The Institution of Electronics and Telecommunication Engineers

IETE Bengaluru Magazine

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From the Predident IETE

I am extremely glad that IETE Bengaluru Centre has launched and successfully published the 3rd edition of its quarterly magazine to provide an overview of technical programmes and related activities conducted by the Centre and also to highlight its achievements and accomplishments in the service of IETE members and its future endeavors to keep up the charter of IETE.

IETE Bengaluru is one of the most active Centres involved in organizing various Techincal Seminars, Symposiums and Conferences on themes relevant to the present paradigms of the Society, The Centre recently organised an International Conference on "IoT, Big Data Analytics & 5 G" from13-15 Dec 2018 which was a grand success.

IETE HQ has always appraised and encouraged all initiatives of its centres in the pursuit of sharing and knowledge.

I wish IETE Bengaluru Centre all the very best and hope that it will continue to further the cause of IETE by fulfilling the professional needs of its members.

Prof (Dr) K T V Reddy

From the Chairman

Dear IETE Members,

We are glad to present you the third issue of the IETE Bangalore Magazine. The positive and encouraging response to the first two issues has enthused us to bring this third issue, which I hope will also be received with similar response. Our effort is to create a media to showcase IETE Bangalore's achievements and also provide informative technical content.

IETE Bangalore organized many technical activities, conferences, seminars and workshops for the benefit of the technical community and has been very active in the last quarter. Details are given in this magazine. However, I take great pleasure in highlighting a couple here.

Of course, the major event of the last quarter was the First IETE International Conference India IICI-2018 from 13th to 15th Dec 2018 at ISRO. The theme of the Conference was Technological Advances & Applications in IOT, Big Data Analytics & 5G in Bangalore. This was a major success. Dr K Sivan, Chairman ISRO inaugurated the conference and gave the inaugural talk. IICI-18 was a very informative conference covering developments in many state-of-art technologies in the domains of 5G, IOT & Data Analytics. Conference was actively supported by ISRO, CDAC & CDOT. We would like to thank all who contributed for the success of the IICI-18 Conference. A detailed report of IICI-18 is given in this Magazine.

IETE Bangalore also organized Students Day on 10th Feb 2019. A Technical Quiz and Pick & Speak competition was held for students.

IETE Bangalore is keen to provide technical support to Institutions and Organizations in organizing courses, workshops, seminars. Please take advantage of this.

We need your contributions and suggestions for the success of IETE Bengaluru Magazine. Looking forward to your response and support.

With warm regards,

HS Bhatia
Chairman, IETE Bangalore

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IETE BENGALURU

From the Hon. Secretary

I am happy that we have been able to bring out this third edition of IETE Bengaluru Magazine on the National Science Day 2019. The Editorial Committee has been constantly working on improving the content and presentation of the Magazine ever since its launch on Engineers' Day in September '18. We gratefully acknowledge your encouragement and support.

IETE Bangalore has hosted a number of events during this quarter the most important among them being the IICI '18 held during Dec. 13-15, a report on which has been included in this issue. We observed the Republic Day and recently celebrated the IETE Student Day; brief accounts of all of them have been included here. The next big events coming up after the Science Day are 'Summer School in Electronics and Computers 2019' and the 'World Telecommunications and Information Science Day' among others. Our endeavor is to take you along with us in all our activities through the medium of the Magazine.

I humbly request all to critically go through the Magazine and provide your feedback so that every edition brought out is better than the previous one.

C. Satyanandan
Hon. Secretary

FROM THE EDITOR'S DESK

Welcome to Third Issue of *iete Bengaluru Magazine!*

Many thanks for the encouragement and support for the previous two issues. IETE Bengaluru is one of the very active centres and is continuously organizing many technical activities which benefit our members. One of the major events in the last quarter was the First IETE International Conference India – IICI-2018. The conference was very successfully organized from 13th to 15th Dec 2018.

We have covered the details of this interesting conference with the theme 'Technological Advances and Applications in IOT, Data Analytics and 5G' in this issue. This issue also covers all the other activities organized by IETE Bangalore in 'Eventful Quarter' and also other regular features like 'Forthcoming Events', 'Technical Articles', 'Know Your Distinguished Persons from Bengaluru', 'Tech Trends' etc. We also want to start a series of articles which looks at interesting aspects of 'key mathematical operators' extensively used electrical sciences – e, pi & j (or i) etc, which will be both enjoyable and also interesting. Due to space constraints in this issue, we propose start it in the next issue and also to add more such article in subsequent issues. Your contributions in this domain or any other technical domain are always welcome.

We would like to thank Prof Sonde and Mr Baranga Bogdan for their articles. Our thanks are always due to Dr K T V Reddy, President IETE, Prof B S Sonde & Mr H Ramakrishna for their constant support & blessings.

Please send your views, suggestions and also be part of the magazine by contributing articles, news clips etc. Thanks for your support and encouragement.

Though we are already well into new year, on behalf of the entire editorial board of *iete Bengaluru Magazine*, let me wish all of you

A Very Happy and Technically Fulfilling Year 2019!

Thank You

Dr M H Kori

On behalf of *iete Bengaluru Magazine* Editorial Board

IETE Bengaluru Magazine Editorial Board: Shri. H Ramakrishna, Prof. HS Bhatia, Shri. C Satyanandan, Shri Jagannatha Rao, Prof. PN Sharada & Dr. M H Kori

KNOW YOUR DISTINGUISHED PERSONS FROM IETE BANGALORE

IETE Bangalore has produced a large number of very distinguished eminent persons who have held high responsible positions who have made significant contributions to industry, research, academics, administration & public policy and in many technical domains.

In this feature ***"KNOW YOUR DISTINGUISHED PERSONS FROM IETE BANGALORE"***, we are attempting to recognize all these eminent people.

In this issue we are listing all the Bangalore IETEians who have been elected as Honorary Fellows.

IETE HONORARY FELLOWS FROM BANGALORE

Bangalore has eleven IETE Honorary Fellows:

1. Prof Satish Dhawan 1984
2. Prof C N R Rao 1987
3. Dr V S Arunachalam 1991
4. Shri Azim Premji 2000
5. Prof V S Ramamurthy 2002
6. Shri G Madhavan Nair 2007
7. Shri N R Narayana Murthy 2008
8. Dr K Radhakrishnan 2010
9. Shri A S Kiran Kumar 2016
10. Shri Kris Gopalakrishnan 2016
11. Dr K Sivan 2018

We are proud of your achievements and contributions!

AN EVENTFUL QUARTER

IETE Bangalore hosted the following events during the quarter:

Dec.13-15 2018: IETE International Conference India 2018 on IoT, Big Data and 5G (Report in this issue)

Dec.22 2018: Department of Electronics and Communication Engineering at GITAM School of Technology, Bangalore campus - Guest Lecture on ***"ASIC Verification & Industry Orientation"*** for ECE students. Lecture given by prof. Sanjeev Kumar Suman, founder of the Edusaksham, EduSuccess Knowledge Systems Pvt Ltd, Bengaluru.

Jan 08 to12 2019: A One Week FDP on "Applications and Hands-on Practice in Machine Learning" conducted by Department of Electronics & Communication Engineering, ***Sri Venkateshwara College of Engineering (SVCE)*** to Faculties of various institutions. The FDP was sponsored by IETE, Bengaluru.

Jan. 13 2019: A course on Advanced FPGA Design was started by Sri. Anil Kumar T S.

Jan. 26 2019: Republic Day Celebration. (Report in this issue)

Feb. 10 2019: IETE Student Day. (Report in this issue)

Feb. 16 2019: Department of ECE of Alva's Institute of Engineering and Technology- Inauguration of the 'IETE Student Forum. Prof. H S Bhatia, Chairman, IETE Bangalore addressed the gathering. The Guest of Honour Prof. C Murali delivered a technical talk on '***Emerging trends in Electronics and Communication for a better tomorrow***'.

Upcoming Events in the Next Quarter

1. ***28-02-2019: Sir C V Raman Memorial lecture***
2. ***03-03-3019: Embedded Systems & Design***
3. ***09-03-2019: Women's Day Celebrations***
4. ***17-03-2019: Java & Android Course***

5. *31-03-2019: One Day Workshop on Signals & Systems with Its Applications*
6. *14-04-2019: Inaugurations of Summer School in Electronics and Computers-2019 (SUSIEC-19)*
7. *05-05-2019: Exhibitions and Valedictory function of SUSIEC-2019*
8. *17-05-2019: World Telecommunication & Information Science Day Celebrations*

iici-18

FIRST IETE INTERNATIONAL CONFERENCE INDIA-2018 (IICI-2018) ON Technological ADVANCES & APPLICATIONS IN IOT, Big DATA ANALYTICS & 5G Dec 13-15, 2018 U R Rao Satellite centre, BANGALORE, INDIA

IETE organized the first 'IETE International Conference India - 2018' (iici-18), on "Technological Advances & Applications in IOT, Big Data Analytics & 5G" on 14th & 15th Dec 2018 at U R Rao Satellite Centre (ISRO) Bangalore. The Conference strung together three very highly topical technologies which are creating waves in technology domain, viz. Internet of Things including Industrial IoT and Machine to Machine Communications, Data Analytics & Big Data including the large data generated by the advent of IoT and the new wireless standard 5G which will have special architecture for IoT. The conference covered not only each individual technologies and their new developments but also discussed the interplay and benefits of the convergence of these three technologies. iici-18 created a platform for experts in these domains to come together and exchange their research and developments. It also provided opportunities for industries and startups to exhibit and announce their new and innovative products, ideas and concepts.

The conference was inaugurated on 14th Dec 2018 at 9.30 am by Dr. K Sivan, Chairman ISRO at URSAC Auditorium. Padmashri AS Kiran Kumar, former Chairman ISRO was the Guest Of Honour and Prof.(Dr.) KTV Reddy, President IETE, presided the inaugural function. Shri. P Kunhikrishnan Director URSAC and General Chair IICI 18 delivered the welcome address. Shri. G Ramesh Conference Chair, Shri. Ganga Prasad Conference Technical Chair and Shri. Bogdan Baranga from PTC Inc.

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Bucharest, Romania participated and spoke at the function. Prof. HS Bhatia Chairman IETE Bengaluru Centre proposed the Vote of Thanks.

The IICI-18 Exhibition, in which many industries and organizations participated, was inaugurated by the ISRO Chairman.

Technical Sessions were held post inauguration on 14th Dec and continued on the second day of the seminar on 15th Dec. Shri Vipin Tyagi, Executive Director C-DOT, delivered the Keynote talk. Several leading industry experts gave Invited talks covering many aspects of IOT, Big Data Analytics & 5G. Contributed papers in these domains were also presented during these two days. A panel discussion was organized on the theme "Convergence of Technologies – IOT, Big Data Analytics & 5G". Experts from the industry expressed their views on the topic. Dr M H Kori moderated the panel discussion. The iici-2018 conference concluded with a valedictory function on 15th Dec evening.

A pre-conference Tutorial was held on 13th Dec.'18, inaugurated at 9.30 am by Dr. KTV Reddy, President IETE. It was well attended by delegates from Industry and Engineering Colleges. Many eminent experts from industry gave expert talks in the Tutorial on IoT, Big Data & 5G.

Overall, iici-2018 Conference and the Tutorial enriched the participants with the latest technical developments in IOT, Big Data Analytics & 5G. iici-2018 was highly successful and all the participants greatly benefitted from this program.

IETE Governing Council Meeting was also held on 13th Dec. at IETE Bangalore. The deliberations continued till dinner at 7 pm at the Sadashivanagar Club, Bangalore.

Republic Day was celebrated at IETE Bangalore with Flag Hoisting by Dr. Surendra Pal Past President IETE.

After the Flag Hoisting Chief Guest interacted with IETE members over tea.

Student Day 2019 at IETE Bangalore

IETE Student Day was celebrated at IETE Bengaluru Centre on 10th Feb. 2019.

The inaugural session started at 2 pm with a welcome address by Prof. CV Ravishankar, Member Executive Committee. Shri. Satyanandan Hon. Secretary read out the Student Day Message from Dr. KTV Reddy, President IETE. Dr. MH Kori DFIETE gave a brief introduction to the Student Day and Prof. GK Venkatesh Member Executive Committee announced the program in detail. Prof. HS Bhatia Chairman gave a short Presidential Address.

The first item in the program was a Quiz competition in which groups of students from various engineering colleges took part. Questions on Electronics, Computer Science and Information Science as well as General Knowledge comprised the Quiz.

The second was a 'Pick & Speak' Competition. Students picked topics at random and spoke on them.

Prof. GK Venkatesh was the moderator of the competitions.

At the end of the program certificates were distributed to the participants and the winners by the Chairman and other Members. Shri. KS Ravi Member Executive Committee proposed the Vote of Thanks.

The whole program was compered and conducted by student volunteers assisted by IETE Bangalore staff.

IETE – THE PAST, PRESENT AND FUTURE

Prof. B. S. Sonde (Past President, IETE)

Having been closely associated with IETE as member of this great Institution for over five decades, the author takes great pleasure in sharing some of his thoughts and experiences on IETE and its programmes/activities through this article prepared for the IETE Bengaluru Magazine on the invitation of its Editorial Board. It is hoped that this article will stimulate the new generation of members to strengthen the core activities of the Institution and initiate new ones in the service of the profession, while ensuring these to be contemporary and relevant to the needs of the society.

1. IETE- Past:

By the middle of the 20th century, the world was witnessing major revolutions in electronics, telecom and computers. Long distance telecom, radio and TV broadcasting and radio aids to navigation had already advanced sufficiently and were influencing the human society. The potential of computers for applications in S&T related areas was beginning to be recognized and major investments were being made for rapid advancements in this field. At the same time, the transistor was invented by Shockley, Brattain and Bardeen and the Information Age was being heralded on the strong foundation of Information Theory postulated by Shannon. In the same period, India had become an independent nation and engaged itself in planned development in several areas of national importance. At this time, a group of enlightened telecom professionals in the country foresaw the significance and relevance of electronics, telecom, computers and related areas in strengthening these national efforts and decided to set up the Institution of Telecommunication Engineers (ITE) as a National Technical Professional Society. This enabled the registration and establishment of ITE at New Delhi followed by its formal inauguration on 2nd November 1953.

The vision of the Founders of ITE was that the Institution should facilitate:

• Up-gradation of knowledge and experience of telecom professionals in the country on a continuing basis through Conferences, Symposia, Workshops, Intensive Courses, Discussion Meetings arranged periodically;

• Setting up of standards for telecom education in India and engaging itself in technical human resource development in all its distinctive areas so as to support industry, utility and service sectors in this field;

• Promotion of R&D and creative activities in telecom and related fields by launching technical publications of high quality and standard, like journals, books, special issues and others with regularity;

• Taking up of other technical activities for advancing the interests and capabilities of technical professionals in the country with a view to make them more productive and competitive in their chosen areas.

These have formed the guiding principles for the IETE programmes and activities from the very beginning, contributing to substantial improvements in technical education and R&D in areas of interest to the nascent electronics and telecom industry and service sectors in the country. It is a matter of great pride for the IETE fraternity that the Institution was formally inaugurated by the revered philosopher Statesman, Dr. S. Radhakrishnan, Vice President of India at that time at an impressive function held in New Delhi. In his Inaugural Address, the Chief Guest exhorted the Members of the Institution: ***"It is your duty in the Institution to establish standards and promote research. It must be the ambition of every young person joining the Institution to do something in one's lifetime that will make a permanent impact on our country."*** Continuing further, he also advised the telecom professionals: ***"As telecom brings peoples***

together, the Institution must bring down distances, make every human being look at another one as an image of oneself and make us feel one earth, peace, goodwill and family".

In his Presidential Address, the first President of the Institution, highly respected senior telecom professional Shri B.R. Batra, while thanking the Chief Guest for his sage advice and good wishes assured him: ***Through our good work, we can change living habits, expand knowledge, speed up commerce, strengthen national security, improve standard of living and add to the health, comfort and pleasures of our fellow citizens".*** He then concluded his address by explaining how telecom could play a crucial role in education, employment generation and national development. From this time onward, the Institution took steady steps to expand its membership, technical programmes and activities r and to have its presence in major cities of telecom importance in the country. In 1973, taking into account the close association and increasing influence of electronics in Telecom, it was decided by the Council to rename the Institution as IETE so as to clearly reflect the rapidly changing environment in the country. Now after over 45 years later, it is highly satisfying to note that IETE has followed the advice of Dr. Radhakrishnan in letter and spirit, kept pace with the goals and vision for the Institution outlined by its first President and scaled impressive heights to become a leading technical professional society in electronics and telecom engineering in the service of the nation.

2. IETE- Present:

Looking back on the role and functions of IETE since its establishment, it is a great pleasure to recall the leadership role provided by the Institution in a number of areas of importance in national development. These include:

- Human resource development through DIP IETE, AMIETE and ALCCS as alternatives to traditional Diploma, UG and PG programmes in the Indian higher education system with Government recognition obtained;
- Thousands of technical professionals at Diploma, UG and PG Degree levels trained, with many of them occupying key positions, playing important roles in industry and elsewhere and contributing significantly to national development;
- Expansion of knowledge base of technical professionals at various levels, both young and old, through structured programmes and activities of a wide variety, conducted at different locations spread far and wide in the country;
- Bringing out high quality technical publications, ~2000 pages annually, covering journals, conference/symposium/workshop proceedings, special issues and others for the intellectual stimulation of professionals and students and promoting R&D work;
- Taking up socially relevant programmes like encouraging College students to associate with IETE through Students' Forums, arranging summer schools in electronics/computers for school children and educating women in computer/IT usage for employability;
- Contributing to National Policies on Education, Technology, Telecom, IT, Start-ups and related areas from time to time after due deliberations at Seminars/Symposia specially convened at for such purposes and presenting the IETE viewpoint;
- Forming Apex Forums on different topics of current interest in the broad areas of electronics, telecom and IT in the country to deliberate on major issues of national importance and bring out position papers for the benefit of society at large;
- Setting up over 60 Centres of the Institution in the country covering major locations of electronics and telecom importance with a view to provide service to its members and meet their needs and aspirations to advance in the profession.
- Recognizing merit, talent and outstanding contributions of IETE Members and honoring them on an annual basis through Fellowships, Awards and other recognitions so as to encourage them towards excellence in their pursuits;
- Cooperating/collaborating with other national/international technical professional societies with a view to serve the IETE members in a broader perspective and also contribute significantly to national endeavor in its chosen fields.

These and related contributions of IETE in recent years have indeed enhanced its reputation significantly in the service of its Members and the society at large.

3. IETE- Future Prospects:

As seen in the previous sections, IETE has demonstrated good progress in ~65 years since its establishment, providing commendable service to its members and other beneficiaries and it is now a premier technical professional society in India. But, now in the 21st century, future progress of IETE appears to be governed by the challenges being faced in the country, such as:

- Economic liberalization in recent years and globalization of Indian industry;
- Penetration of IT in all sectors of human activities, leading to IT-enabled solutions;
- Service sector becoming major force for employment generation and economic progress;
- Emergence of knowledge as a key driver for the progress of nations;
- Ever increasing influence of S&T developments on everyday life; and,
- Rapid obsolescence of old practices and shrinking time scale of new developments.

As IETE has the necessary technical capabilities to

circumvent these challenges through its programmes and activities, its future prospects appear to be bright. Thus, it calls for the continuation of some of its on-going activities covered earlier after reviewing them thoroughly and taking up new ones as suggested below. It is expected that these measures will enable IETE to continue to be at the forefront of technical professional societies in the country. The suggestions for new programmes and activities are as follows:

a) Higher Technical Education: To consider all aspects of technology enabled learning in electronics, telecom, computers and related areas and provide practical solutions with a view to enhance the access ratio from the present 22% to ~40% in the next five years

b) Quality and Standard of Technical Education: Deliberate/develop different methods to enhance the quality and standard of education in electronics, telecom, computers and related areas and get them recognized by National Regulatory Bodies for use in India;

c) Low cost solutions to Technological Problems: Conduct surveys and encourage innovation by start-ups and others in products to save scarce energy resources, minimize pollution, save environment, conserve ecology and at low cost for a better future;

d) Technical Standards: Associate with national /international technical standards Bodies and contribute to national development in a significant way by encouraging the design and technology of low-cost, high performance products in the IETE areas of interest;

e) New Technologies: Set up professional groups in chosen areas of electronics, telecom, computers and related areas to anticipate new advances, take up their impact analysis, conduct feasibility studies and prepare position papers on them for wide dissemination.

4. Concluding Remarks:

In these ~65 years since its founding, the Institution has come a long way and established itself as a premier technical professional society for electronics, telecom, computers and related areas in the country. It is now necessary for IETE to prepare itself to take up new initiatives as indicated above so that it can scale new heights and continue to meet the professional needs of its members and others in the same way as in the past. The Local Centre like Bengaluru comprising of highly talented professionals in the IETE areas can play a significant role in this endeavor.

Demystifying 5G! – Peripheral, but Essential Technologies

Dr M H Kori

In the previous two article we had looked at what is 5G, why 5G was needed and what are its extended scope, apart from higher data rates. Just to recollect, there are three primary pillars on which 5G is based.

1. Enhanced Mobile Broadband (eMBB). 5G is set to increase data speeds up to 10Gbps. eMBB is the most obvious extension of LTE capability, providing higher speeds for applications such as streaming, Web access, video conferencing, and virtual reality.

2. Massive Machine-Type Communications (mMTC). The Internet of Things (IoT) including wearables, smart home appliances and connected cars, is expected to grow exponentially over the next 10 years. This means 5G networks will need to accommodate billions of connected devices. Massive machine-type communications extends LTE Internet of Things capabilities—for example, NB-IoT—to support huge numbers of devices with lower costs, enhanced coverage, and long battery life.

3. Ultra-Reliable and Low-Latency Communications (URLLC). This will be particularly important for industrial applications, driverless cars, tactile internet applications and better user experience. Of the three categories, URLLC enables wireless applications never before possible.

We also looked at some fascinating technologies which facilitate meeting the above requirements. We covered some critical aspects of the following technologies in the last issue:

1. 5G New Radio (NR)
2. Massive MIMO & Beam Forming
3. mmWave for 5G

Let us explore a few more exciting technologies in this issue which are critical to 5G, but are not exclusively used only in 5G.

1. Network Function Virtualization (NFV), Network Slicing

Network Function Virtualization

Network Function Virtualization refers to the replacement of network functions on dedicated appliances—such as routers, load balancers, and firewalls—with virtualized instances running as software on commercial off-the-shelf hardware. NFV's purpose is to transform the way networks are built and services are delivered. With NFV, any enterprise can simplify a wide array of network functions, as well as maximize efficiencies and introduce new revenue-generating services faster and easier than ever before.

NFV is a key enabler of the coming 5G infrastructure, helping to virtualize all the various appliances in the network. In 5G, NFV will enable network slicing—a virtual network architecture aspect that allows multiple virtual networks to be created atop a shared physical infrastructure. Virtual networks can then be customized to

meet the needs of applications, services, devices, customers or operators. In 5G, NFV will also enable the distributed cloud, helping to create flexible and programmable networks for the needs of tomorrow.

Network Slicing

Network slicing allows a network operator to provide dedicated virtual networks with functionality specific to the service or customer over a common network infrastructure. Thus it will be able to support the numerous and varied services envisaged in 5G.

Network slicing is a form of virtual network architecture using the same principles behind software defined networking (SDN) and network functions virtualisation (NFV) in fixed networks. SDN and NFV are now being commercially deployed to deliver greater network flexibility by allowing traditional network architectures to be partitioned into virtual elements that can be linked (also through software). Network slicing allows multiple virtual networks to be created on top of a common shared physical infrastructure. The virtual networks are then customised to meet the specific needs of applications, services, devices, customers or operators.

In the case of 5G, a single physical network will be sliced into multiple virtual networks that can support different radio access networks (RANs), or different service types running across a single RAN. It is envisaged that network slicing will primarily be used to partition the core network, but it may also be implemented in the RAN.

Network slicing is expected to play a critical role in 5G networks because of the multitude of use cases and new services 5G will support. These new use cases and services will place different requirements on the network in terms of functionality, and their performance requirements will vary enormously.

For example, an autonomous car will rely on V2X (vehicle-to-anything) communication which requires low latency but not necessarily a high throughput. A streaming service watched while the car is in motion will require a high throughput and is susceptible to latency. Both would be able to be delivered over the same common physical network on virtual network slices to optimise use of the physical network.

Network slicing will maximise the flexibility of 5G networks, optimising both the utilisation of the infrastructure and the allocation of resources. This will enable greater energy and cost efficiencies compared to earlier mobile networks.

Each virtual network (network slice) comprises an independent set of logical network functions that support the requirements of the particular use case, with the term 'logical' referring to software.

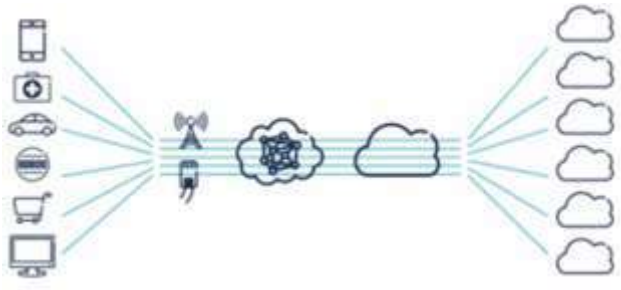
Each will be optimised to provide the resources and network topology for the specific service and traffic that will use the slice. Functions such as speed, capacity, connectivity and coverage will be allocated to meet the particular demands of each use case, but functional components may also be shared across different network slices.

Each will be completely isolated so that no slice can interfere with the traffic in another slice. This lowers the risk of introducing and running new services, and also supports migration because new technologies or architectures can be launched on isolated slices. It also has a security impact, because if a cyber attack breaches one slice the attack is contained and not able to spread beyond that slice.

Each will be configured with its own network architecture, engineering mechanism and network provisioning. It will typically contain management capabilities, which may be controlled by the network operator or the customer, depending on the use case. It will be independently managed and orchestrated.

The user experience of the network slice will be the same as if it was a physically separate network.

Distributed Cloud Technology



Distributed cloud technology allows multiple data centers to appear as a single, virtual data center. In 5G, NFV will be about more than merely moving functions to commodity hardware. The 5G NFV distributed cloud computing environment will be scalable, resilient, and fault-tolerant. Combining distributed cloud technology with virtualized network functions (VNFs) will allow the VNFs to be deployed based on performance and other requirements, making it easier for operators to optimize, manage, and maintain networks.

2. Mobile Edge Computing

MEC is a foundational network architecture concept, which will help 5G networks live up to their potential as "living networks", while delivering significant capability gains required for IoT, enhanced mobile broadband, virtual reality, self-driving vehicles, and more. In MEC, computing capabilities are pushed closer to the radio access network (and, in turn, closer to subscribers), enabling low-latency and high-bandwidth access to content, applications and services. The distributed MEC architecture also makes it ideal for supporting high volumes of connected devices, which will generate even higher volumes of data interactions.

The Radio Access Network is only one of multiple pieces that will enable 5G. Virtualization is another, as is multi-access edge computing: MEC.

MEC is entwined with 5G, but it's not exclusive to 5G. MEC can be implemented in LTE networks as well, and industry players have been exploring how MEC can be used in a number of contexts to support the internet of things and enterprise applications, and how their networks need to

evolve to support MEC.

Multi-access edge computing concepts have picked up a variety of names as they have begun to emerge: edge cloud; fog computing; mobile edge computing. MEC is essentially placing compute and storage resources closer to the consumer or enterprise end user. As ETSI describes it, MEC is "an evolution of cloud computing [that]brings application hosting from centralized data centers down to the network edge, closer to consumers and the data generated by applications." MEC aims to improve content delivery and application user experience by cutting out the often-long and imperfect network path between the end user's device and the location where the data they are accessing is hosted, in order to lower latency, increase reliability and improve overall network efficiency.

MEC is seen, on one hand, as a way for mobile network operators to improve the operations of their own networks in terms of latency, reliability and efficiency. MEC gives network operators the chance to become cloud providers, taking a page from the success of companies like AWS and Google and leveraging their networks in a new way. Distributed sites, from central offices to C-RAN aggregation points to cell towers themselves, become potential locations for compute, storage and analytics resources as part of a virtualized, automated, flexible service environment that lets third parties take advantage of geographic closeness to the user — and, when 5G enters the picture, to a wireless network environment with unprecedented speed, capacity and ultra-low latency on which to create.

By becoming edge cloud providers, network operators are hoping to leverage their wireless and wired infrastructure to shift their relationships with application developers and the users who consume those services, and ideally, become more like the agile, cloud-providing tech companies that have driven so much innovation and revenue that operators have struggled to monetize.

In particular, MEC is seen as key to massive IoT deployments and as crucial for analyzing large amounts of data coming from increasingly connected things.

The mobile network today is very much a monolithic, centralized, hub-and-spoke, hardware-based network which is quite inflexible, especially when one looks at segmenting or slicing the network. Although a lot of the talk about 5G has been about a new radio for 5G, actually it's more about the architecture, and driving that transition from hardware to software, toward programmability — and really, a big shift in the architecture is in terms of centralized to more distributed.

Hence these technologies like Mobile Edge Computing, Distributed Cloud, Network Slicing & NFV are as critical to 5G as the other technologies like NR, mmWaves, Massive MIMO & Beam Forming.

After covering all the critical technologies of 5G in these 3 articles, we will be exploring commercial aspects, deployment schedules and status of 5G in the next issue!

Ref:

1. LTE to 5G - 5G Americas / Rysavy Research White Paper
2. 5G Era – GSMA
3. 3GPP Reports
4. Inside 5G
5. sdx central
6. 5g.co.uk
7. RCR Wireless

SUSIEC-2019

IETE Bangalore proudly announces the 40th edition of "Summer School in Electronics and Computers (SUSIEC-2019) commencing on Sunday, the 14th April 2019.

SUSIEC program has become one of the best programs for the school going students to learn the basic skills and knowledge of Electronics & Computers. We at IETE are proud that many students who attended SUSIEC programs in the past later did their graduation in engineering and are pursuing their career in Electronics/ Computer engineering successfully in India and abroad'

All the participants in this course will demonstrate their projects during the Exhibition at the valedictory function to be held on Sunday, the 5th May 2019. The top performers will receive cash awards instituted by M/s ASM Technologies Limited in memory of Late Dr. S Srikantan, former chairman, M/s ASM Technologies and former Chairman IETE Bengaluru Centre as **"Dr. S Srikantan Memorial Award".**

Position	Nos.	Amount for each Participant (Rs.)	Total (Rs.)
First Prize	3	5000+3000	24000.00
Second Prize	3	4000+3000	21000.00
Third Prize	3	3000+3000	18000.00
Consolation Prize	41	3000	123000.00
TOTAL	50		1,86,000.00

In addition, all participants will receive an Electronics tool kit and components worth Rs 2500/- (approx.) each, sponsored by **M/s ASM Technologies Ltd.** and a Participation Certificate. The panel of judges will consist of eminent personalities from the technical field. For registration and other details of **SUSIEC-19**, please visit www.ieteblr.in. Names of nominees with their contact details may be sent on or before 10th April 2019. **Venue:** IETE Bldg. Ganganagar Extn. Bellary Road Bengaluru 32

INTERNET OF THINGS & AUGMENTED REALITY

Mr Baranga Bogdan

The Internet of Things and Augmented Reality are, without doubt, a game-changer for the Industry of the Future.

Whereas, the IOT technologies are concerned with accumulation of data (sensing), processing that data (thinking) and converting the data into actionables (acting). The Augmented Reality technology is concerned with putting that data back into the physical world in the form of graphics and animations. The adoption of these 2 complementary technologies are resulting in great efficiencies for Industries and humans alike.

For an efficient IOT implementation, Sourcing and Contextualizing data, Analysing and Synthesizing it, Orchestrating it to provide insights and Engaging People must be done in a very seamless fashion (Pic 1)

Manufacturers worldwide are seeing the value in Digital Transformation. The statistics given in Picture 2 show that most of the world's manufacturers are in the process of adopting IOT technology to improve their business outcomes and methods.

Augmented Reality technology gives us new ways to visualize, instruct and interact with machines and with other humans, regardless of distance. (Picture 3)

Considering the example of a washing machine, we can see how the 3 major stakeholders in the lifecycle of a washing machine, the Consumer, the Manufacturer and the Service/Maintenance company, benefit from the use of IOT / AR technologies.

Consumer Perspective: The consumer can visualize where to position his washing machine, thereby determining the size of it. He can shop being well-informed on the cost versus benefit. After purchase, he can set it up and operate with the use of digital manuals and graphics. He can diagnose/notify and get help in a very smooth fashion with the use of IOT/AR Technoloaies.

Manufacturer Perspective: The Manufacturer company can optimize his factory operations by Remote monitoring and Predictive maintenance on his shop-floor. They can instruct workforce and incorporate design improvements with visuals and real-time information. They can also derive predictive intelligence from all the washing machines that are functioning in people's homes.

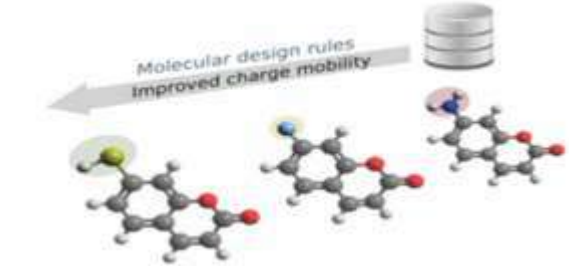
Service Perspective: The service company can use the data that is coming in from various washing machines on the field and diagnose well in advance of a failure actually happening. Subsequently, they can send spare parts to the consumer, even without the consumers intervention at times. Once the spare parts are delivered, instructions can be given to the consumer on how to replace a specific part. If the Service company chooses to send a technician in cases of advanced spare parts, they can send a technician who has had minimal-to-zero training on the field and depend on technology for him to do the right thing.

There is no doubt that IOT/AR technologies will make the world around us smarter in the immediate future. Next-generation devices and machines will be so smart that our children wouldn't be able to perceive a time when devices were not. On those lines, Mark Weiser had said,

"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."

TECH TRENDS

Chemical data mining boosts search for new organic semiconductors



https://www.sciencedaily.com/releases/2019/02/190214115543.htm

Both the carbon-based molecular frameworks and the functional groups decisively influence the conductivity of organic semiconductors. Researchers at the Technical University of Munich (TUM) now deploy data mining approaches to identify promising organic compounds for the electronics of the future.

Producing traditional solar cells made of silicon is very energy intensive. On top of that, they are rigid and brittle. Organic semiconductor materials, on the other hand, are flexible and lightweight. They would be a promising alternative, if only their efficiency and stability were on par with traditional cells.

Together with his team, Karsten Reuter, Professor of Theoretical Chemistry at the Technical University of Munich, is looking for novel substances for photovoltaics applications, as well as for displays and light-emitting diodes -- OLEDs. The researchers have set their sights on organic compounds that build on frameworks of carbon atoms.

Contenders for the electronics of tomorrow

Depending on their structure and composition, these molecules, and the materials formed from them, display a wide variety of physical properties, providing a host of promising candidates for the electronics of the future.

“To date, a major problem has been tracking them down: It takes weeks to months to synthesize, test and optimize new materials in the laboratory," says Reuter. "Using computational screening, we can accelerate this process immensely.”

Computers instead of test tubes

The researcher needs neither test tubes nor Bunsen burners to search for promising organic semiconductors. Using a powerful computer, he and his team analyze existing databases. This virtual search for relationships and patterns is known as data mining.
"Knowing what you are looking for is crucial in data mining," says PD Dr. Harald Oberhofer, who heads the project. "In our case, it is electrical conductivity. High conductivity ensures, for example, that a lot of current flows in photovoltaic cells when sunlight excites the molecules."

Algorithms identify key parameters

Using his algorithms, he can search for very specific physical parameters: An important one is, for example, the "coupling parameter." The larger it is, the faster electrons move from one molecule to the next.

A further parameter is the "reorganization energy": It defines how costly it is for a molecule to adapt its structure to the new charge following a charge transfer -- the less energy required, the better the conductivity.

The research team analyzed the structural data of 64,000 organic compounds using the algorithms and grouped them into clusters. The result: Both the carbon-based molecular frameworks and the "functional groups," i.e. the compounds attached laterally to the central framework, decisively influence the conductivity.

Identifying molecules using artificial intelligence

The clusters highlight structural frameworks and functional groups that facilitate favorable charge transport, making them particularly suitable for the development of electronic components.

"We can now use this to not only predict the properties of a molecule, but using artificial intelligence we can also design new compounds in which both the structural framework and the functional groups promise very good conductivity," explains Reuter.
https://www.sciencedaily.com/releases/2019/02/190213132205.htm

High-performance quantum dot mode-locked laser on silicon

Ten years into the future. That's about how far an electrical and computer engineering professor and his research team are reaching with the recent development of their mode-locked quantum dot lasers on silicon. It's technology that not only can massively increase the data transmission capacity of data centers, telecommunications companies and network hardware products to come, but do so with high stability, low noise and the energy efficiency of silicon photonics.

Ten years into the future. That's about how far UC Santa Barbara electrical and computer engineering professor John Bowers and his research team are reaching with the recent development of their mode-locked quantum dot lasers on silicon. It's technology that not only can massively increase the data transmission capacity of data centers, telecommunications companies and network hardware products to come, but do so with high stability, low noise and the energy efficiency of silicon photonics.

"The level of data traffic in the world is going up very, very fast," said Bowers, co-author of a paper on the new technology in the journal Optica. Generally speaking, he explained, the transmission and data capacity of state-of-the-art telecommunications infrastructure must double roughly every two years to sustain high levels of performance. That means that even now, technology companies such as Intel and Cisco have to set their sights on the hardware of 2024 and beyond to stay competitive.

Enter the Bowers Group's high-channel-count, 20 gigahertz, passively mode-locked quantum dot laser, directly grown -- for the first time, to the group's knowledge -- on a silicon substrate. With a proven 4.1 terabit-per-second transmission capacity, it leaps an estimated full decade ahead from today's best commercial standard for data transmission, which is currently reaching for 400 gigabits per second on Ethernet.

The technology is the latest high-performance candidate in an established technique called wavelength-division-multiplexing (WDM), which transmits numerous parallel signals over a single optical fiber using different wavelengths (colors). It has made possible the streaming and rapid data transfer we have come to rely on for our communications, entertainment and commerce.

The Bowers Group's new technology takes advantage of several advances in telecommunications, photonics and materials with its quantum dot laser -- a tiny, micron-sized light source -- that can emit a broad range of light wavelengths over which data can be transmitted.

"We want more coherent wavelengths generated in one cheap light source," said Songtao Liu, a postdoctoral researcher in the Bowers Group and lead author of the paper. "Quantum dots can offer you wide gain spectrum, and that's why we can achieve a lot of channels." Their quantum dot laser produces 64 channels, spaced at 20

GHz, and can be utilized as a transmitter to boost the system capacity.

The laser is passively 'mode-locked' -- a technique that generates coherent optical 'combs' with fixed-channel spacing -- to prevent noise from wavelength competition in the laser cavity and stabilize data transmission.

This technology represents a significant advance in the field of silicon electronic and photonic integrated circuits, in which the primary goal is to create components that use light (photons) and waveguides -- unparalleled for data capacity and transmission speed as well as energy efficiency -- alongside and even instead of electrons and wires. Silicon is a good material for the quality of light it can guide and preserve, and for the ease and low cost of its large-scale manufacture. However, it's not so good for generating light.

"If you want to generate light efficiently, you want a direct band-gap semiconductor," said Liu, referring to the ideal electronic structural property for light-emitting solids. "Silicon is an indirect band-gap semiconductor." The Bowers Group's quantum dot laser, grown on silicon molecule-by-molecule at UC Santa Barbara's nanofabrication facilities, is a structure that takes advantage of the electronic properties of several semiconductor materials for performance and function (including their direct band-gaps), in addition to silicon's own well-known optical and manufacturing benefits.

This quantum dot laser, and components like it, are expected to become the norm in telecommunications and data processing, as technology companies seek ways to improve their data capacity and transmission speeds.

“Data centers are now buying large amounts of silicon photonic transceivers," Bowers pointed out. "And it went from nothing two years ago.”

Since Bowers a decade ago demonstrated the world's first hybrid silicon laser (an effort in conjunction with Intel), the silicon photonics world has continued to create higher efficiency, higher performance technology while maintaining as small a footprint as possible, with an eye on mass production. The quantum dot laser on silicon, Bowers and Liu say, is state-of-the-art technology that delivers the superior performance that will be sought for future devices.

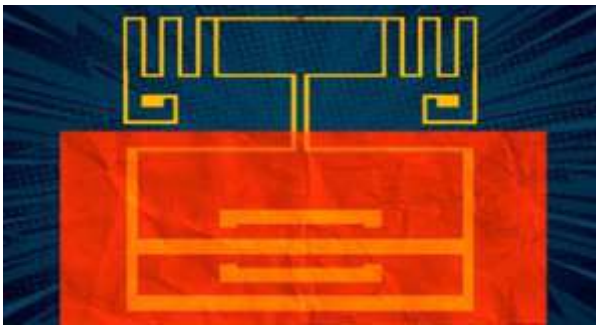
“We're shooting far out there," said Bowers, who holds the Fred Kavli Chair in Nanotechnology, "which is what university research should be doing.”

https://www.sciencedaily.com/releases/2019/01/190128111718.htm

Converting Wi-Fi signals to electricity with new 2D materials

Device made from flexible, inexpensive materials could power large-area electronics, wearables, medical devices, and more

Imagine a world where smartphones, laptops, wearables, and other electronics are powered without batteries. Researchers have taken a step in that direction, with the first fully flexible device that can convert energy from Wi-Fi signals into electricity that could power electronics.



Researchers from MIT and elsewhere have designed the first fully flexible, battery-free "rectenna" -- a device that converts energy from Wi-Fi signals into electricity -- that could be used to power flexible and wearable electronics, medical devices, and sensors for the "internet of things."

Imagine a world where smartphones, laptops, wearables, and other electronics are powered without batteries. Researchers from MIT and elsewhere have taken a step in that direction, with the first fully flexible device that can convert energy from Wi-Fi signals into electricity that could power electronics.

Devices that convert AC electromagnetic waves into DC electricity are known as "rectennas." The researchers demonstrate a new kind of rectenna, described in a study appearing in Nature, that uses a flexible radio-frequency (RF) antenna that captures electromagnetic waves -- including those carrying Wi-Fi -- as AC waveforms.

The antenna is then connected to a novel device made out of a two-dimensional semiconductor just a few atoms thick. The AC signal travels into the semiconductor, which converts it into a DC voltage that could be used to power electronic circuits or recharge batteries.

In this way, the battery-free device passively captures and transforms ubiquitous Wi-Fi signals into useful DC power. Moreover, the device is flexible and can be fabricated in a roll-to-roll process to cover very large areas.

"What if we could develop electronic systems that we wrap around a bridge or cover an entire highway, or the walls of our office and bring electronic intelligence to everything around us? How do you provide energy for those electronics?" says paper co-author Tomás Palacios, a professor in the Department of Electrical Engineering and Computer Science and director of the MIT/MTL Center for Graphene Devices and 2D Systems in the Microsystems Technology Laboratories. "We have come up with a new way to power the electronics systems of the future -- by harvesting Wi-Fi energy in a way that's easily integrated in

large areas -- to bring intelligence to every object around us."

Promising early applications for the proposed rectenna include powering flexible and wearable electronics, medical devices, and sensors for the "internet of things." Flexible smartphones, for instance, are a hot new market for major tech firms. In experiments, the researchers' device can produce about 40 microwatts of power when exposed to the typical power levels of Wi-Fi signals (around 150 microwatts). That's more than enough power to light up a simple mobile display or silicon chips.

Another possible application is powering the data communications of implantable medical devices, says co-author Jesús Grajal, a researcher at the Technical University of Madrid. For example, researchers are beginning to develop pills that can be swallowed by patients and stream health data back to a computer for diagnostics.

"Ideally you don't want to use batteries to power these systems, because if they leak lithium, the patient could die," Grajal says. "It is much better to harvest energy from the environment to power up these small labs inside the body and communicate data to external computers."

All rectennas rely on a component known as a "rectifier," which converts the AC input signal into DC power. Traditional rectennas use either silicon or gallium arsenide for the rectifier. These materials can cover the Wi-Fi band, but they are rigid. And, although using these materials to fabricate small devices is relatively inexpensive, using them to cover vast areas, such as the surfaces of buildings and walls, would be cost-prohibitive. Researchers have been trying to fix these problems for a long time. But the few flexible rectennas reported so far operate at low frequencies and can't capture and convert signals in gigahertz frequencies, where most of the relevant cell phone and Wi-Fi signals are.

To build their rectifier, the researchers used a novel 2-D material called molybdenum disulfide (MoS2), which at three atoms thick is one of the thinnest semiconductors in the world. In doing so, the team leveraged a singular behavior of MoS2: When exposed to certain chemicals, the material's atoms rearrange in a way that acts like a switch, forcing a phase transition from a semiconductor to a metallic material. This structure is known as a Schottky diode, which is the junction of a semiconductor with a metal.

"By engineering MoS2 into a 2-D semiconducting-metallic phase junction, we built an atomically thin, ultrafast Schottky diode that simultaneously minimizes the series resistance and parasitic capacitance," says first author and EECS postdoc Xu Zhang, who will soon join Carnegie Mellon University as an assistant professor.

Parasitic capacitance is an unavoidable situation in electronics where certain materials store a little electrical charge, which slows down the circuit. Lower capacitance, therefore, means increased rectifier speeds and higher operating frequencies. The parasitic capacitance of the researchers' Schottky diode is an order of magnitude smaller than today's state-of-the-art flexible rectifiers, so it is much faster at signal conversion and allows it to capture and convert up to 10 gigahertz of wireless signals.

"Such a design has allowed a fully flexible device that is fast enough to cover most of the radio-frequency bands used by our daily electronics, including Wi-Fi, Bluetooth, cellular LTE, and many others," Zhang says.

The reported work provides blueprints for other flexible Wi-Fi-to-electricity devices with substantial output and efficiency. The maximum output efficiency for the current device stands at 40 percent, depending on the input power of the Wi-Fi input. At the typical Wi-Fi power level, the power efficiency of the MoS2 rectifier is about 30 percent. For reference, today's best silicon and gallium arsenide rectennas made from rigid, more expensive silicon or gallium arsenide achieve around 50 to 60 percent.

AI Microscopes

https://www.techworm.net/2018/07/most-astonishing-tech-inventions-2018.html

Scientists have started to actively utilize AI robotic microscopes in order to study the underwater life. They have been paying especially close attention to plankton, which is responsible for the water's quality. They've been trying to analyze it so that they could figure out how to save the oceans.

These AI microscopes can monitor sea creatures 24/7, taking pictures and providing important data. If the IoT technology is utilized and the camera focus is improved, it could allow scientists to monitor the sea life in real-time, thus enabling them to look for solutions more effectively.
https://techlurn.org/upcoming-technologies-2019.html

12th International Radar Symposium India 2019 (IRSI-19)

10-14 Dec 2019 | Venue : NIMHANS Convention Centre, Bangalore INDIA

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Welcome to 12th International Radar Symposium India 2019 (IRSI-19) 10-14 Dec 2019

The International Radar Symposium India 2019 (IRSI-19 the 12th in the series, being jointly organized by IEEE Bangalore Section, IET Bangalore Network, IETE Bangalore Centre and Society of Electronic Engineers (SEE), co-sponsored by Bharat Electronics (BEL), Defence Research & Development Organisation (DRDO), Hindustan Aeronautics Ltd (HAL) and Indian Space Research Organisation (ISRO) is scheduled for 10-14 Dec 2019. First IRSI was conducted in 1983 and was revived in 1999 as a biennial series.

The response and success of the previous events, which set several benchmarks, are remembered by all participants. IRSI has grown from strength to strength over the years and the current edition is poised to scale new heights with enhanced international participation. The large scale Radar India Exhibitions with provision for more than 100 exhibition stalls will be an added attraction. Live Demos are also being organised.

IRSI-19 Call for Papers:

Original contributions, based on theoretical /experimental work, are solicited from Scientists / Engineers / Academicians / Users working in radar and related broad areas such as:-

- Radar Systems
- Weather and Atmospheric Radars
- SAR/ISAR Imaging Radars
- Radar Receivers / MICs / MMICs
- Guidance and Navigational Aids
- RCS/Stealth / Anti-Stealth Technologies
- Tracking and Instrumentation Radar
- Antenna Arrays, Active / Passive
- Thermal Management & Packaging Issues
- Ground Penetration Radar techniques
- Foliage Penetration Radar Techniques etc
- MEMS & Nano Technology in Radar Applications
- Target Recognition
- Antenna Elements
- Ultrawideb and Techniques
- RDP and Data Fusion
- Terahertz Technologies
- Millimetric Radars
- Digital Array Radars
- Radar Signal Processing
- Radar Displays
- Radar ECM/ECCM
- New Materials in Radar
- Radar Transmitters and MPMs

IMPORTANT DATES

Last Date to submit Abstract	30th April 2019
Last Date for Full Paper Submission	30th August 2019
Final Acceptance Notification	30th Sept 2019
Presenting Author Registration	30th October 2019
Last Date to receive advertisements	20th Nov 2019
Tutorials	10- 11th Dec 2019
Symposium	12-14 Dec 2019

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