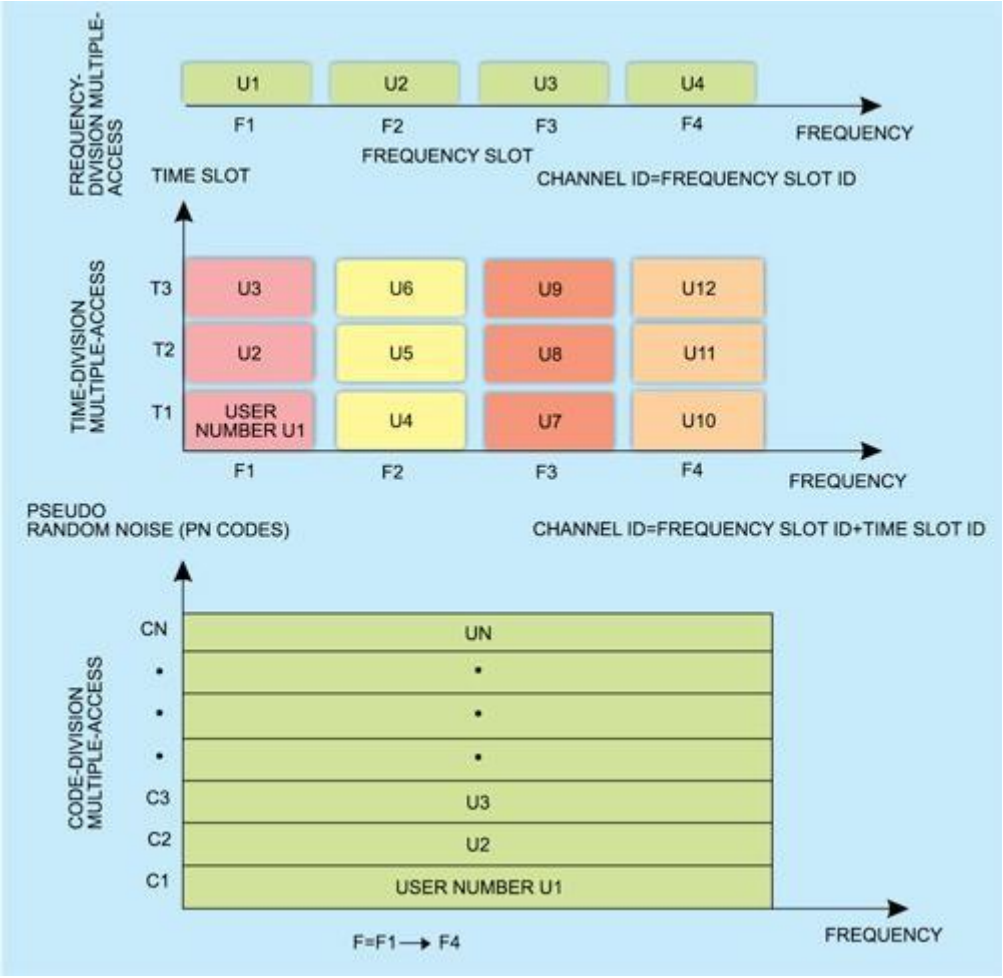
duration of their call. Analogue cellular channels carry both voice using FM and digital signalling information using binary FSK.

Digital cellular system. It provides improvements in both capacity and performance. FDMA uses a frequency canalisation approach to spectrum management, while time-division multiple access (TDMA) utilises a time-division approach. The entire available cellular RF spectrum is sub-divided into narrow-band radio channels to be used as a one-way communication link between cellular mobile units and base stations.

Multiple access technologies for cellular systems

Generally, a fixed amount of frequency spectrum is allocated to a cellular system. Multiple access techniques are deployed so that the users can share the available spectrum in an efficient manner.

For wireless communication, multiplexing can be carried out in three dimensions: Time (TDMA), frequency (FDMA and its variation OFDMA) and code (CDMA).



FDMA, TDMA, and CDMA multiple-access techniques

In TDMA the available spectrum is partitioned into narrow frequency bands or frequency channels, which, in turn, are divided into a number of time slots. In case of North American digital cellular standard IS-136, each frequency channel (30 kHz) is divided into three time slots, whereas in

European digital cellular system GSM each frequency channel (200 kHz) is divided into eight time slots. Guard bands are needed both between frequency channels and time slots.

In FDMA, users share the available spectrum in a frequency band called traffic channel. Different users are assigned different channels on demand basis. The user's signal power is concentrated in a relatively narrow frequency band. All the analogue cellular systems used FDMA system.

OFDM is a multi-cellular transmission technique where a data stream is carried with many lower-rate subcarrier tones. It has been adopted in mobile communications to combat hostile frequency-selective fading and has been incorporated into wireless network standards.OFDM is a multi-cellular transmission technique where a data stream is carried with many lower-rate sub-carrier tones. It has been adopted in mobile communications to combat hostile frequency-selective fading and has been incorporated into wireless network standards. OFDM combines the advantages of coherent detection and OFDM modulation and has many merits that are critical for future high-speed transmission systems. By using up/down conversion, electrical bandwidth requirement can be greatly reduced for the OFDM transceiver, which is extremely attractive for high-speed circuit design where electrical signal bandwidth dictates the cost. Lastly, signal processing in the OFDM transceiver can take advantage of efficient algorithm of fat Fourier transform (FFT)/inverse FFT, which suggests that OFDM has superior scalability over channel dispersion and data rate.

Digital modulation keying

Communication systems often involve modulation of a carrier, which results in a bandpass waveform. A digital signal can be used to modulate the amplitude, frequency or phase of a sinusoidal carrier producing three different forms of digital modulation: amplitude-shift keying (ASK), frequency-shift keying (FSK) and phase-shift keying (PSK). In addition to these basic techniques, there are some modulation schemes that employ a combination of amplitude and phase modulation. It may be noted that unlike ASK signal, PSK transmission is polar. At the same time, ASK is a linear modulation scheme, whereas PSK is a non-linear modulation scheme. PSK has a superior performance over ASK.

Quadrature phase-shift keying (QPSK). Digital modulation techniques mentioned above are spectrally inefficient in the sense that the available channel bandwidth is not fully used. Spectral efficiency can be improved by using QPSK. It is a system for two message sources. In this system modulation carriers in phase quadrature are combined to form the output waveform. In QPSK the amplitude of the modulator waveform and modulator gains are made as nearly equal as possible.

Differential phase-shift keying (DPSK). DPSK is a modification of PS that avoids the need to provide synchronous carrier required for detection of PSK signals. It is an ingenious technique whereby the carrier reference is derived from the received waveform in the preceding bit interval by use of a 1-bit delay. In essence, the received waveform delayed by 1-bit duration serves as its own reference.

Data transmission using packet switching

This is done by supplying various addressed packets, which are interconnected to have the conversation. New dedicated paths are created for sending the data. From the multiple paths to the destination, any path can be used to send data. Cellular digital packet data was designed for optimal operation with an analogue cellular system, especially AMPS.

Short message service. Short message service is the most common packet service that is supported on digital cellular networks like GSM, IS-136, EDGE and PDC (packet data service). It is a store-and-forward/packet mode service that provides inter-working with the various applications and services within a fixed network. For message transfer between relevant network entities, control and signalling channels (instead of normal traffic channels) are generally used for data transmission.

General packet radio service (GPRS). GPRS essentially represents add-on capabilities to the basic voice-optimised cellular network that nevertheless maintain the essential characteristics of radio-access technology.

Enhanced data rates for GSM evolution (EDGE). In order to enhance the data handling capabilities of 2G service, radio-access portion had to be modified. This modification was evolved in Europe in the form of EDGE. EDGE also supports a link adaptation mechanism that selects the best combination of modulation and encoding schemes based on the timevarying link quality.

EDGE concept applies to both circuit-mode and packet-mode data and is sufficiently generic for application to other digital cellular systems. It works in the 200 kHz bandwidth with one or more high-level modulation schemes and a range of efficient coding methods. Modulation schemes are offset QPSK and offset 16 QAM.

Spread spectrum

It is a special communication technique that purposefully uses much more RF bandwidth than necessary to transmit a signal. This helps in improving the signal-to-noise (S/N) ratio. The main advantages of this technique are secure communication and resistance to intentional jamming. There are 75 channels in the 2400-2483.3MHz band. There are two methods of performing spread spectrum:

Frequency hopping. This technique spreads the narrow-band signal as a function of time. The transmitted frequency is changed to a different pre-assigned channel several times per second (hopped). The order in which the pre-assigned channels are selected is ‗pseudo random.' In other words, the channel order is seemingly random but actually repeats itself at a defined interval. The specific order in which frequencies are occupied is a function of code sequence and the rate of hopping from one frequency to another is a function of information rate.

Direct sequence. This technique spreads a signal by expanding the signal over a broadband portionof the radio band. It uses a locally generated pseudo noise (PN) code to encode digital data to be transmitted. The most practical all-digit version is direct sequence. Binary phase-shift keying is the simplest and most often used modulation technique.

One of the most important features of spread-spectrum signals is that these contain a large number of very different signalling formats, used for communicating data symbols. It means that the receiver which detects one of these formats cannot detect any other format within a single message. The number of formats used in a spread-spectrum system is called multiplicity factor of the communication link and amounts to thousands.

CDMA. CDMA is a form of direct-sequence spread-spectrum technology that allows many users to occupy the same time and frequency allocations in a given band/space. CDMA assigns each user a unique spreading code to spread the baseband data before transmission, in order to help differentiate signals from various users in the same spectrum. It is the platform on which 2G and advanced 3G services are built. After speech, the codec converts voice into digital signal. CDMA spreads the voice stream over the full 1.25MHz bandwidth of the CDMA channel, coding each stream separately. The receiver uses a correlator to despread the wanted signal, which is passed through a bandpass filter. Unwanted signals are not despread and not passed through the filter.

The rate of the spreading signal is known as the ‗chip rate' as each bit in the spreading signal is known as ‗chip.' All 2G networks support only single-user data rates of the order of 10 kbps, which is too slow for rapid e-mail and Internet browsing.

CDMA provides more than ten times the capacity of the analogue AMPS and five times the calling capacity of GSM and TDMA systems. It requires fewer cell sites than GSM and TDMA.

Personal communication system

Personal communication system (PCS) is a new class of cellular telephone system such as AMPS. PCS systems are a combination of cellular telephone network and intelligent network, which is the entity of super-simple transfer (SST) inter-office protocol the distinguishes physical components of the switching network such as signal service point, signal control point and signal transfer point from the services provided by SST network.

In essence, PCS is the North American implementation of European GSM standard. GSM utilised its own TDMA access methods and provided expanded capacity and unique services such as caller ID, call forwarding and short messaging. A critical feature was seamless roaming, which allowed subscribers to move across provider boundaries. The effort was directed towards second-generation cellular systems.

In 1990, a second frequency band was specified. This band included two domains—1710-1785 MHz and 1805-1880 MHz, i.e., twice 75 MHz; three times as much as the primary 900MHz band.

Digital enhanced cordless telecommunication (DECT). DECT is a type of PCS system. DECT standard was developed by European Telecommunication Standards Institute (ETSI) for wireless PABX

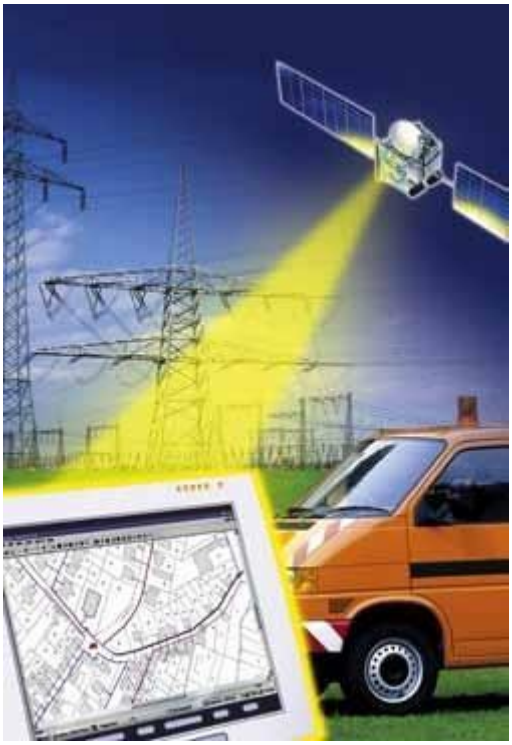
data LAN applications that represent closed environments requiring minimal open cordless access, since it was essential that products from different vendors not only coexist but interwork with each other.

DECT system has a TDMA/TDD frame structure with 24 slots that are equally allocated for downlink and uplink operation. DECT specifiesboth simplex (half-slots) and duplex (full slot) operation. Higher data rates are achieved by utilising multilevel modulation. The basic modulation scheme is a two-level Gaussian filled frequency-shift keying (GFSK), which is supplemented with 8-level modulation scheme leading to as high as 2.88 Mbps per carrier.

GSM

Global system for mobile communications (GSM) was developed by the Group Special Mobile, which was an initiative of the Conference of European Post and Telecommunications (CEPT) administrations. GSM was firs devised as a cellular system in a specific 900MHz band called the primary band. This primary band includes two sub-bands of 25 MHz each, 890-915 MHz and 935-960 MHz.

GSM systems like Iridium, Globalstar and ICO use constellations of low-earth orbit (LEO) or medium-earth orbit (MEO) satellites and operate as overlay networks for existing cellular and PCS networks. Using dual-mode, these extend the coverage to any and all locations on the earth's surface.



GPS–a reliable navigational aid anywhere on the earth

International Mobile Telecommunication-2000 (IMT-2000) is a standard developed by ITU for 3G. It ensures global mobility in terms of global seamless roaming and service delivery. An appreciation of the role of numbering and identities in mobility management, international roaming, call delivery, and

billing and charging is important in understanding the operation of mobile and personal communication networks.

Personal communication satellite service (PCSS) uses LEO satellite repeaters incorporating QPSK modulation and both FDMA and TDMA.

The main advantages of GSM are international roaming (in harmony with ISDN principles assuring inter-working between ISDN and GSM) and features like privacy and encryption, frequency hopping, discontinuous transmission and short message service. Other facilities include call forwarding, barring, waiting, hold and teleconferencing.

The basic architecture comprises a network sub-system, base station sub-system, mobile stations, and system interworking and interfaces. A subscriber identity module (SIM) is required to activate and operate a GSM terminal. The SIM may be contained within the mobile station or it may be a removable unit that can be inserted by the user in his mobile set.

New developments along the way

Before we proceed to evolution from 1G to 4G, let me touch upon the new developments that took place in 1G to 4G.

Global positioning system (GPS). GPS is a reliable navigational aid available anywhere on the earth, operating in all weather conditions 24 hours a day. It can be used by marine, airborne and land users. GPS technology was developed in 1983.

GPS consists of three segments:

Space segment. GPS consists of 24 NAVSTAR satellites along with three spare satellites orbiting at 20,200 km above the earth's surface in six circular orbital planes with a 12-hour orbital period each. These satellites operate at L1 band (1.575 GHz) continuously broadcasting navigational signals called coarse acquisition code. These codes can be received by anyone for decoding and finding navigational parameters like longitude, latitude, velocity and time.

Control segment. It consists of a master control station (MCS) and a number of smaller earth stations called monitoring stations located at different places in the world. Monitoring stations track satellites and pass on the measured data to the MCS. The MCS computes satellite parameters (called ephemeris) and sends them back to the satellite, which, in turn, broadcasts to all GPS receivers.

User segment. The user segment consists of all moving and stationary objects with GPS receivers. A GPS receiver is a multi-channel satellite receiver that computes every second its own location and velocity.

Bluetooth. Compared to WLAN technologies, Bluetooth technology aims at so-called ad-hoc piconets,

which are local-area networks with a very limited coverage and without the need for an infrastructure. The term „piconet‟ is a collection of Bluetooth devices that are synchronised to the same hopping sequence. One device in the piconet can act as master and all other devices connected to the master act as slaves. The master determines the hopping pattern and the slaves have to synchronise to this pattern. The hopping pattern is determined by the device ID—a 48-bit worldwide unique identifier. The phase in the hopping pattern is determined by the master‟s clock. All active devices are assigned a 3-bit active member address.

All parked devices use an 8-bit parked member address. Devices in standby mode do not need an address. The goal for Bluetooth development was to use a single-chip, low-cost, radio-based wireless network technology for laptops, notebooks, headsets, etc.

Bluetooth operates in the 2.4GHz ISM band. However, MAC, physical layer and the offered services are completely different. Bluetooth transceivers use Gaussian FSK for modulation and are available in three power classes: Class 1 (max. power 100 mW), class 2 (max. power 2.5 mW) and class 3 (max. power 1 mW).

Journey from 1G to 4G

1G system. 1G specifications were released in 1990 to be used in GSM. 1G systems are analogue systems such as AMPS that use FDM to divide the bandwidth into specific frequencies that are assigned to individual calls.

2G system.These second-generation mobile systems are digital and use either TDMA or CDMA method. Digital cellular systems use digital modulation and have several advantages over analogue systems, including better utilisation of bandwidth, more privacy, and incorporation of error detection and correction.

2.5G system. It was introduced mainly to add latest bandwidth technology to the existing 2G generation. It supports higher-data-rate transmission for Web browsing and also supports a new browsing format language called wireless application protocol (WAP). The different upgrade paths include high-speed circuit-switched data (HSCSD), GPRS and EDGE.

HSCSD increases the available application data rate to 14.4 kbps as compared to 9.6 kbps of GSM. By using four consecutive time slots, HSCSD is able to provide a raw transmission rate of up to 57.6 kbps to individual users.

GPRS supports multi-user network sharing of individual radio channels and time slots. Thus GPRS supports many more users than HSCSD but in a bursty manner. When all the eight time slots of a GSM radio channel are dedicated to GPRS, an individual can achieve as much as 171.2 kbps. But this has notbrought any new evolution.

EDGE introduces a new digital modulation format called 8-PSK (octal phase-shift keying). It allows nine

different air interface formats, known as multiple modulation and coding schemes, with varying degree of error control and protection. These formats are automatically and rapidly selectable. Of course, the covering range is smaller in EDGE than in HSCSD or GRPS.

3G system. To overcome the short-comings of 2G and 2.5G, 3G has been developed. It uses a wideband wireless network that offers increased clarity in conversations. Countries throughout the world are currently determining new radio spectrum bands to accommodate 3G networks. ITU has established 2500-2690MHz, 1700-1855MHz and 806-960MHz bands. Here the target data rate is 2 Mbps. The data is sent through packet switching. Voice calls are interpreted through circuit switching.

3G W-CDMA (UMTS). Universal Mobile Telecommunication System (UMTS) or W-CDMA assures backward compatibility with 2G and 2.5G TDMA technologies. W-CDMA, which is an air interface standard, has been designed for always-on packet-based wireless service, so that computers and entertainment devices may all share the same wireless network and connect to the Internet anytime, anywhere.

W-CDMA supports data rates of up to 2.048 Mbps if the user is stationary, thereby allowing high-quality data, multimedia, streaming audio, streaming video and broadcast type services to consumers. With W-CDMA, data rates from as low as 8 kbps to as high as 2 Mbps can be carried simultaneously on a single W-CDMA 5MHz radio channel, with each channel supporting between 100 and 350 simultaneous voice calls at once, depending on antenna sectoring, propagation conditions, user velocity and antenna polarisation.

Time slots in W-CDMA are not used for user separation but to support periodic functions. (This is in contrast to GSM where time slots are used to separate users). The bandwidth per W-CDMA channel is 4.4 to 5 MHz

Since the global standard was difficult to evolve, three operating modes have been specified: A 3G device will be a personal, mobile, multimedia communication device (e.g., TV provider redirects a TV channel directly to the subscriber's phone where it can be watched). Second, it will support video conferencing, i.e., subscribers can see as well as talk to each other. Third, it will also support location-based services, where a service provider sends localised weather or traffic conditions to the phone or the phone allows the subscriber to find nearby businesses or friends.

3.5G.It supports a higher through-put and speed at packet data rates of 14.4 Mbps, supporting higher data needs of consumers.

4G system. It offers additional features such as IP telephony, ultra broadband Internet access, gaming services and HDTV streamed multimedia. Flash-OFDM, the 802.16e mobile version of WiMax (also known as WiBro in South Korea), can support cellular peak data rates of approx. 100 Mbps for high-mobility communications such as mobile access and up to 1 Gbps for low-mobility

communications such as nomadic/local wireless access, using scalable bandwidths of up to 40 MHz The infrastructure for 4G is only packet-based (all-IP).

Rooftop Solar Plants a Viable Business Opportunity

Solar rooftop installations are a good investment option considering both tangible and intangible benefits

For organisations planning to shift from conventional energy to solar power use, a rooftop solar photovoltaic (PV) power plant can not only be a money saver but also money spinner with excess power supplied to the utility grid. While the Ministry of New and Renewable Energy (MNRE) is still in theprocess of laying down specifications for incentives, experts feel that with the right policies and execution, solar rooftop installations can be a hot trend in green technology. It is a profitable business concept, and hence a viable investment option.

Installation and Requirements

When solar PV modules are installed on a building's rooftop to generate solar power, it is called a rooftop power plant. Rooftop PV installation can either be done for standalone use or to feed into the grid.

Some of the factors to consider before installing a solar power plant on your building's rooftop include electrical load, current rate, roof size, load capacity and geographic location of the building. The subsidy given by the central and state governments, local utilities, and local community regulations and incentives are also some key determinants in the evaluation.

Rooftop solar arrays are best installed on a large and flat roof where direct sunlight without shadow from the surrounding structures is available. If there is shadow on a part of the terrace during theday, PV solar panels are unable to harvest the sun's energy for that period of time. Let us look at the key considerations while evaluating solar rooftop options.

First, it is important to have a basic understanding of the components of a solar power system and how these generate electricity. PV solar power systems are very simple electric power generating systems comprising the following basic components:

1	A set of PV panels that convert sunlight (photons) into direct-current (DC) electricity.
2	A racking system that firmly holds the panels to the roof, exposing these to the sun at an advantageous angle.
3	Inverters that convert DC electricity into alternating current (AC) electricity.
4	Wiring that connects everything.
5	A storage battery (in the case of a grid-fed power plant, a large-sized battery is not necessary to store and use that power after sunset).
6	A variety of means to tilt the panels toward the sun to generate more electricity.
7	Energy meters to record the energy that is supplied to the grid.
8	Junction boxes.
9	Earthing kits

Currently, commercially available silicon-based solar PV panels are made from solar cells encased in a special type of toughened glass. Silicon solar modules have been in the field for more than 50 years and perform quite predictably. These are guaranteed for 25 years of field life but the power yield drops about 0.6 per cent a year. One can use monocrystalline (made from a single crystal) or

polycrystalline (made from multiple crystals) panels. Monocrystalline panels are a little more efficient but the cost per watt is almost the same.

How to supply solar power to the grid?

If the solar power generated from a rooftop installation is to be injected into the grid, one needs toenter into a power purchase agreement (PPA) with the local distribution utility in whose area the solar system is located. Under this agreement, a tariff is determined by the appropriate State Electricity Regulatory Commission (SERC). However, the issues related to grid integration, metering, measurement and energy accounting for projects are under consideration with the government.

There is no cost involved in the transmission of energy unless the power is transmitted at high tension (HT) levels (11 kV or 33 kV), and special monitoring and metering hardware are deployed at HT levels. In the current scenario, metering arrangements for rooftop grid-interactive power plants are under active consideration by the government.

While no special arrangements are required to inject power into the grid, there is a safety aspect that needs to be factored in while transmitting energy. There is always a risk involved, as when the grid fails the solar power system automatically stops injecting power into the grid. This is called islanding,where the inverter isolates itself. This is a standard feature built into solar power inverters, making these safe for residential and commercial applications. A standalone feature in the inverter would enable captive consumption of the solar power generated in the event of any grid outage.

Copper-indium gallium-diselenide (CIGS) panels may become the preferred type for commercial rooftop projects in another five years. These have the potential to deliver reasonable efficiencies at a lower cost than traditional crystalline panels. However, the cost per watt may not necessarily go down, only the panel size per watt may drop. Today, solar panels (depending on the brand) are bankable, that is, banks loan capital for their purchase.

The solar energy can be used for captive consumption or exported to the grid. The electrical energy (DC) or the solar power generated by the solar PV modules during the sunshine hours is stored in the batteries for use, as and when required. The energy stored in the batteries is converted into 230V AC mains using an inverter. This energy automatically synchronises with the grid and gets injected into it.

Installation by integrators

Many solar system installers and owners have had good experience in anchoring the panel structures. This has to be done scientifically and with care. It is possible to have non-anchored installation systems but these need to be very carefully designed to with-stand heavy winds. Such systems are designed to connect the solar power system to a roof using weights, rather than fasteners that must be anchored to the roof.

Solar installation companies, often called integrators, can complete a small rooftop project within a few weeks. Before signing a contract with an integrator, evaluate the roof for solar installation with respect to:

Roof condition The roof should be in a good state prior to solar installation. If it needs significant repair or replacement, get this done before installing the solar array.

Space availability Solar power projects work best on flat roofs without obstructions.

Weight load Some roofs are not designed to hold much additional weight. Ascertain the acceptable weight you can add to your roof before signing a contract.

Investments involved

Of all the components of a solar PV plant, solar module accounts for the biggest cost—it can be 70 per cent of the total project cost. The cost per watt is currently Rs 130-150 ex-factory. The investment primarily depends upon the size of the power plant, which varies from a small kilowatt to multi-megawatt plant. At present, good-quality off-grid rooftop solar power plants can be installed at a cost of Rs 250,000 per kW.

Under the National Solar Mission policy, the benchmark price for an off-grid system is Rs 270,000 per kW peak. For a grid-connected system, it is Rs 190,000 per kW peak. The government also provides a 30 per cent subsidy on the benchmark price. Installation costs would differ in case of remote installations and poor site conditions.

Economic advantages

The total investment per kW in a small power plant, for example, 10kW, will be the same if not less than in a large 5MW plant. It is therefore viable to go for small grid-fed plants owned by small privately- owned utilities. A buying rate of Rs 17 or 18 per unit of electricity from such plants will attract thousands of small investors like a magnet. In most areas in India, solar power can then be a fiscally sound investment that reduces electricity payments immediately, as well as hedges the small solar plant owners against local utility price increases.

If solar power is fed into a small city grid like Miraj, Ratnagiri or Ratlam, all consumers in that area will get cleaner uninterrupted power from the local copper grid. The high impedance of the local grid helps power to remain local, improving the local power quality. That's why all other countries in the world allow solar plant owners to feed power into the local grid at the low voltage end.

It therefore makes sense to set up a solar rooftop plant in cities or towns facing severe electricity

shortages. Today, the cost of generating electricity using a diesel generation (DG) set is in the range of Rs 20-22 per unit, whereas generating solar power costs only Rs 13-15 per unit.

Based on the current prices and assuming that one takes advantage of the 80 per cent depreciation permitted on such investments, in the first year the cost of power per unit (kWh) from a well-maintained solar plant will be less than Rs 8 per watt for a plant of any capacity between 5 kW and 1 MW. Thus solar rooftop installation is a good investment option considering both tangible and intangible benefits.

Eligibility criteria for project proponent

While the government is yet to announce the policy for rooftop grid-connected power plants, it has laid down certain guidelines for rooftop PV and other small solar power plants connected to distribution networks at voltage levels below 33 kV. Hereinafter, the programme is referred to as Rooftop PV & Small Solar Power Generation Programme (RPSSGP).

Technical criteria. The project schemes that propose to deploy PV modules and inverter systems are considered to be technically qualified and eligible for participation in the RPSSGP scheme only if these comply with relevant IEC/BIS standards and/or applicable standards as specified by the Central Electricity Authority (CEA). For solar PV projects to be selected under this scheme, it is mandatory that these are based on crystalline silicon technology and use modules manufactured in India. There will be no mandatory domestic content requirement for projects based on other technologies. For solar thermal technology, it is mandatory that the technology is demonstrated and such projects should be operational for one year. Project proponents should submit documentary evidence and an undertaking in this regard along with their applications to the competent authority in the state.

Metering arrangements. Metering arrangements should be made by the project proponents in consultation with the distribution utility keeping in view the guidelines or regulations notified by the respective state electricity regulatory commissions, if any. Meters should comply with the requirements of CEA regulations on the meter installation and operation.

Financial criteria. The project proponents should submit their letters of commitment along with board resolution for equity investments in the project, calculated on the basis of Rs 40 million per megawatt on a pro-rata basis.

Infrastructure criteria for land requirement. The project proponents should make arrangements for land required for the project as per conditions outlined by respective state competent authority.

Infrastructure criteria for grid connectivity requirement. The plant should be designed for interconnection with the grid at the distribution network at the voltage level depending on the installed capacity of the rooftop PV or small solar system generator.

(For the complete requirement list please visit www.mnre.gov.in)

The government is also encouraging the use of rooftop power plants as a substitute for diesel-consuming and polluting DG sets. Most commercial buildings are dependent on diesel generators during power cuts. Investing in a rooftop solar power plant can offset diesel consumption and makethe returns attractive. Added to this, the 30 per cent central finance assistance (CFA) in the form of capital subsidy would encourage investors. With a rooftop installation, one can recover the project's

cost within five t six years. Also, typically, a solar power plant has a life of 25 years with proper maintenance.

The return on investment (ROI) completely depends on the power purchase agreement signed by the project developer. While earlier the buying rate for power was Rs 17 per unit, today companies are ready to sell it at Rs 11 per unit, making only a marginal profit. Considering the current trend, the power purchase price can be estimated at Rs 13-14, so one can expect ROI within six to seven years.

More benefits for commercial units

Rooftop installation makes more sense for commercial establishments as these can utilise the solar power during peak-load daytime periods, thus saving the money required to set up battery banks. Any amount of power not used can be stored in a battery bank for use at night when energy consumptionis the least (about 10 per cent compared to the day).

Moreover, for small business establishments or small and medium enterprises (SMEs), a rooftop installation for grid connection is far more profitable than a multi-megawatt plant which requires installation of six to eight transformers. Transformers are at most 98 per cent efficient and therefore while generating solar power; some energy is lost due to the inefficiency of these transformers. So it is profitable to install smaller power plants with 100 per cent of electricity production, which can then be transferred to the local utility.

Government's role in encouraging small producers

Change in government policies will help rapid growth of the solar power sector in our country via rooftop and other low-power solar plants. MNRE should quickly clarify when the power utilities will be instructed to buy solar power from 5kW-100kW solar plants at the same rate as +1MW plants. As more and more rooftop solar power plants feed power into the grid, local power utility companies should be happy to buy power at a higher price as this will help them earn carbon credits.

MNRE needs to remove all the remaining roadblocks to encourage rooftop and backyard solar power plants of 5 kW to 500 kW capacity to feed their solar power into the grid and augment shortage of supply from utility companies. Every other country in the world pays a high rate for such solar power fed into the grid and this makes such an investment very rewarding. The available metering technology is secure enough for the government to not worry about misuse.

Government subsidies

Government subsidies for standalone rooftop PV installations vary from state to state. For standalone use, today, there is a system that comes with a 40-watt solar panel, 40V battery and two LED bulbs for around Rs 8000, to which the government provides close to a 50 per cent subsidy. By installing this solar system, monthly electricity bills fall by about Rs 60 a month (calculated at the rate of Rs 2

per unit). Conventional electricity bills are currently about Rs 6-7 per unit for residential purposes and Rs 10-12 per unit for commercial establishments. The government is yet to announce the final specifications and subsidies (or incentives) for rooftop installations that feed into the grid.

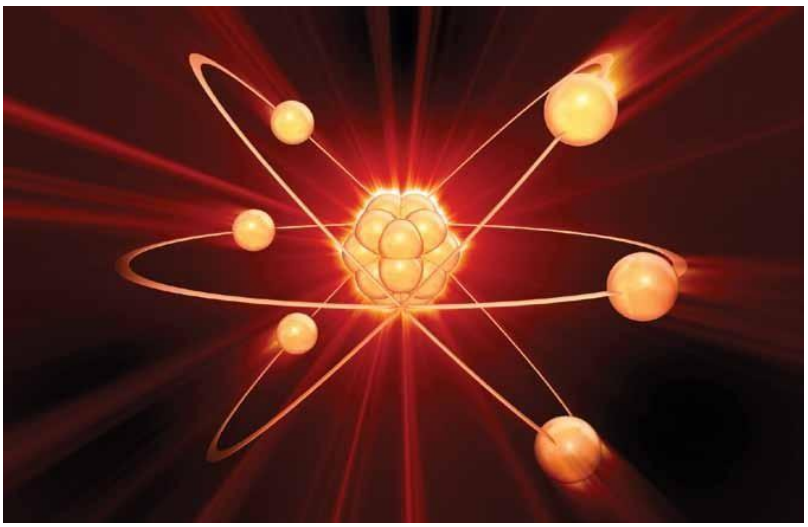
Some challenges

The major challenge faced by the project developers is to realise the benefits of the policy. Not only do the specifications vary from state to state but also the buying rates. Some companies are buying power at as low as Rs 11 per unit, thus discouraging players from venturing into this segment as they make only a marginal profit.

Another challenge is that some unscrupulous players, instead of injecting solar power from their panels, may connect the mains power (conventional electricity) from their neighbour's building to the grid. In such a scenario it becomes difficult for the energy meter to detect the mode of power. However, this challenge is being overcome by introducing innovative DC energy meters that detect the kind of power being transmitted and accept only the power generated by solar PV panels. While this concept is yet to take off in India, there are some specifications laid down y the government with regard to metering.

Nanotechnology: The lord of Small things!

While many hail nanotechnology as 'the' phenomenon of the new age, and one of the most potent emerging forces in the field of technology, there are others who dismiss it as a subject fit only for research labs. This article aims to explore the truth behind these claims, and track the direction in which nanotechnology is moving



―Everything can be made in some way better―stronger, lighter, cheaper, easier to recycle―if it's engineered and manufactured at the nanometre scale.‖

―Stan Williams director-Quantum Science Research HP Labs

JULY 2011: The 21st century can easily be called the era of portable devices that are lighter, smaller and a whole lot powerful in configuration than their predecessors. All this has largely been rendered possible with the size of the processor shrinking to the nanometre scale. These small-sized processors, also called microprocessors, have enabled the electronics manufacturers to build products that are smaller in size, have faster processing speeds and are powerful. However, experts view this development more as the continuation of existing microelectronics rather than a breakthrough in the nanotechnology space. They believe that this is merely a small application of nanotechnology and doesn't represent even an iota of the potential that nanotechnology holds for the future of electronics.

Indeed, nanotechnology is not merely about reducing the size of processors to nanometres. Its domain is vast and still remains largely unexplored. Considering the research happening across the globe, and the advances so far in this space in terms of the development of new circuit materials andso forth, the technology surely holds a lot of promise for the technologists and electronics industry alike.

Apart from this, nanotechnology is being also viewed as a solution to the limitations of the current technologies. If we look at the current situation of digital electronics, there is presently no credible alternative to silicon complimentary metal-oxide-semiconductor (CMOS); all other technologies having failed to meet the standards of logic circuits. The improvements in silicon technology are also getting closer and closer to the 'brick wall' and this worries a lot of technology professionals and industrialists. It is anticipated that sometime around the end of this decade (2018 or so), it will become physically impossible to etch smaller features in silicon. Another challenge is that at lesser than 20nm sizes, silicon becomes electrically 'leaky,' which can cause short-circuits.

Is 'nano' the way to go?

With the current materials and technologies nearing the upper limit, scientists and researchers have built a lot of hope around nanotechnology, which according to them can help in developing alternative methods and materials. They believe that someday nanotechnology will revolutionise the global economy by providing power tools that will produce high-tech products using low-tech resources at low costs.

There is no denying the fact that on the concept level, nanotechnology holds a lot of promise. But in spite of breakthroughs prophesied in this field by many a scientist and futurist, especially if we consider the application of nanotechnology in the field of electronics, there hasn't been much headway ever since the technology's emergence in 1990s. In fact, the term nanotechnology has become more of a misnomer with different groups defining its periphery and scope differently.

To demystify the term and gauge the direction towards which the technology is moving, we turned to a few technology experts.

How much does 'nano' measure up in size?

Nanotechnology, which is sometimes shortened to ‗nano-tech,' is the study of manipulating matter on an atomic and molecular scale. Generally, nanotechnology deals with structures sized between 1 to 100 nm in at least one dimension. It involves developing materials or devices possessing at least one dimension within that size. However, when it comes to the size, the opinions in the technology space are divided. There are some who claim that 45, 32 or 22nm technology does not qualify as nanoelectronics.

VassiliosGerousis, senior architect, Cadence Design Systems, shares some of the varied viewpoints that are widely making rounds in the industry and amongst the science and engineering communities: ―One opinion, which comes from the research fraternity deals with nodes that are between the dimensions of 10 nm and below, such as carbon tubes. Another opinion coming from the applied research domain caters to nodes between 14nm and 20nm. The third viewpoint is from the application side and is focused on 40nm and 28nm.‖

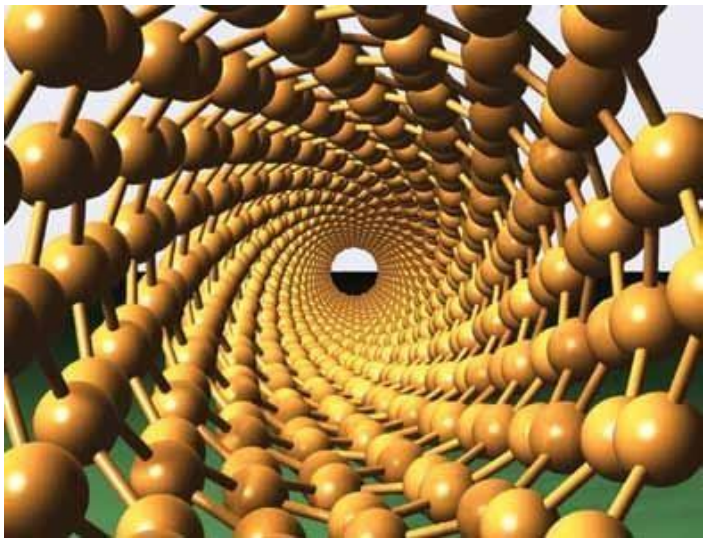
Yet another view is that CMOS technology, even using nanoscale features, does not fully qualify as nanotechnology, because it uses mostly top-down fabrication to reach nanoscale dimensions. In this view, electronic devices should be labelled nanoelectronics only if these contain typical nanostructures such as carbon nanotubes or nanowires and dots. ―However, the CMOS people themselves consider all technology nodes below 100 nm as nanoelectronics, since they comply with the basic definition of nanotechnology objects, i.e., structures with critical features below 100 nm,‖ says Marc Van Rossum, strategic adviser, Imec. -At Imec we share this view, and also consider several advanced top-down CMOS fabrication techniques such as extreme UV lithography and other nanoscale patterning tools to be part of nanotechnology,‖ he adds.

Considering that there are several possible definitions and opinions for ‗nano' that have been used of late, the confusion has prevailed. ―Nanoscale is commonly defined as smaller than 100 nm and, by that definition; modern electronics have been at nanoscale for about a decade. This is the definition that Intel uses,‖ quips Michael Mayberry, director—components research, technology and manufacturing group, Intel.

A competing definition typically used for nanomaterials is to count both size and process for

fabrication. Here some insist that making larger objects smaller doesn't count and you should only count those using bottoms-up methods.

Clearing the air on the subject, Dr Denis Koltsov, consultant in Nanotechnology, BREC Solutions (UK), says, –Unfortunately, there is a lot of misunderstanding of the term ‗nano' in whole of the nanotechnology community. The subgroups like nanoelectronics seem to deviate from an official ISO definition of nanotechnology if they are claiming that 45-22nm technology is still not nano electronics. Any device that is smaller than 100 nm in at least one dimension would be classed as nano-device. This also applies to thin-film devices like hard disks. While it is (understandably) difficult to call a big hard disk a nano electronics device, it is definitely not correct to reject a 22nm technology from nano-electronics community by definition. A much more appropriate definition for those that work with molecules and nano tubes would be molecular electronics or pico technology (1nm-0.1nm size). Please note that these are not ISO definitions.‖



Carbon technologies such as carbon nanotubes are becoming more and more relevant in this race to continue the Moore's law

Dr James Canton, futurist, adviser, CEO, Institute for Global Futures www.FutureGuru.com, and author of the book Extreme Future, adds another perspective, —People think that nano science is about size, while it is more about capturing in small platform a dense amount of functionality and performance.‖ Also, nano is about changing the concept of synthetic consciousness in developing other forms of intelligences that can function at the quantum level.

How far is nano from going main stream in electronics?

Going beyond the concept, let us now look at the way nanotechnology has evolved in the last one decade and the direction towards which it is heading.

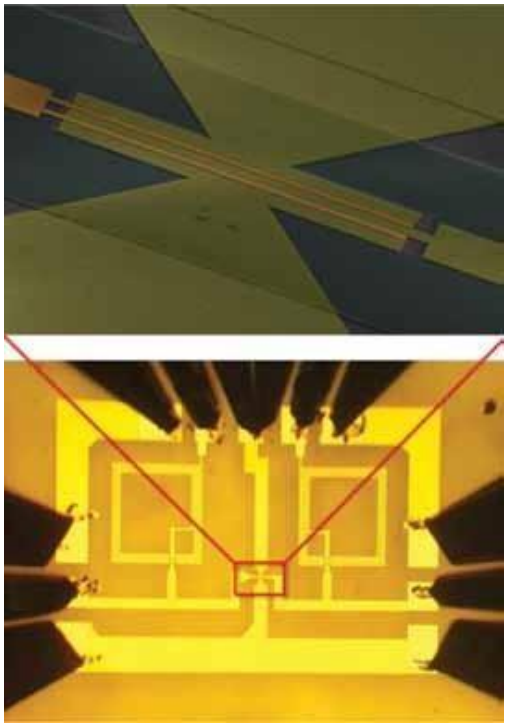
If we look at the application side, it is believed that most of the nanoelectronics technologies (at the transistor level) demonstrated today—such as hybrid molecular/semiconductor electronics, one

dimensional nanotubes/nano-wires and advanced molecular electronics—are futuristic and not usable anytime in the near future. As a general statement it is true. The industry has had its share of doubts about the wide scale adoption of nano-technology in electronics. Currently, in the mainstream we see 40nm and 28nm technologies, says Gerousis. Most of the work that is underway below the 20nm dimension is in the research and development phase.

The key challenge that is being faced by the industry and researchers is that while the nanomaterials are exotic, these are not easy to produce. Some of the exotic nanomaterials, including carbon nanotubes, have very interesting proper-ties as materials. But the industry still lacks the ability to precisely form and use them for electronics where we typically need to fabricate billions of transistors at once, opines Mayberry.

―The largest of the exotic material demonstrations have been of the order of a handful of devices working together. Nevertheless, considering the pace of science and technology advances, I think eight to ten years from now we might be using some of these exotic materials in electronics production. For applications requiring less precision some of these nanomaterials are already in use,‖ he adds.

Devices using carbon nanotubes or nanowire transistors show promise for specialised sensors, and there is also some perspective for nanowire solar cells. But molecular devices have only proven their relevance at the diode level, and a genuine single molecule transistor (three-terminal device) with acceptable characteristics is still out of reach.



IBM's recently announced first integrated circuit fabricated from wafer-size graphene

—Nanoscale spin transistors are also interesting, but they exist only at the exploratory level. In any case, those devices still require huge break-throughs in many challenges such as reproducibility, dimensional control, positioning, contacts, doping and transport properties in general. At this time, none of these technologies has a proven advantage over CMOS,‖ Rossum avers.

But it is equally true that all nano-techniques, which are compatible with CMOS, are worth considering to over-come the bottlenecks related to lithography, such as power dissipation and leak-age, signal transmission speed and integrity, adds Rossum. —The goal is to push CMOS node scaling-down to 16 nm, 11 nm or even below. At 11 nm there will still be no need for CMOS alternatives. However, below that scale the situation is less clear. It has sometimes been stated that molecular or atomic devices would offer many attractive features, but the truth is that in conventional electronics the laws of quantum mechanics work against us once we reach the quantisation level,‖ he opines.

So, where does the paradox lie? Why a technology that is so promising at the concept level has failed to scale up when it comes to its mainstream application in the electronics domain? Enumerating a few reasons, Kolstov says, —The research in molecular nano-electronics is unfortunately very sensational. What I mean is that a research group may measure some effect from one device and write a very popular paper. However, this result has limited use for industrial community since it may not be reproducible, and in some cases is simply wrong. Some recent publications (http://www.nanotechia.org/global-news/is-there-plenty-of-room-at-the-bottom-for-nanomanufacture) argued that some applications of nanoelectronics may never be manufacturable.‖

—If we look at the developments so far, it won't be wrong to say that nanoscience is both futuristic and here today,‖ affirms Dr Canton. While it is true that the progress made so far in this domain has still not been too fruitful, yet there are areas where the application of nano-science has led to interesting results. Dr Canton enumerates, -Molecular electronics have been shown in the Quantum Computing Lab of Stan Williams at HP to be possible. IBM has done extensive work in nano computer chip development that will likely extend silicon's life as a chip platform. Mercedes uses nano on coatings for autos to protect the driver. Having said this, nano is emerging and the potential is great, but it is in the early stages.‖

Looking beyond processors...

The relevance of nanotechnology and nano materials for reducing the size of transistors can't be ignored. —Carbon technologies using carbon nanotubes (CNTs), graphene or other allotropes are becoming more and more relevant in this race to continue the Moore's law,‖ opines Dr Denis Koltsov. But it would also be worthwhile to explore a few other areas in the electronics space where nanotechnology can potentially have its influence. Let's take a look at a few of such domains.

Digital displays. The quality of digital display screens in electronic devices can be improved by reducing the power consumption while decreasing the weight and thickness of the screens. Nano

research projects are underway to make use of electrodes made from nanowires to enable flat panel displays, which are likely to be a lot thinner than the current flat panel displays. —CNTs, which are up to 100-times stronger than steel, and yet only one sixth of its weight, are also being used to direct electrons to illuminate pixels and to develop light-weight, millimeter thick ‗nanoemmissive' display panel,‖ informs Rossum. A company called Rosseter in Cyprus is already producing them for commercial use because of their rugged chemical, physical and mechanical properties.

MIT researchers have also created a quantum dot-organic light emitting diode (QD-OLED). While the traditional LCDs are lit from behind, the quantum dots have the capability of generating their own light, and these dots can be manipulated to emit any colour imaginable, with no range limit as seen with traditional devices.

For larger memory size. With consumers demanding electronic devices such as music players, mobile phones and computers with gigabytes of memory, the future electronics devices will surely need even larger memory sizes. —The current storage technologies, like Flash memory technology, has an upper-size limit as well as a rewrite limit (between 10,000 and 100,000 writes). Thereafter it will no longer be able to store data. To gear-up to meet with this requirement, multiple examples of memory technologies are being explored that use more exotic materials than what is used in production today,‖ says Mayberry.

Nanosized magnetic rings are being tried to make magneto resistive random access memory (MRAM), which research has indicated may allow memory density of 62 GB per square centimetre (400 GB per square inch). Research is also on for using microelectro-mechanical system (MEMS) techniques to control an array of probes, whose tips have a radius of a few nanometres. These probes are used to write and read data onto a polymer film, with the aim of producing memory chips that have a formidable density. There is also ongoing research for the use of nanosized ‗dots' of nickel, which it is hoped could be used to store terabytes of data, even for home and personal users.

Rossum says, –There are many ideas of using nano features in non volatile memories—molecular structures, metallic nanodots, organic molecules, nanostructured materials and so on. Although their applications are not yet mature, it is still an interesting avenue of research.‖

Nano research projects are underway to make use of electrodes made from nanowires to enable flat panel displays

In making existing technologies better . —The developments in nano-technology as a sector have already shown us that this new technology is not only about doing things better, faster at a smaller scale, but also about adding new functionality to existing technologies,‖ says Kolstov.

—The devices, sensors, etc, are gaining another option, like, for example, the development of Spin-FET. In that case the charge and spin of the electrons are used to offer novel functionality. I think the advent of CNT electronics applications, Spin-FETs and properties of graphene are the hottest topics in industry at the moment. I am sure this may change, but in the meantime there is a lot to research in those areas,‖ he adds.

For health care and environment. Nano today is about size and material science innovations. In the future it will be about designing matter at the atomic level to address climate change, hunger, war, healthcare and energy needs,‖ believes Dr Canton. In the future, convergence of nanoelectronics with bioelectronics could be important for health and comfort applications, provided the technology becomes affordable. -Already, nano wires are being used to restore movement in crippled legs, by restoring neural path-ways to connect the brain to the body for movement,‖ informs Dr Canton. A few more possibilities include nano-energy development or storage, nano-geoengineering to clean up the planet, nano-machines to enhance the food supply to resolve world hunger, nano-intelligence to enhance humans and to use nano-devices to deliver drugs or medicines to help heal people.

Faster data transfer between devices and networks. According to nanoforum.org, optoelectronics can help in dramatically increasing data transfer rates within devices like PCs by replacing the existing copper wiring. Instead, in the future, quantum dot-based lasers may also be used to transfer information between components within devices at the speed of light, with each piece of information ‗coded' using a unique wavelength of light.

If we look at external networks, data transfer can take place more rapidly between two points if we increase the number of nodes in information networks. This will become possible through the

development of cheap ambient-sensor networks based on nanotechnology, and will help the telecommunication sector to achieve better data transfer rates.

Circuits for wireless devices. IBM Research scientists recently announced the first integrated circuit fabricated from wafer-size graphene, and demonstrated a broadband frequency-mixer operating at frequencies up to 10GHz (10 billion cycles/second). Designed for wireless communications, this graphene-based analogue integrated circuit (having the thickness of an atom) could improve today's wireless devices and points to the potential for a new set of applications.

Ankit Singh Rawat

MAN OF THE ISSUE

Pranav Mistry

Meet Pranav Mistry the man behind Samsung's latest innovation, the Galaxy Gear smartwatch - an Indian origin techie who hails from the small town of Palanpur in Gujarat

Pranav Mistry is the Head of Think Tank Team and Director of Research of Samsung Research America. He introduced the Samsung smartwatch - a wearable tech device that acts as an extension to the phone by discreetly alerting users to incoming messages and calls on its screen. His father said that when he was about 11, he (Pranav) used to say, ‗main bada ho kar bahut naam kamaunga' (When I grow up, I'll earn a lot of fame).

Born in 1981, Pranav was like any other child, said Mistry senior, but his IQ powered him to the 1st rank in every academic year he spent at Vividhlakshi Vidyamandir, Palanpur. ―He was good in every activity be it studies, music (he sings) or sports (plays badminton),‖ said a proud father.He studied in his mother tongue, Gujarati, and later joined Nirma University, Ahmedabad for his BE in computer engineering. He went on to complete his post-graduation (industrial design) from IIT-Bombay, which earned him a job with Microsoft in Hyderabad and a president's award from APJ Abdul Kalam.

Mistry is also unique in how he turned out to be a scientist from a town known worldover for its diamond traders. ―We never cared about money. Knowledge was our wealth,‖ said Kirti, an architect himself. ―Ours is a family of reason; we knew what he was capable of and patronised it.‖ Kirti never thought of moving to Mumbai for his son's studies and better exposure. Palanpur was always good enough to shine on this diamond.

Galloping towards stardom

SixthSense won Mistry the 2009 Invention Award by Popular Science. He was also named to the MIT Technology Review TR35 as one of the top 35 innovators in the world under the age of 35, and has also been called -one of ten, best inventors in the world right now‖. Mistry has been listed as one of the 15 Asian Scientists To Watch and as one of the most powerful digital Indians.In 2010, he was named to Creativity Magazine's Creativity 50.His current list of research topics is proof, but Mistry has always made time for his family which now lives in Ahmedabad. ―He was here last year and even we are often in the US for at least 2-3 months a year,‖ said his father. Pranav is married to a Chinese girl, a fashion designer, who dabbles in marketing branded clothes in China. Mistry has been called "one of ten, best inventors in the world right now" by Chris Anderson. GQ India listed Pranav as one of the most powerful Digital Indians. He was listed as one of the 37 Indians of Tomorrow by India Today. Recently, Pranav Mistry was honored as Young Global Leader 2013 by World Economic Forum.

Before joining Samsung he was a research assistant and a PhD candidate at MIT Media Lab. Before joining MIT, Pranav worked as a UX Researcher with Microsoft. Pranav holds a Master's degree inMedia Arts and Sciences from MIT and Master of Design from Industrial Design Center, IIT Mumbai. Among some of his other work, Pranav has invented Mouseless – an invisible computer mouse; SPARSH – a novel way to copy-paste data between digital devices; Quickies – intelligent sticky notes that can be searched, located and can send reminders and messages; Blinkbot - a gaze and blink controlled robot; a pen that can draw in 3D; and a public map that can act as Google of physical world. Pranav's research interests include Augmented reality, Ubiquitous computing, Gestural interaction, AI, Machine vision, Collective intelligence and Robotics.

COMPANY OF THE ISSUE

Apple

Since its humble beginnings as a computer company flogging hand built machines conceived by an out of work college dropout, the Apple empire has certainly come far. Today, Apple Inc has almost 50,000 employees and reported a $14 billion profit in 2010, becoming one of the most valuable computer technology companies in the world. Moreover, it has become a unique brand phenomenon with Apple products being snatched up all across the world - and consumers are still clamouring for more.

From the first Apple I to the iPhone 4 - here's a look back at some of big Apple wins and a few of its failures through the years.

1976 - Apple was first founded on 1 April 1976 by Steve Jobs, Steve Wozniak and Ronald Wayne. Wayne subsequently sold his share of the company back to his partners for $800. The first offering by the company was a hand built Apple I personal computer retailing for $666.66.

1977 - The Apple II was introduced. Boasting colour graphics, open architecture and a floppy disk drive interface, the Apple II was positioned well ahead of its competitors and subsequently became the personal computer of choice for the business world with the VisiCalc spreadsheet program.

1983 - The Apple Lisa was launched, the first to feature a Graphical User Interface (GUI).

1984 - Apple launches the Macintosh with its powerful TV commercial directed by Ridley Scott. The Mac was a success thanks to its advanced graphical capabilities - perfect for desktop publishing.

1985 - Co-founder Steve Jobs resigns from Apple and goes on to develop a new computer company, NeXT Inc.

1989 - 1991 - Macs go portable with the Macintosh Portable and the PowerBook, which set the ground for the layout and ergonomic design for most future laptops and personal computers.

1986 - 1993 - During this time, Apple produces a few product flops including a digital camera, portable CD players and video consoles. The Newton was Apple's foray into portable handheld computing devices but also had limited success.

1996 - Apple purchases NeXT, bringing Steve Jobs back into Apple as an advisor. He eventually became the interim CEO until 2000 when he officially stepped into the role permanently.

1998 - The iMac, with its advanced digital video editing capabilities, would become the launching pad for Apple's return to being a computer industry leader.

2001 - Apple introduces the first generation iPod which would revolutionise the digital music industry and become hugely successful with almost 300 million iPod units in its various forms and generations sold since its debut.

2003 - To follow up on the iPod's success, Apple launches its iTunes store.

2005 - Apple releases its popular line of Intel powered computers with the introduction of the popular MacBook, MacBook Pro and iMac. These would eventually come to replace its previous models of the PowerBook, iBook and Power Mac. Today, the Intel powered models have been updated and re-released and continue to be some of the most popular computer models sold today.

2007 - The first Apple iPhone is launched revolutionising smart phone technology and mobile computing. The App Store allowed third party developers to make and distribute iPhone compatible applications, including some of the most popular games today, like Words with Friends and Angry Birds.

2010 - Continuing to blaze new paths, Apple introduces the iPad tablet computer that worked with all iPhone applications. The iPad has already sold almost 15 million units in its first year and consumers are already looking to buy or rent an iPad 2.

Today, Apple fans are waiting for more updates on their favourite products with the iPhone 5 and the iPad 2 expected to debut in 2011.Those looking to stay up to date with their favourite Apple gadgets may look to rent a MacBook or iMac computer for a short lease term, giving them the flexibility to upgrade at a later time.

On September 12, 2012, Apple unveiled the iPhone 5, featuring an enlarged screen, more powerful processors, and running iOS 6. The latter includes a new mapping application (replacing Google Maps) that has attracted some criticism. It was made available on September 21, 2012, and became Apple's biggest iPhone launch, with over 2 million pre-orders pushing back the delivery date to late October.

On October 23, 2012, Apple unveiled the iPad Mini, which features a 7.9-inch screen in contrast to the iPad's 9.7-inch screen. Apple also released a third-generation 13-inch MacBook Pro with a Retina display; the iPad 4, featuring a faster processor and a Lightning dock connector; and new iMac and Mac Mini computers. After the launch of Apple's iPad Mini and fourth generation iPad on

November 3, 2012, Apple announced that they had sold 3 million iPads in three days of the launch, but it did not mention the sales figures of specific iPad models.

On November 10, 2012, Apple confirmed a global settlement that would dismiss all lawsuits between Apple and HTC up to that date, in favor of a ten-year license agreement for current and future patents between the two companies. It is predicted that Apple will make $280 million a year from this deal with HTC.

In December 2012, in a TV interview for NBC's Rock Center and also aired on the Today morning show, Apple CEO Tim Cook said that in 2013 the company will produce one of its existing lines of Mac computers in the United States.In January 2013, Cook stated that he expected China to overtake the US as Apple's biggest market.

In March 2013, Apple announced a patent for an augmented reality (AR) system that can identify objects in a live video stream and present information corresponding to these objects through a computer-generated information layer overlaid on top of the real-world image.

At the Worldwide Developer's Conference on June 10, 2013, Apple announced the seventhiOS operating system alongside OS X Mavericks, the tenth version of Mac OS X, and a new Internet radio service called iTunes Radio. iOS 7 and OS X Mavericks are both expected to be released during fall 2013, while the iTunes Radio Service, which will be integrated with Apple's personal voice- assistant software program Siri, is scheduled for release in the second half of 2013. The radio service features more than 200 stations according to company's statement.

On July 2, 2013, Apple announced the recruitment of Paul Deneve, Belgian President and CEO of Yves Saint Laurent, to Apple's top ranks. A spokesperson for the company stated, "We're thrilled to welcome Paul Deneve to Apple. He'll be working on special projects as a vice president reporting directly to Tim Cook.

Ankit Srivastava