India's R&D Centres of Excellence

Centers of Excellence (CoEs) aim at making India globally competitive by leveraging the public-private partnership model for development of cutting-edge technologies. A curtain raiser...

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Based on the public-private partnership model, quite a few Centres of Excellence (CoEs) have been set up in India for the benefit of society. Funded by the government, these CoEs aim to provide high-quality training, undertake advanced research and develop globally competitive tools within a defined timeframe. The focus is on technology development and transfer, path-breaking scientific research, development of trained human resources and economic outreach.

CoEs have been set up in the areas of telecom, wireless technology, bioinformatics, lasers and optoelectronic devices and nano-electronics. Let's see why was the need felt to create these centres of excellence, their structure, objectives and areas of research, and the role of the government and industry.

CoEs in bioinformatics

Bioinformatics is the application of information technology to the study of molecular biology. Its rapid growth has been triggered by the explosion in biological information as a result of sequencing of genomes and study of crystal structures. The post-genomic era is faced with the stupendous task of evolving tools and technologies to generate vital and useable knowledge out of primary sequence and structure data. This necessitates acquisition of high-end computing capabilities, network access to a broad range of primary data and availability of highly trained human resource.

Department of Biotechnology has decided to establish five CoEs in bioinformatics in accordance with the recommendations of the task force on bioinformatics. The Department feels that the software/databases developed, research leads generated and training-cum-educational activities undertaken should be enhanced to serve as vehicles for advanced research, training and product development of international quality.

The objectives of the proposed CoEs are:

1. Build upon the national bioinformatics initiatives that have been taken till now.
2. Undertake advanced research in frontier areas of bioinformatics and computational biology.
3. Develop world-class human resource in bioinformatics.
4. Establish effective academia-industry interface.
5. Pursue and promote international cooperation with leading institutions, organisations and countries in the world.
6. Create world-class platforms for technology development, transfer and commercialization.

Structure. The fundamental objective is to create IIT-level capabilities for bioinformatics by building upon the existing structures and involving the existing institutions. The Task Force on Bioinformatics made a detailed assessment of the capabilities, infrastructure and achievements of the existing Distributed Information Centres (DICs). The DICs were asked to make presentations before the Task Force. The following DICs have been identified for upgradation into CoE on the basis of their potential, capabilities and achievements:

1. Jawaharlal Nehru University, New Delhi
2. University of Pune, Pune
3. Indian Institute of Science, Bangalore
4. Madurai Kamraj University, Madurai
5. Bose Institute, Kolkata

Objectives. CoEs in bioinformatics would undertake advanced research, education, training and solution development and develop economic outreach for bioinformatics based-industries. These would combine computational science and high-throughput molecular biology to extract biologically relevant leads from the growing body of sequence and structure information, and utilise them for the advancement of understanding of biological processes.

TABLE I
Priority Areas of the Proposed Bioinformatics CoEs

Institution	Priority area
Bose Institute	Molecular modelling and genetic engineering
Indian Institute of Science	Structural biology and bioinformatics
Jawaharlal Nehru University	Computational genomics
Madurai Kamraj University	Genetic engineering and structural bioinformatics
University of Pune	Computational biology and genomics

In order to avoid, even eliminate duplication of objectives and for maximal utilisation of resources, each of the proposed CoEs will be focusing on a well-defined area of bioinformatics. Also, the centres will have a fair amount of flexibility so that the mechanisms and objectives of CoEs do not conflict with the procedures and systems of the host institutions.

Mode of implementation. The CoEs would be established through financial support from the Department of Biotechnology (DBT). Interaction and linkages with industries and international organisations would be encouraged. A special committee would be constituted in DBT to monitor the progress of the CoEs. It is also proposed to enter into an MoU with the host institutions to clearly delineate the duties and responsibilities of DBT and the host institution.

CoE in lasers and optoelectronic devices

Cochin University of Science and Technology (CUSAT) is one of the few institutions in India that have facilities for R&D activities and manpower training in photonics and related fields. In recognition of the outstanding work carried out by a group of teachers and researchers in photonics and related subjects, the University Grants Commission (UGC) identified CUSAT as a 'university with potential for excellence in lasers and optoelectronic sciences.' Following this selection by University Grants Commission, CUSAT established a separate and independent 'CoE in lasers and optoelectronic sciences' (CELOS).

The activities under the CELOS have been jointly proposed by the International School of Photonics (ISP), Department of Physics and Department of Electronics in CUSAT. Based on the recommendations of the experts, UGC has made a budgetary allocation of Rs 35.456 million towards the R&D activities at the centre.

One of the main objectives of CELOS is to strengthen research in the fields of lasers and optoelectronic sciences and to build them to a level of competence comparable with international standards.

As approved by the Expert Committee of the UGC, CELOS has established a national facility centered around 'Tsunami'—a spectra physics make Ti:Sapphire pico/subpicosecond laser system with an amplifier. Research activities have been initiated by CELOS in the fields of optical fibre amplifier, fibre-optic sensors, photonic materials, microwave photonics, laser-produced plasma, non-linear processes, biophotonics and related fields.

CoE in nanoelectronics

The Centre of Excellence in Nanoelectronics (CEN) at the Indian Institute of Science (IISc) focuses on research and education in the areas of nano-scale electronics, devices, technologies, materials, micro and nanoelectromechanical systems, bioelectronic interfaces and integrated small-scale systems. It runs a multidisciplinary research programme involving more than 40 faculty members from various departments of engineering and basic science.

The CEN is funded by the Ministry of Communication and Information Technology (MCIT), government of India, under a collaborative project between IISc and IIT Bombay. It is currently building a state-of-the-art nanofabrication facility with a clean room spanning 1400 square metres. In addition, there are several planned characterisation labs that will cater to material, electronic, mechanical and chemical characterisation.

Currently, research projects under CEN utilise fabrication and characterisation facilities scattered over the IISc campus in various participating departments and centres. Apart from carrying out frontier research in the areas mentioned above, the centre aims at creating technologies that can be commercially exploited by industries. It is also engaged in an ambitious plan for generating high-caliber manpower and entrepreneurs in the field of nanoelectronics and nanoengineering. It offers an interdisciplinary PhD program named 'nanoengineering for integrated systems' for students aspiring to work in any of the research areas mentioned above.

TABLE II
Fields of Excellence for Telecom CoEs

Field of Excellence in Telecom	Associated Institute	Sponsor
Next-generation network & network technology	IIT, Kharagpur	Vodafone Essar
Telecom technology & management	IIT, Delhi	Bharti Airtel
Technology integration, multimedia & computational maths	IIT, Kanpur	BSNL
Telecom policy, regulation, governance, customer care & marketing	IIM, Ahmedabad	IDEA Cellular
Telecom infrastructure & energy	IIT, Chennai	Reliance
Disaster management of info systems & information security	IISc, Bangalore	Aircel
Rural application	IIT Mumbai	Tata Telecom
Spectrum management	WPC, Chennai	Govt with industry consortium

Research areas at CEN, IISc

- Nano CMOS transistors
- Non-silicon-based transistors
- Novel memory architectures: FeRAM, MRAM, phase-change memory
- High-K gate dielectrics
- Magnetic materials for RF CMOS
- Spintronics
- Molecular rectifiers
- Soft lithography
- Self-assembled monolayers
- Ferroelectrics and phase shifters
- RF MEMS
- Optical MEMS
- Piezo-electric sensors
- Acoustic sensors
- Inertial sensors
- Testing and characterisation of nano-scale phenomenon
- Bio sensors and actuators
- CMOS-MEMS integration
- Energy harvesting and power MEMS
- Organic electronic devices and sensors
- Shape memory materials and devices
- Simulation and modeling nano-scale phenomenon
- Novel system architecture paradigms
- Chemical and gas sensors

Interaction with the industry. One of the main mandates of CEN is to create technologies for industries working in the fields of nanotechnology-enabled products or systems. Therefore CEN seeks active collaboration with interested industries. There are various possible modes of interaction with the industry:

1. Short-term projects
2. Long-term collaborations
3. Pre-competitive technology research consortium

These programmes are designed with flexibility of interaction and mutual benefit as the dual goals.

Short-term projects. Industries interested in collaborating on design, fabrication, or characterisation of nano- or micro-engineered components, or systems that require a few months to a couple of years, can approach the centre under this scheme.

Long-term collaboration. Industries interested in umbrella collaborations covering single or several areas of nanoelectronics or nanoengineering over a long period of two to ten years are encouraged to go through this mechanism that is designed for maximum R&D benefit to the industry. Collaboration under this programme is channeled through society for Innovation and Development (SID)—an outreach arm of IISc that handles large industrial projects.

Pre-competitive technology research consortium. This is a membership-based open programme that invites active participation of interested industries in a pre-competitive technology creation mission. The areas of open research are defined by the member industries.

Telecom CoEs

The unprecedented growth of innovative services and technologies is challenging the existing demarcation of business markets, services, providers, users and government regulations in the information and communication industry. Many of the existing legal provisions governing telecommunication and broadcasting have become outdated and there is a need for a unified regulatory mechanism. The solution to these problems can only be tackled by extensive in-house research and talent development. If the growth rate is to be sustained, the problems of the rural hinterland need to be tackled at a faster pace, as the urban sector will soon get saturated thus stagnating the growth.

Commodore J. Jena, director-coordination centre, Telecom Centres of Excellence, informs that the proposed telecom CoEs will fill the gap that has been created due to rapid pace of evolution and growth of telecom sector. Broadly, these CoEs will be working on enhancing the talent pool, technological innovation, securing information infrastructure and bridging of digital divide. They will also cater to requirements of South Asia as regional leaders.

Objectives. The telecom CoEs will provide a platform for think-tank activities with the following objectives:

1. Each one focuses on a niche area of activity in the telecom domain to build excellence that is at par with world standard rather than getting defocused by embracing the vast spread of telecom technology.

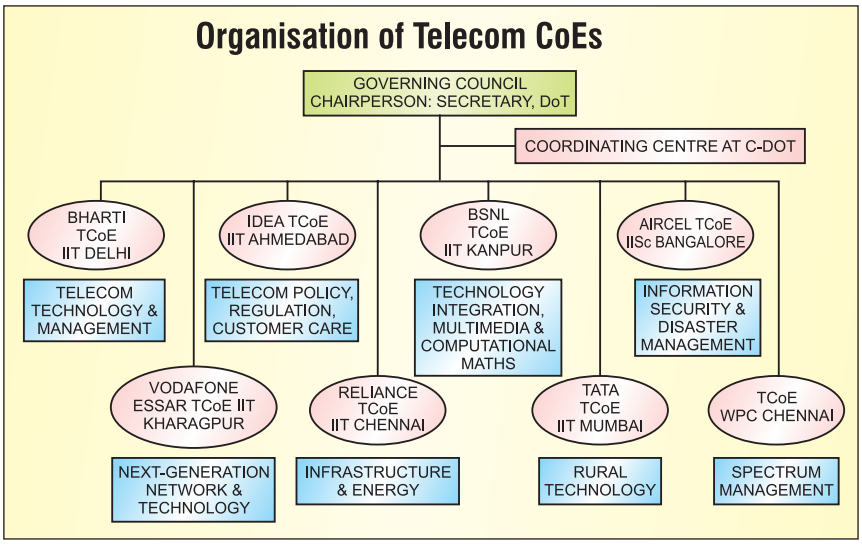
2. Undertake India-specific application development that matches with behavioural pattern of the masses and adds value to their day-to-day activities both economic and social.

3. Undertake cross-pollination of the best practices world over and make it suitable in the Indian context. This helps in creating optimal models that avoid duplication and wastage of recourses especially in the field of the converging information and communication technologies.

4. Macro infrastructure planning that enables a systematic and sustained growth in a cost-effective manner.

5. Creation of market-ready talent pool and continuous talent-building endeavour through training of the trainer.

6. Integration and benchmarking of



technology that can ultimately lead to form standards for manufacturing or rendering services.

7. Create an environment of innovation in the top academic institutes of the country to enable absorption of the current technology and develop future-ready indigenous capability.

Functioning. There will be a two-tier organisational structure for functioning of the CoE; a governing council for strategic planning and an autonomous core group at each centre for tackling local issues. There will be a coordinating centre, which will coordinate activities amongst the CoE. The governing council will be formed under the chairmanship of Secretary, DoT with the heads of the seven sponsoring organisations and heads of the institutes as members of the governing council, and it shall be serviced by the coordinating centre which is to be set up at Centre for Development of Telematics (C-DoT). Each centre will be managed by the core group under the co-chairmanship of the head of the institute and sponsor operator consisting of at least seven members.

Coordinating centre. It will have industry representatives with requisite domain knowledge in running such CoEs and will have infrastructure and support from C-DoT. ITU will be consulted for putting a representative of theirs in the coordinating centre to bring in international perspective.

Funding. CoEs will be funded by the sponsoring service provider (90 per cent) and the government of India (10 per cent). The coordinating centre will get its budget through grants from the government and sponsoring organisations.

Future roadmap. Association of foreign universities with the CoEs will bring in the international perspective in respect of regulatory and technological issues. This relationship will keep CoEs in sync with the evolution and challenges in the telecom sector. The association will also keep the CoEs updated about the latest international practices including spectrum management.

The relationship will also bring in considerable benefits to foreign universities in respect of access to research of such a large, reputed and efficient talent pool in telecom R&D. This will also facilitate the capacity building of telecom professionals in South Asia and other emerging markets. These CoEs will also help passing on the best practices followed in Indian telecom sector which has made it one of the most efficient and low-cost telecom networks in the world.

A VPN will be set up with hub at the coordination centre (being set up at the premises of C-DoT, Delhi) to facilitate sharing of research results and to promote collaborative research.

CoE in wireless technology

The Indian telecom services industry has grown by leaps and bounds in recent years, riding on mobile wireless technology. The Indian market for

wireless telephony and broadband Internet access is second only to China's in size and potential.

The Centre of Excellence in Wireless Technology (CEWiT) has been set up under a public-private initiative with the mission of making India a leader in the research, development and deployment of wireless technology. It is an autonomous institution, temporarily headquartered at IIT Madras.

As wireless research moves slowly beyond 3G and towards fourth-generation technology, CEWiT seeks to play a proactive role in creating IP. CEWiT will engage with academic and industry research groups in India to focus research on areas with strong potential. It will also foster collaboration with similar efforts worldwide. CEWiT seeks to actively participate in international standards bodies, and to assist government and public institutions in policy-making, spectrum management and regulation.

Although the focus of CEWiT is advanced research, it proposes to interact extensively with service providers in India right from the beginning. The aim is to continually refine the requirements of next-generation wireless technology, eventually leading to the creation of a 4G standard. IPRs generated in the interim will be sought to be incorporated in intermediate standards.

There are a number of companies in India that are now involved in sophisticated product development work in the wireless area. CEWiT will actively work with them to enhance the value of the products coming out of India, and make them central to the needs of Indian operators. CEWiT believes that exports will follow as a natural corollary. Apart from R&D, the industry will play a key role in prototyping and field trials of new technology.

CEWiT will divide its activities in the first few years into three phases:

- Phase I: Formative Phase
- Phase II: Research Phase
- Phase III: Field Trial Phase

CEWiT will enter into the detailed research phase based on the plan defined in Phase I. There will be a series of concurrent activities in this phase that will be broadly covered under the following heads:

1. Creation of standards: Inventions will be patented and piloted for inclusion in the emerging standards. Till 4G standardisation takes off internationally, CEWiT will participate actively in other emerging technology standards forums.

2. Development of reference designs, protocol stacks and ASICs as well as prototypes of equipment based on the emerging standards.

3. Collaboration with service providers for field trials and application development for the new technology.

CEWiT recognises that any new-generation technology has a cycle time of 5 to 10 years. Thus 4G systems will become a reality only when the whole world is ready for them. Hence the centre proposes to also develop intermediate technologies based on near-term and medium-term operator requirements. For the near-term, state-of-the-art technologies like WiMAX (802.16), HSDPA and hybrid cellular+WiFi technologies are potential candidates.

CEWiT will also assist operators to optimise the 2.5G infrastructure to increase capacity and coverage. This will provide significant learning, which would be of significant importance in developing the next-generation technologies.

This is the phase when the prototypes of various parts of the systems developed by different companies will reach the field trial stage. CEWiT will collaborate with the companies, as well as assist in linking with telecom operators for field testing and understanding the technologies, applications and commercial implications. This phase will follow the research phase for each new technology that is pursued in the near, medium and long terms. Ultimately, this experience will create a strong linkage between R&D, industry and operators to prove, fine-tune and deploy 4G-based products and services.

CEWiT will also continuously engage with policy makers and regulators in the country in working towards a coherent, growth-friendly environment for India to become a world player in wireless technology.

CoE for Wi-Fi technologies

In line with the charter to develop futuristic networking, the Networking & Internet Software Group (NISG) at C-DAC, Pune is working in the area of wireless networking with a focus on the 802.11 wireless networks, also called Wi-Fi networks. A CoE for Wi-Fi Technologies is therefore proposed to be set up at C-DAC, Pune to encompass the activities related to Wi-Fi.

Scope of activities. In addition to IEEE 802.11a/b/g standards, NISG is looking into the complete spectrum of associated IEEE and IETF standards. It is also looking into innovative applications of Wi-Fi and issues related to large-scale deployment of WLANs/PWLANs.

Priority areas are:

1. Establish state-of-the-art and advanced wireless infrastructure.

2. Carry out technology development and R&D activities in various aspects/issues related to 802.11. The areas currently envisaged are usability, manageability, mobility and security of Wi-Fi networks and innovative applications of the same.

3. Develop linkages with multinational/private companies and academic institutions in India and aboard for joint R&D and technology development activities.

4. Develop linkages with government organisations for collaborative development as well as deployment of the wireless technologies developed.

5. Disseminate knowledge gained in the field through publications, training and consultancy.

Infrastructure and institutional linkages. The CoE has already set-up a basic wireless infrastructure with a few access points and wireless stations. The commercial/carrier-grade wireless hotspot is also operational. Discussions are on for the setting up of more advanced wireless infrastructures.

On the technology development and R&D front, institutional linkages with Pronto Networks, USA, The State University of New York, USA, and Indian Institute of Technology Kanpur are under discussion.

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