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VISION, MISSION AND STRATEGIC PLAN

AUGUST 2, 2022

DHIRUBHAI AMABANI INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGY
Gandhinagar

Abstract

This document elaborates a strategic plan that points to the steps we will take to reach our goals in a well-considered time-frame.

The steps i) to consolidate our strengths in our teaching and research capabilities, ii) to enhance emerging areas of growth in our academic programmes and research verticals, iii) to modify some of our existing institutional structures and governance and make way for a transition of our Institute from a limited multi-discipline institute to a truly multi-disciplinary and interdisciplinary university are discussed in this document.

In **Section 1** of this document the original vision and a retrospective on this Institute is presented. In **Section 2** the vision of DAIICT on academic programs is written. Several ideas on the cutting-edge research and knowledge creation activities are presented in **Section 3**. In **Section 4** the visions on innovation and entrepreneurship are described. In **Section 5** the plans for outreach activities of DAIICT for the State and Country are discussed. In **Section 6** the plans on recruiting and retaining high quality faculty in DAIICT, essential for the growth in quality in all aspects, are outlined. The growth in Infrastructure and in the Resource Center are discussed in **Sections 7 and 8**, respectively. The changes in the Governance necessary for an overall growth are outlined in **Section 9**. In **Section 10**, the plans on improving the student life in the campus are presented.

In each section of the document **short-term objectives** and **longer term aspirations** of the Institute are identified.

1.0 BACKGROUND ON DAIICT

DAIICT was founded in 2000 as a unique university devoted to the cutting-edge inter disciplinary area of Information and Communication Technology (ICT). ICT was emerging as the technology of the future bringing in the fourth Industrial Revolution. Well known and highly qualified faculty members joined DAIICT and developed a curriculum and research program steeped in all aspects of ICT, societal, scientific, and technical. This spirit has been nurtured for the last 18 years and DAIICT wants to continue its excellence in interdisciplinary teaching and research well into the future.

The vision of the institute is to become a globally recognized institution that offers an innovative ICT program, outstanding faculty, an atmosphere of innovation, a responsive administration, a vibrant campus and a collaborative learning environment that *continuously adapts* to the changing landscape of Information and Communication Technologies.

Our goal is to be recognized, locally and globally, as a trendsetter in innovative research in ICT and ICT education. Toward this, we plan to design and deliver academic programs in both disciplinary and multidisciplinary domains to prepare students for a rapidly changing career environment

The specific goals are as follows:

- To pursue academic excellence by fostering a learning environment that integrates teaching, research and scholarship.
- To attract the best students from across the country and abroad and offer them a holistic education suited to a rapidly changing career environment.
- To conduct interdisciplinary research in the cutting-edge of information and communication technology with a view to business creation and social improvement in the State and the Nation.
- To have strong relationships with top universities of the world with exchange of faculty, students, and resources.
- To follow best practices in academic administration from across the world.

1.1 The Unique undergraduate programme at DAIICT

As a pioneering ICT centric institution, DAIICT has played an invaluable role in establishing a premier ICT undergraduate programme in India.

This unique undergraduate programme has introduced a pedagogic model that is inter-disciplinary and research oriented. Its foundational core offers students a deep understanding of the fundamentals of CS, ECE and IT along with a solid grounding in mathematics and science,

It also integrates inputs from the Humanities and Social Sciences (such as Literature, Sociology, Anthropology and History) into its Core Curriculum in order to give students a contextual and critical understanding of technology and its applications in society. It was the first BTech programme in India to introduce the novel interdisciplinary course of STS or Science, Technology and Society for undergraduates.

Its Rural Internship course offers students exposure to real life contexts where they can engage with communities to solve problems of livelihood, health, education etc.

Our pedagogical principles are driven by what are deemed to be the three critical components of 21st century engineering education- “ideation or generative thinking, broad pattern-recognition, critical thinking and complex communication”. Our teaching and evaluation processes are guided by a valuation of deep learning outcomes that go far beyond grades.

The overall objective of the BTech programme has been to give engineers a holistic education that would help them acquire a deep knowledge base, a range of cognitive and communication skills and a social outlook that enable them to work as responsible engineers and citizens.

Apart from its undergraduate programme DAIICT also has a vibrant PG programme that offers Masters and PhD courses in ICT, Sciences, Math and Humanities/ Social Sciences and Design.

Our faculty are involved in cutting edge research and publications not only in the ICT and related domains but also in the Humanities and Social Sciences. Their work has been published in peer-reviewed academic journals and books by both national and international publishing houses.

2.0 ACADEMIC PROGRAMMES AT DAIICT

A short preamble

- Undergraduate (BTech) degrees in ICT, Computational Science, Maths and Computing;
- MTech degrees in ICT, EC (jointly with CRRao Inst.), Data Science (jointly with IIT Jammu) ...
- MSc in IT, Data Science...
- MDes in Communication Design...
- PhD in ICT, Science, Mathematics, Humanities and Social Sciences.

2.1 Short Term Strategies

2.1.1 Towards A Multidisciplinary University

Based upon its foundational vision and inherent capabilities and also in the light of the imperatives for Higher Educational Institutes as stated in the Government of India's New Education Policy 2020, DAIICT seeks to effect a transition from an ICT centric institution to a multi-disciplinary university in this decade. We wish to effect this transition by enhancing the interdisciplinary thrust of our academic programmes and by incorporating more diverse disciplines in both our UG and PG programmes.

Our goal is to introduce new UG and PG programmes and to increase current student strength from 1700 to 4000 in the next 5 years and to 8000 students in the next 10 years.

This will be achieved in a phased manner by introducing new multi-disciplinary and interdisciplinary programmes at both UG and PG level. We also wish to strengthen our Continuing Education programme and introduce new collaborative or Joint Certificate programmes.

To nurture the spirit of interdisciplinary and research led learning we will hire faculty who are not only accomplished in their respective disciplinary domains but who are keen to accept innovative teaching and research challenges.

In sum, DAIICT seeks to build on its present academic strengths to further diversify its academic offerings and restructure its organization

to sustain and nurture a vibrant multi-disciplinary and interdisciplinary teaching and research ecosystem.

2.1.2 Attracting Quality Students with A Robust Admissions Policy:

We need to advertise our strengths to the outside world. This has to be a multi-pronged effort and has to be done on a continuous basis. It should not be limited to placing advertisements during admission cycles. DAIICT also seeks to provide greater opportunities and amenities on campus to attract international students.

2.1.3 International Partnerships and Student and Faculty Exchange Programmes

International partnerships between universities help students to pursue higher studies in different countries, training them better for a global job-market and for multinational companies and thus, they obtain better jobs after their studies. The number of publications in good journals also increases. One in five of the world's scientific papers are co-authored internationally. The rate of internationalization is growing rapidly, with unhindered communication channels and inexpensive travel. Universities across the world are already seeking to make the most of the possibilities this presents by forming global partnerships and fostering relationships with other institutions. Such partnerships have contributed enormously to academic and scientific progress. DAIICT encourages and facilitates and would strengthen the following:

1. MOU's with leading foreign universities.
2. Faculty Visit/Exchange between DAIICT and a foreign university.
3. Getting internationally reputed researchers as adjunct faculty.
4. Student Exchange at UG and PG levels between foreign universities.
5. Admission of foreign postgraduate students in various Masters' programs and in PhD.
6. Admission of foreign undergraduate students in various Bachelors' programs.

2.2 Long Term Strategies

2.2.1 New Programme Options and Specializations- Honours And Minors

We plan to strengthen and adapt our undergraduate (UG) program, and make it diverse and multidisciplinary, so that it matches the requirements of the future. We have already introduced an Honours degree within our existing BTech in ICT programme, we now wish to extend and structure it further by introducing a more flexible ICT programme with opportunities for specialization in both Honours and Minors offerings.

Honours will be offered in the areas such as machine learning and artificial intelligence (ML and AI), robotics, unmanned aerial vehicles (UAV) engineering, biomedical engineering, bitcoin and cyber currency, computational linguistics, next-generation wireless communication, wireless sensor networks and cyber-physical systems, quantum computing, chaos-theory-inspired optical wireless communication, etc. Minors will be offered in the areas such as Digital Humanities, Computational Sciences, Mathematical Finance, Design, Sociology, Literary and Cultural Studies.

At the post-graduate (PG) level, each of the major areas of UG specialization will be available as a research domain. The PG students will engage in a deeper research, greater width and depth of the knowledge in the specific discipline and will aim at generating innovative ideas and intellectual capitals. We also plan to offer interdisciplinary Master's programs that transcends the disciplinary boundaries.

At both the UG and the PG levels, the offering of the courses will be modularized. This will allow the students to not only engage in a deep study of a specific domain but also pursue broader interests such as entrepreneurial thinking, design thinking, leadership, music, art, meditation, etc.

3.0 RESEARCH AT DAIICT

Founding fathers of DAIICT knew that the glory of an educational institution rests on the research performed and outcome of the research and innovation activities in the long. Thus, research in the cutting-edge areas of ICT, humanities, science and mathematics was emphasized in DAIICT from the very beginning. Faculty members with strong research credentials were actively brought into DAIICT to build infrastructure and administration of the Institute. The curriculum developed emphasized the research and innovation through projects and not just rote learning. Research based Masters and PhD programs were also initiated right from the inception.

DAIICT has continued this tradition of research and innovation for the last 20 years. Several research projects in ICT, social science, mathematics, artificial intelligence, machine learning, speech processing, communication technology and several other topics have been completed.

The sponsored projects are being executed in DAIICT by various research groups is given in Table-1

Table-1

No.	Description
1	Development of Cross Lingual Information (CLIA) System
2	Indian Digital Heritage (IDH-HAMP)
3	Development of Text to Speech System in Indian Languages
4	Techniques for robust face recognition with pose variation
5	Developing of Infant Cry Analyzer using source and system features
6	Speech based Access of Agricultural Commodity Prices and Weather Information in 12 Indian Languages/ Dialects
7	Ultra Wide Band Dielectric Resonator Antenna
8	Techno Feasibility Study on Automation of Hydroponics and Green House Cultivation
9	Processor RTL Customization and Development of Low Power Design Flow Methodology
10	Enabling Technologies for Remote Health Monitoring
11	Kinetic Modeling of Large size Negative Ion Sources for Fusion Application using Emerging Parallel Processing Computer Architectures
12	Study of Privacy, Accountability and Ownership in IoT
13	Detection of heavy metal pollution in vegetation and characterization of soil clay minerals using AVIRIS-NG Data
14	UCMA: A Toolset to Automatically Analyze Functional Requirements Specified in the Use Cases
15	Development of microwave absorber (Carbonyl Iron filled Silicone Rubber Sheets) in 1 to 8 GHz range.

16	Desertification and Land Degradation: Monitoring, Vulnerability Assessment and Combating Plans"
17	A platform for Cross lingual and Multilingual Event Monitoring in Indian Languages
18	Using Mobile Sensing Mechanism to access Smart-Phone Addiction and Its Negative Impact on students
19	Design and simulation of Beamforming Algorithms and Baseband Technologies for SATCOM
20	Multiscale and Simulation of complex Plasma Dynamics during High Power Millimeter Wave Breakdown
21	Design and Field Training Testing of an Energy Autonomous Internet of Things Enabled Cattle Estrus Detection Device Targeted for Resource Constrained Regions
22	Design and simulation of Physical layer and Medium Access Control (IMAC) Layer Functionalities of Future Mobile Satellite Systems
23	Development of Ultra Low Power And Low Voltage Time to Digital Converter(TDC) for Space Applications

These projects are clearly in the cutting-edge areas of Natural Language Processing, Speech Processing, Millimeter-wave based RF Communications, Satellite Communication, IoT, Mobile Communication, Sensor Development for Agriculture, Image Processing and Pattern Recognition, etc. Several of these projects are parts of large projects running as a national consortium in India. Several of them are in Phase II of execution. These projects are sponsored by the National Govt. agencies such as DST, ISRO, etc.

Along with these sponsored research projects several start-up business projects are running the Incubation Center of DAIICT. An Anchor Institute program for training the teachers of the various colleges and universities in the State of Gujarat is also an important project in DAIICT.

Based on such a strength in the domain of research DAIICT wants to enhance the research capabilities in future. The short and long term plans on research activities are presented below.

3.1 Short Term Strategies

3.1.1 Partnerships and Collaborative Research

We plan to develop national and international partnerships and develop joint programs with other institutions and industrial bodies. This will attract the international students as well as employees at the companies to engage in our continual learning and education programs (CEP).

International partnerships between universities are beneficial to all faculty and students. Such partnerships bring fame and recognition both inside and outside of the country and improve ranking. With an increase of prestige and ranking, more research funding from sponsoring agencies and the industries flows to the university and better quality students, researchers and faculty members join the university. This sets up a cycle of prosperity for the universities involved.

3.1.2 Enhancing Existing Research Infrastructure

DAIICT encourages high quality research by Faculty members, students and PhD scholars by providing necessary infrastructure and resources.

DAIICT would like to strengthen the research activities further by suitably rewarding the faculty members and research scholars.

3.1.3 RESEARCH CLUSTERS AND SCHOOLS

Although we have a series of informal research clusters at DAIICT, if we want to make our research count, then our existing research clusters must be formalized. We also need to invest in testbeds and other kinds of research facilities. The research clusters could subsequently be developed into Schools. DAIICT's move to a multidisciplinary university could thus be envisaged through its restructuring as a **confederation of schools and centres bound to a common vision of academic excellence.** Discussion are taking place between the administration and the faculty members to form the following Schools:

1. Computer Science and Information Technology

2. Natural Sciences and Mathematics
3. Electronics and Communication Engineering
4. Humanities, Social Sciences and Design
5. Computational and Data Science

A **Centre for Interdisciplinary Studies**, would also be established by faculty committed to expanding and deepening inter-disciplinary research and teaching through collaborative projects. This Centre could help facilitate funded research projects.

3.2 Long Term Strategies

3.2.1 Research Verticals

Based on the research activities now and the research expertise of the faculty members of DAIICT, the various schools listed above would go into targeted research projects of national and international importance. These would be built around the present capabilities of DAIICT's research groups as well as by newer areas that have a direct social, economic or policy implication. It has to be remembered that these verticals depend not only on the strengths in ICT, Math, Science related areas but also in the domains of STS, Anthropology, Design, Art, Literature and Philosophy.

3.2.1.1 The School of Humanities, Social Sciences and Design

This school is planning to go into the areas: i) ICT for Development (ICT4D), ii) ICT and Public Policy Research, iii) Design for Inclusive Development.

3.2.1.2 ICT for Development (ICT4D)

The more and more the world goes 'digital' in most domains of human life including education, work, health, social life and leisure, it becomes increasingly important to understand and critically engage with these transformations from both a technical and sociological perspective. It is important to develop research projects that will not only look at broader macro-level changes but focus more specifically on the ways in which digital technologies particularly revolve around **questions of access, use and impact** lives and livelihoods of India's diverse population. The overall objective of such research would be to understand how ICTs can address

challenges of **inclusive development.** Our faculty are already engaged in research related to the applications of ICT in agriculture, rural development and environment.

3.2.1.3 Design for Inclusive Development

In the area of research verticals for our programme in **Communication Design**, we wish to develop themes laid out for our Master Degree projects. Most of our Masters Degrees projects are in the areas of **Cultural Conservation and Heritage**, **Education and Environment.** Communication Design is critical in raising awareness and sensitizing citizens to questions of survival, social cohesion, cultural identity and a sustainable environment in a rapidly changing world. Communication Design research projects could be both practice-based and theoretical in orientation.

3.2.1.4 ICT and Public Policy Research

Public policy: Research directed towards understanding the innovation and regulatory ecosystem in the IT/IT enabled sector through empirical studies of the following; data collection policy, data security policy, data privacy policy, data usage policy, public communication & awareness of privacy/security, accountability policy**.**

3.2.2 The School of Computer Science and Information Technology

The School of Computer Science and Information Technology at DAIICT is a vibrant group with several faculty members who would undertake several activities in the domain of i) ICT and Health Science.

3.2.2.1 ICT and Health Science

Importance of the information and communication technology (ICT) in a healthcare system is not hidden to the world. ICT in healthcare encompasses better coordination of ICT technologies and the various healthcare services. Various ICT technologies such as information technology (IT), electronics and communication, artificial intelligence, pervasive computing and multimedia have immense potential in improving the quality of healthcare delivery and providing

pervasive access to it at a lower cost. ICT aimed at improving or building healthcare services such as electronic medical record system, sensor and remote patient monitoring, telemedicine, and spreading wellness to the community. Currently, broadband and cellular connectivity which is the backbone of ICT is exponentially growing across India. It enables a person even seated in a rural area to access various healthcare services available distantly. Therefore, ICT can effectively and rapidly narrow down the urban-rural divide in healthcare services and bring down the cost of the healthcare system. Moreover, envisage of a national digital health mission scheme 2020 will lead to an upsurge in demand for workforce expertise in ICT in the healthcare domain. As ICT is deep-rooted in the Dhirubhai Ambani Institute of Information and Communication Technology (DA-IICT), the institute is ready to take up this opportunity and challenge to cater the upcoming demand by offering a minor programme in ICT in healthcare.

3.2.3 The School of Natural Sciences and Mathematics

This school has plans to start interdisciplinary work in the area of Quantum Computing.

3.2.3.1 Quantum Computing

Quantum computing is an emergent technology that harnesses quantum mechanical principles, that is, the physical laws of subatomic scales to power computers. Scientists believe that some properties of the quantum mechanical world such as ‘superposition’, ‘interference’ and ‘entanglement’ have no classical analogues and enhance the ability of quantum computers to do certain computational tasks. Quantum computers for instance are vastly more powerful than classical computers for factoring large composite integers. Quantum computing, which was an academic research area only a few years back, has now entered the industrial research and start-up stage.

Even though the task of building an actual scalable quantum computer is an extremely difficult one a lot of progress has been made in the last decade and many companies such as IBM, Google, Microsoft, etc. are betting big on the technology to succeed. What kinds of tasks will scalable quantum computers be good at? Currently scientists think that large data processing, simulation of atomic physics such as in quantum chemistry, secure cryptographic

protocols, machine learning, accurate weather prediction and financial modeling will be the first uses of quantum computers.

Recently in 2019 Google announced quantum supremacy which is a term used to describe a specific computational task that is performed faster by a quantum computer than the fastest supercomputers. India too, has recently announced a huge quantum computing initiative. The quantum computing field is a cutting edge interdisciplinary mixture of physics, computer science, mathematics and electrical engineering. Given the interdisciplinary nature of DA-IICT, its faculty core strengths it will make a lot of sense to invest early into quantum computing in terms of offering verticals that satisfies the needs of students and society.

3.2.4 The School of Electronics and Communication Engineering

Institute in collaboration with ISRO and SAC in Ahmedabad would enhance its current projects to grow into the following areas i) Deep Space Missions and Networks, ii) Fiber in the Sky Networks, iii) Digital Agriculture and Remote Sensing.

3.2.4.1 Deep Space Missions and Networks

Over the last few years, deep space has become a hot topic. Along with established organizations like National Aeronautics and Space Administration (NASA), European Space Agency (ESA) and Indian Space Research Organisation (ISRO), aerospace industries like Boeing, Lockheed Martin, and Northrop Grumman, there are many companies interested in space such as Virgin Galactic, SpaceX, Blue Origin, RedWorks, Made in Space, Planetary Resources and Deep Space Industries. The potential technologies that are being envisioned for the deep space communications include advanced communications technologies, along with reconfigurable (software-defined) radios, advanced antennas and beamforming methods, optical/laser based communication links, data and image compression, Delay Tolerant Networks (DTNs), etc.

3.2.4.2 Fiber in the Sky Networks

While Artificial Intelligence and Machine Learning have attracted recent attention in the industry and academia, a lesser-known technological area in the field of Information and Communication

Technology (ICT) has recently been of a considerable interest in the industry. The objective is to bring broadband connectivity anywhere and anytime to the masses – *through the skies*. The interest in the development of this technology in the industry is evidenced by recent large investments in building the High Throughput Systems (HTS) by nearly all the major industrial leaders worldwide. Tesla is developing the StarLink satellite systems with 3500 Low-Earth Orbit (LEO) satellites. Amazon's competing system is called Project Kuniper with more than 5000 LEO satellites.

The companies like Softbank, Qualcomm and Virgin Atlantic have funded the development of the OneWeb system with more than 800 LEO satellites. Google is building Project Loon and Facebook – through internet.org – is developing a multi-layered High Altitude Platform System (HAPs). The objective of these various planned initiatives is identical – to bring high throughput data links anywhere anytime by laying the "fibers in the sky". The research challenges involved include the design of multi-layered hierarchical space-based High Altitude Platforms (HAPs), the use of optical and mmWave radio links, the design and implementation of the baseband technologies inspired by the machine learning and Artificial Intelligence (AI), tracking antennas, inter-satellite links, and software-defined and self-organizing networks.

DA-IICT's vision plan includes developing a one-of-its-kind research center at its Gandhinagar campus that is integrally involved in the research and development required to bring these various futuristic systems to fruition.

3.2.4.3 Digital Agriculture and Remote Sensing

Some of the key thrust areas identified under Digital India for Ministry of Agriculture & Farmers' Welfare are incorporation of space technologies, development of mobile apps, GIS Mapping etc. Developing technologies such as Big Data Analytics, Internet of Things (IoT), Block Chain, Artificial Intelligence (AI), Robotics & Sensors, etc. are interrelated and used to optimize the decision making process in the agriculture sector. (Doubling Farmers'' Income – volume XII).

The DAIICT's vision in the agriculture sector will focus on development of information generation algorithms, data processing/mining, data analytics, and data visualization. This may be achieved by seamless integration of space technology, GIS,

artificial intelligence, robotics and sensors. The primary disciplines that will be addressed are crop, soil, weather, irrigation and pest and diseases.

The key technology areas for information generation are ground based sensors for weather, soil moisture data. Key efforts will be made for designing new sensors and data collection, processing and dissemination. Appropriate downscaling technology needs to be evolved for integration with low resolution data sets to be used in tandem.

The next source of data generation technology would be UAV or high resolution satellite data in both optical and microwave regions. Appropriate image processing algorithm should be developed for data processing, classification using AI or machine learning technology.

Besides data generation, another focus area would be data analytics. Research area will focus using both machine and deep learning technology for descriptive, predictive and prescriptive technology. Different strategies may be adopted in different application areas for example crop, soil, weather and pest and diseases.

4.0 INNOVATION AND ENTREPRENEURSHIP IN DAIICT

The Institute wishes to be a trendsetter in research and innovation in ICT and ICT education. To achieve this, DAIICT plans to prepare its students for a rapidly changing professional environment. The vision of our institute is to help build a knowledge-led society founded on intellectual competitiveness for global leadership. To build intellectual competitiveness in academic institutes, a comprehensive vision plan for Innovation is an important task.

Our vision, understanding and ideas to embed a strong innovation culture among various stakeholders of the institute are reflected in this section. It outlines our motivation to promote innovation on our campus. The view represented here is broad and holistic.

4.1 Why is Innovation important?

What is critical to our country achieving global leadership in the digital technology centric society is intellectual competitiveness and to build it in academic institutes, a comprehensive vision plan for innovation is an important task. Information & Communication Technologies have been at the centre of technological innovations witnessed in the last two decades. Advances in automation, the digitization of information, unprecedented access to data and the democratization of knowledge are transforming every sector of our economy. Deep technology fields such as Artificial Intelligence, Robotics, Block chain, Advanced Material Science, Biotech, Quantum computing - will continue to be the dominating trends in technology innovation for years to come. The scope, scale and ubiquity of these disruptions is truly unprecedented.

The digital revolution is accelerating every day and Universities must change at a faster pace as we embrace the tech-driven economy. This is especially true for technology institutes. While continuing to educate the next generation students, all the premier universities must also embrace its ever-expanding role in catalyzing economic development through driving innovations within the academic setting. Technology institutes are well positioned to meet the challenges of the digital revolution head on and play an important role in building innovation ecosystems and economies.

There are endless examples of innovation seeded at universities which went on to become some of the largest successes of our lifetime. Facebook, Reddit, Google, Snapchat and Dropbox - all were created by students while at universities. A right combination

of expertise, structure & resources are needed to breed a culture of innovation at a Technology Institute.

The vision of our institute is to follow the strategy of leading through innovation so that we can maintain a competitive edge in the current education sector. Creativity is the heart and soul of innovation; design is one of the prime catalysts of the process. To create an innovation culture in the campus, we need to inspire and navigate students to become potential '**Makers**'. Makers in turn can create Makers' movement to generate new ideas, designs and products.

Based on our experience and research, we believe that the innovation culture, mindset and ecosystem should be embedded in the academic framework so that it is addressed coherently.

4.2 Innovation at DAIICT

DAIICT, through multiple labs available across its campus, provides students with software and other hardware equipment support experimentation. The labs have become a place for students to experiment, learn and get hand-on experience on making and innovating. The labs have become an innovation hub on DAIICT's campus.

DAIICT's eminent faculty possesses expertise in a wide variety of technologies such as cryptography, IoT, cognitive computing, Wireless and Space Communication, bioinformatics, photonics and more. The faculty not only provides inspiration for innovating ideas but also provides mentoring to students interested in pursuing those ideas further.

Since its inception in 2011, DAIICT's incubation centre called DCEI (DAIICT's Centre for Entrepreneurship & Innovation) has provided breadth of support to students and faculty interested in building innovative technological solutions to solve real world problems. Incubation space, technology labs and seed funds are made available to support their journey. Moreover, the incubation centre runs multiple workshops throughout the year to provide practical training to student innovators.

The institute also provides financial support through government schemes such as SSIP & TiDE to give shape to student and faculty innovations. DCEI, in special cases, also extends these support to innovators from outside of their community.

4.3 Proposed initiatives to strengthen Aptitude for Innovation at DAIICT

DAIICT is aggressively promoting innovation culture in the campus. However, there is a potential to do much more. We started by pondering over a few fundamental questions such as:

- How to motivate students to become makers, innovators?
- How to create makers' movement within our institute?
- What changes to be incorporated in our academic structure to accelerate this shift?
- What cultural changes need to be implemented in order to achieve desired results?
- What more training & support to the Makers is required to ease their journey of innovation and commercialization?
- And lastly, how to scale up our efforts?

4.3.1. Building Innovation Culture

Our first objective is to build an innovation culture, mindset, environment & **attitude** on our campus, among our community of students & faculty. The idea is to expose students to this new way of thinking through coursework and projects; to teach them to explore the nexus of technology and other verticals to not just understand technology but also to understand their application in various fields; to teach them the importance of leadership, teamwork and collaboration.

Our belief is that the following initiatives will help us to reach there:

4.3.1.1 Lab-Space to Maker-Space

Ideating and prototyping innovative ideas requires creativity and work space that fulfills the ever changing needs of multidisciplinary teams for collaboration. Just providing space with software and equipment is no longer sufficient or relevant. To create a space where innovation can thrive, there is a need to upgrade these spaces to accommodate special needs of innovators.

One of the key changes that we propose is to align Maker Space timing with students' academic schedule to promote usage.

Moreover, it is also important to staff these spaces with experienced personnel who can provide training and guidance to innovators. To increase the success rate of innovation, welcoming collaborators from fields such as design & business would be initiated. Regularly organizing events such as hackathon, design-thinking workshops, business modelling workshops would help innovators in building cohesive skill sets to succeed. And in the process, also create a vibrant and active community of innovators on campus.

Lastly, it is of utmost importance that student innovators are explicitly mentored to understand that failure is acceptable. In order to achieve this - maker space staff, mentors & faculty should be given training to build the culture of "*tolerance for failure*" within the maker space.

4.3.2 Changes in academic structure to accommodate innovation

Innovation does not happen within a constraint time schedule. In contrast, it requires time & mind space to ignite & thrive. Keeping students overly busy with academic responsibilities generally do not help in building innovation culture on campus. Students perform best when they are inspired and encouraged to question the norm and think outside the box. But students cannot do this when they hardly have any free time on their hands. They need to have the freedom to pursue the ideas they are passionate about. We propose that students are given one to two hours of time each day for tinkering and innovating.

Moreover, it is also important to expose students to innovation & entrepreneurship through structured training in the form of course work. Making this course project-based would help students a great deal in getting practical training along with theoretical knowledge. This type of structured environment gives students an opportunity to take risks and deal with uncertainties usually associated with innovation & entrepreneurship. It is important to make this a compulsory credit course to gain serious attention from younger students. In our opinion, as students mature during their life on campus, it becomes difficult to mould them to become innovators. Therefore, it is important to start this process early in their student life. Considering this, we propose to make this coursework available for first year students on campus.

This way they get exposure to innovation and entrepreneurship early on and would have more time to pursue it during their college

life if they choose this path. We propose to implement two more key changes in academic structure to accommodate students who aspire to innovate and startup a business.

- Startup track BTech program - To accommodate students' interest in innovation & entrepreneurship, DA-IICT could consider offering an extended BTech program, called the Startup Track. The idea is to provide more time to these students so that they can comfortably complete graduation requirements as well as pursue innovation in a safe & supportive environment of DA-IICT.

  The Startup Track is not meant to be an easy route to graduation. On the contrary, it is a more difficult track where along with pursuing a startup, the student will be required to complete the required credits for graduation. Given the intensity of this track, a minimum GPA requirement of 7.0 should be put in place.

  The deliverables for the Startup Track is divided into two parts 1. Innovation and 2. Entrepreneurship.

  Innovation refers to the process of:

  1. Empathizing with the user
  2. Defining the need
  3. Ideating the solution
  4. Prototyping the technology and
  5. Testing

  Students will have a maximum of two years to achieve this objective. After the successful completion of this phase, students will be awarded a "Certificate of Innovation" to mark their achievement.

  The second part, Entrepreneurship refers to commercialization of the innovation made in the first phase. It is clearly understood that not all innovation can be commercialized. So, at this point, student & faculty mentor will have to make a decision whether to pursue this innovation further to commercialize it. If the commercialization is not feasible, students will be asked to move back to regular track and will be required to finish their remaining

academic requirements. In this scenario, students will graduate by 5th year.

If the commercialization of innovation done in the first part is clearly feasible then the student can continue on the Startup Track and can work on it for two more years. At this stage, promising startups can be incubated at DCEI and provided with support in terms of incubation space and funding. “Certificate of Entrepreneurship” will be awarded to students who successfully completed the required tasks.

It is critical to acknowledge here that the successful completion of the Startup Track is not tied to success of innovation or commercialization. But rather with the amount and quality of work put in by the student.

- Deferred Placement Service - entrepreneurship post-graduation can sit for placement for upto two years from graduation

In order to accommodate a scenario where a student is deciding to take up entrepreneurship post his/her graduation, making placement facilities available if the venture fails - could reduce risk factor and increase peace of mind for students and families. This mechanism is already available in top most technology and management institutes across the world and in India.

4.3.2 Forge Collaborations with Industry

Synergistic collaboration with leading companies and foundations could help the institute in transferring innovation from the lab to practice. While such collaborations may provide funding to talented students, the bigger advantage is establishing links to exchange ideas with the industry experts and in turn prepare students with critical skills required to survive a rapidly changing work environment.

These collaborations are highly beneficial for both the sides. Companies gain access to scientific talent and latest research and Universities gain access to industry understanding and financial support.

4.3.3 On-campus activities to build innovation momentum

Dialogues on Innovation & Entrepreneurship- should be an ongoing activity on campus. One possible step to do so is to set up an Innovation & Technology Entrepreneurship Club on campus. The club should independently run by students with an agenda to promote awareness about innovation and entrepreneurship among students.

Moreover, successful (and not so successful) innovators and entrepreneurs can be invited on campus to share their experiences and perspective on the subject. Interested students can interact with these speakers. This could potentially work as a catalyst for student inspiration.

4.4. Enabling Makers

Our second objective is to give students & faculty, who are genuinely interested in innovation, tools and training they need. A somewhat older school of thought suggests that it takes a genius to innovate. However, lately there are multiple frameworks that have been made available - such as design thinking, which can systematically guide innovators through the process. Academic institutes and Universities should put such teaching in place to increase the **aptitude** of innovation in their community.

4.4.1. Practical training through Project Work

It is important that we provide a “safe place to try” for serious innovators. Hence, we came up with a few project work ideas that can be integrated as part of academic work. Since this is academic work, students can continue to work on their innovation and simultaneously get credits for graduation requirements. Currently students, who are innovators, have to find free time over and above their academics to work on their project. If implemented, what we suggest has the potential to make students’ workload manageable and hence, more students opting in for innovation projects.

- Rural Internship at a Startup for 2nd year students
- Summer Internship Opportunity at a Startup for 3rd year students
- Startup as a BTech project for the 4th year students

As a trial, we have already tried implementing “Startup as a BTech Project” last year. Looking at the number of applications we received and how the student teams worked on their startup, it seems like a very plausible integration and can be scaled up.

4.4.2. Workshops & Boot camps

In the last decade, enough research has been done to identify the best framework and tools for managing innovation. One such framework is called design thinking - which works on the concept of user centric design and follows a five steps process of innovation - empathise, define, ideate, prototype & test. We plan to conduct workshops to teach design-thinking to our students every semester. This, we believe, would prove very useful to our student innovators to systematically manage their innovation process and reduce time & resource wastage.

If we see enough excitement from our students & faculty around innovation - we may even consider running an Accelerator program on campus.

4.4.3 Incubation Support

DCEI, the Incubation centre at DAIICT, currently supports student innovation through mentoring, providing office space and financial support. However, this support needs to be scaled up. The most important aspect that needs to be added is helping students in evaluating the commercial viability of their innovation and helping them achieve it. Periphery services such as company incorporation, patent filing etc. should also be included as part of support provided by the incubation centre.

4.5. Scaling Ecosystem Efforts

Lastly, if the initiatives mentioned above show promising results and fundamental shifts as far as innovation is concerned, then these efforts need to be scaled up to **amplify** its effects. It is expected that some initiatives will work better than the others. It would help to expand the initiatives that are working well, beyond the DAIICT community. This means creating meaningful collaborations with surrounding academic institutes with complementary disciplines such as - design, communication, architecture, & more. DAIICT is

strategically positioned to be a thought leader in the area of technology innovation & entrepreneurship. It can do so by creating meaningful resources and making it available for a larger local and national community of innovators.

The well-rounded implementation plans for “Vision for Innovation” presented in this document would depend on many critical parameters such as mobilization of fund & resource availability. However, it is our belief that to put down our “Vision for Innovation” in this document is a big step to consolidate our intentions and commitments.

5.0 OUTREACH TO SOCIETY

Our social commitment to extend ICT-enabled support to rural communities is well-established within our UG programmes. All students have to do a mandatory rural internship as part of their BTech course requirements. They are also encouraged to develop ICT solutions to various social problems as part of their BTP. Students at both the UG and PG levels are also encouraged to pursue industrial internships in order to acquire a wider understanding of the economic and business implications of ICT.

Our engagement with local colleges and institutions has been long established through academic conferences, workshops and the offering of short term courses to college faculty in the state. Our overall aim is to strengthen linkages with colleges and universities in and around Gujarat, mentor New Technical Universities in Gujarat / Western Region and introduce new ODL initiatives and contribute toward improving public perceptions of the Institute and create a vibrant research ecosystem in the state.

The Department of Industries and Mines, through the Center for Entrepreneurship Development (CED) proposed a scheme known as the Anchor Institute Program (AIP). The idea behind this scheme was to identify the best institute based in Gujarat in a given domain and define it as an Anchor Institute (AI) for that domain. DAIICT, being a premier ICT institute in the state of Gujarat with expertise in the area of Information and Communication Technology, was chosen to lead the AIP.

The AIP at DAIICT started on 1st June, 2018, under the mandate of this program, DAIICT would be responsible for training the faculty members of various engineering institutes of Gujarat, industry professionals and students. The main goal of this program was to make students and professionals of Gujarat “industry ready”. To achieve this goal, the participants in the training workshops were given hands-on training on industry standard software and hardware by DAIICT faculty members and selected industry experts. In the first year, under the AIP, DAIICT conducted 18 training programs and trained 180 faculty members from the Gujarat state. In the coming winter semester Institute will start online training for mentors', students and research scholars.

Since its inception, DAIICT is committed to impart research based teaching. Faculty members having PhD degrees from all parts of the world make it more cohesive to have a research environment prevailing in the campus. All programs including undergraduate programs have a considerable amount of research components included in the curriculum.

DAIICT has provided valuable leadership in IEEE and ACM Gujarat Section for several years and regularly sponsors and organizes technical activities throughout the State of Gujarat. Faculty are engaging in the cutting edge research and are involving students for such research.

One of the ways to connect to the research community is to be in touch with fellow researchers as well as peers in the field of interest. There are two such professional bodies of researchers which enable not only peer to peer connection but also to make the public aware of the current state of the art of research in various fields of computer and communication.

Majority of faculty are members of IEEE, ACM or both. Connectivity to such profession bodies make the faculty members aware of all current research problems of their respective domain be in computer science or communication science. Many of the faculty members are also having senior member grades, the higher grades in IEEE. This is an acknowledgement by IEEE towards the recognition for the contribution of DAIICT faculty members to the domain of research. The Institute has also subscription of a large digital resources of both IEEE and ACM. Not only faculty but students are benefited by accessing such digital resources.

Faculty members are very active in the local and global activities of both these organizations, IEEE and ACM. There are many active volunteers from DAIICT working as the executive committee members of IEEE Gujarat section and ACM Gandhinagar. Most of the time faculty of DAIICT are heading the local chapters and motivate many other volunteers to work hard to have collaborative work for the promotion of research and innovations.

In many programs of the local organization unit, faculty members from DAIICT take part as resource persons for conducting enriched technical programs. Faculty members of other institutes in Gandhinagar and in general in Gujarat, find these programs useful

to enhance their capacity as researchers in various fields of research and innovation.

5.1 Short Term Strategy

There is a significant rise in online program delivery around the world. The online delivery has become new normal in the education sector during COVID pandemic. There are a lot of opportunities for DAIICT to launch Online Distance Learning (ODL) courses and training programs for students and professionals in the global scenario.

DAIICT is primarily focussed on ICT. In the fourth industrial revolution ushering the era of communications along with artificial intelligence, machine learning, internet-of-things there is a lot of demand for online training to supplement the traditional education in universities.

5.1.1 ODL and Teaching Beyond the Campus

DAIICT wishes to fulfill this role by starting online short courses, diplomas and degrees. Collaboration with foreign universities and top industries are now being sought to implement such programs. Such online programs would also help DAIICT to generate resources to foster the overall growth in the next several years.

5.1.2 Stronger Alumni Connect for Teaching and Mentoring New Programmes

DAIICT regularly contacts alumni working abroad for developing collaborations on research and teaching (regular, short-term, FDA) and for developing MOUs. Alumni who are well established abroad would be offered adjunct faculty positions in DAIICT as per the norms. A committee would look into the selection of the alumni for adjunct faculty positions.

The goal is to reach out to alum at regular intervals and offer them teaching and research opportunities that are flexible, interdisciplinary and with strong incentives for research and innovation in curriculum development in both on-line/on campus/ blended mode. New verticals to be identified keeping in view the Global Industry and Research Trends

With a larger faculty pool DAIICT could also offer Faculty Development Programmes and Executive Development Programmes in areas of its expertise. DAIICT encourages Organization of short courses, workshops, and schools

5.2 Long Term Strategy

The Institute's goal is towards creating a robust Academic and Research Ecosystem in the state to enhance the overall educational aspirations of the state. Apart from mentoring institutes/universities in the state in the relevant disciplines to improve the quality of education we also wish to explore the possibility of creating consortium with leading universities of Gujarat to provide required academic/research support to the new institutes.

To this end we are committed to opening up our high-end computational resources to researchers of other institutes. We also offer online classes and other digital learning platforms to complement the faculty needs of the other institutes.

Artificial intelligence forms the basis of automation and decision making in the technology-driven and data-centric world of today. It includes the areas of machine learning, deep learning and complements the areas of image processing and computer vision significantly. With the monumental increase in the volume of text data, language processing tasks such as information retrieval, language translation and text to speech conversion have become indispensable.

One of the strengths of DA-IICT is that a large number of faculties are working in these areas of research. This presents an opportunity for collaborative research among research groups, internally, with other premiere institutes in Gujarat as well as across the country.

The vision of the Group for Artificial Intelligence and Language Processing (AILP) is to create a vibrant research ecosystem in the institute and in the AILP community at large by undertaking various research related activities. These activities include bi-monthly colloquia on in-house research, as well as expert talks by eminent researchers from across the world. AILP centre would also engage in offering short term courses such as seminar series, summer schools and winter schools on the broad areas of AI and LP.

A common platform in the form of AILP Group shall bring together researchers from across the institutes to nurture students' intelligence and lead the way for research and innovation. In the foreseeable future, AILP centre envisions expansion of the reach of the initiative and engagement in fruitful collaboration within and outside India.

6.0 RECRUITING AND RETAINING QUALITY FACULTY AND RESEARCHERS

6.1 Short-term strategy

The short-term strategy of the institute is to move towards a multidisciplinary University. To achieve this goal, we need to recruit

- 10-15 faculty per year with outstanding academic credentials and committed to the values of innovation, collaboration and interdisciplinary scholarship

- Post-Doctoral Fellows to conduct cutting edge research jointly with regular faculty members.

In order to enhance the research power of the institute, we need to offer a good balance between teaching and research load

6.2 Long- term strategy

For the Institute to grow we need diverse faculty in terms of specializations, experience, age, gender and national and international profiles. This will be critical for the Institute's academic networking with other institutions of higher learning and research.

DAIICT will continue to encourage and facilitate Faculty Visit/Exchange with both national and foreign universities of repute.

7.0 GROWTH IN INFRASTRUCTURE

DAIICT wants to continue its excellence in interdisciplinary & multi-disciplinary teaching and cutting edge research. The institute aspires to become a locally and globally recognized institute by i) offering undergraduate and postgraduate programmes to meet the quality human resource needs of the Industry and Research Institutes, ii) creating a vibrant campus and a collaborative learning environment that continuously adapts to the changing landscape of Information & Communication Technologies and related areas.

7.1 Short Term Strategy

The current student enrollment is around 2000 (UG -1500; PG-450; PhD-50;). We would like to increase enrollment to 2500 in the next two years. We need to attract non-traditional students through an Online Distance Learning (ODL) programme. These include students taking professional education/ advanced academic courses/ certificate program, participants in continuing education and lifelong learning. We wish to have online students' registration for ODL around 3000-4000 in next two years. We wish to cater primarily to these categories of students and provide a "Virtual Campus- Digital campus" for instruction and daily operations. We would like to have a well-designed Digital Campus in the long run. We have discussed Digital Campus in the next section.

The UG programme is fully residential however, we wish to make our campus residential for all UG & PG students in near future. This enables students and research scholars to use laboratories/ computational facilities more effectively. To fulfill this goal, we need to build additional hostels for boys and girls. In addition, we need to construct smart classrooms for on campus lecture sessions and online content delivery for ODL programmes.

7.2 Long term strategy

The Institute wishes to attract foreign students on campus by introducing new attractive UG programmes and joint research programmes with foreign institutes. We may need to build International students hostels. As we increase the number of students, we need to build a bigger auditorium for placement and to conduct the Convocation ceremony of the institute.

Plan to introduce new academic programs with

- Greater flexibility
- No hard separations
- Multidisciplinary and holistic education across science, social sciences, humanities, and arts to ensure the unity & integrity of all knowledge.
- Emphasis on conceptual understanding
- Outstanding research is a prerequisite for outstanding education and development.

DA-IICT aspire to grow in the following directions

1. Scientific collaboration with premiere institutes in India and abroad.
2. Replicating this joint program with other institute in India and abroad.
3. Introduce more undergraduate and post graduate programs which are the need of the hour.
4. Incorporating foreign nationals as adjunct faculty.
5. Institute is also planning to build up a strong relationship with related industries.
6. Institute would like to include industry as partner to a couple of academic program.
7. Including industry personnel and distinguished alumnus as professor of practice.

Long Term Strategy

- Launching more UG/PG programs on AI and ML, Data Science, Digital Informatics, NLP, Design and ICT by 2023 - 2024.
- Increase Academic and Research collaboration with premier National and International Institutes for starting new PG level joint programs by 2025. New collaborative program with industry.
- Increasing the student strength to 3000 by 2028.
- Incorporating at least 15 foreign nationals as adjunct faculty and including more industry personnel and distinguished alumnus as professor of practice by 2027.
- Increasing the infrastructure two folds to facilitate teaching, learning and research by 2030.
- To create a better brand name for the institute by entering into the top 50 of the NIRF ranking by 2024.

Increase the student strength to 3000+ by 2028

- Introducing new UG Programs from the next academic year;
- Enhancing Academic and Research collaboration with premier National and International Institutes for starting new PG level joint programs;
- Increasing the intake of UG students (PAN India);
- Increasing the intake of UG students (Foreign nationals/NRIs);
- Increasing the intake of PG students;
- Increasing the intake of PhD students;
- Introducing Online Distance Learning (ODL) as part of NEP initiatives;

Plans to accommodate on campus 3000+ students strength

- Significant enhancement of infrastructure to facilitate teaching, learning and research
- Smart Class rooms, Labs, Computing Facilities
- Significant enhancement of the Hostels to accommodate students on campus;
- Additional faculty strengths to reach the Faculty : Student Ratio 1 : 25
- Financial Outlay for Infrastructure, ICT Equipment, Additional Faculties;
- Establishing a strong research collaboration with leading industries in the field of ICT in India;
- Adding foreign nationals as adjunct faculty;
- Inclusion of more industry personnel and distinguished alumnus as Professor of Practice.

Infrastructure built since 2018

Details	Area	Cost (Amt in Crore)
Extension of Women Hostel (Capacity - 36x 2)	550 Sq.Mt	2.38
Renovation of Existing Boys hostel (462 and 18 store Rooms)	14690 Sq.Mt	5.20
New Boys Hostel (Capacity G+3 Flrs) GF: Triple sharing: 28 rooms Double Sharing – 16 Rooms All three floors: Triple Sharing: 28 and Double sharing – 18 (On each floor)	8475 Sq.Mt	20.69
Lab extension	804 Sq.Mt.	3.45
Fire Fighting system for the Campus	Entire Campus	1.04
Modification of existing Club House for placement activities	870 Sq.Mt.	0.80
	Total	**33.56**

Action Plans to build additional Infrastructure

Sr. No.	Indicators	Year				
		2021-22	**2022-23**	**2023-24**	**2024-25**	**2025-26**
1.	Infrastructure (Rs. Crores) Proposed additional investment					
	a) Academic Buildings i) New Academic/Faculty Block Built-up area 1350 Sq.Mt. (G+2 Floors) ii) Academic Administration Building Extension Built-up area: 120 sq. Meters (G+1)					
	b) New Hostel building (G+3) for Boys					
	c) Extension of one floor in new hostel Built-up area: 2118.98 sq. meter					
	d) Upgradation of ICT and existing laboratories					
	e) Setting up of new laboratories					
	f) New Classrooms capacity: g) 280 students = 3 class rooms h) 120 students = 7 class rooms Provision: G+3 Phase 1 : G+1					
	i) Extension of RC (Library) Reading Hall Built-up area: 600 Sq. Mt (G+1)					
	Total Investment (Amount in Crores)		**30.00**	**50.00**	**50.00**	**60.00**

Indicators		Year				
2.	Academics	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**
	a) UG (Four years) i. B.Tech – (ICT + ICT Honours with minor in Computational Science) ii. B.Tech in Mathematics and Computing (MnC) **iii. New Program** a. B.Tech in Computer Science with specialization in data Science (CS-DS) or equivalent	 350 50	 460 60	 460 60 120	 460 60 120	 460x4 =1840 60x4 = 240 120x3 = 360
	b) PG (Two Years) i) MSc (IT) ii) MSc (DS) iii) M.Tech iv) MDes v) PhD vi) **New Programs for Academic Year 2022-23** MSc (Agri Analytics)	 120 60 110 20 20	 150 60 150 20 40 30	 150 60 150 20 40 30	 150 60 150 20 40 30	 150x2 = 300 60x2 = 120 150x2 = 300 20x2x = 40 40x5 = 200 30x2 = 60
					Total	**3460**
3.	Scholarship & Financial Aid a) Number b) Rs. c) % of fees	 280 3,23,87,040 10%	 305 3,81,35,370 10%	 340 4,67,62,580 10%	 380 5,74,21,800 10%	
4.	Research Funding from External Agencies (Amount in Lakh)	780.00	858.00	987.00	1165.00	1300.00
5.	**Thrust Areas of R&D**	Artificial Intelligence; Computer Vision, Machine Learning; Cyber Security; Embedded Systems and Robotics; Data Sciences; Wireless Communication including 5G-IOT				

6.	Research Plan and Outcomes	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**
	a) Ph.D. to be Awarded	7	14	18	23	30
	b) Post –Doctoral Fellowship granted (nos.) (Amount Rs. in lakh)	34.00	51.00	58.00	87.00	100.00
	c) Patents / IP (nos.)					
	d) Consultancy (Amount in Lakh)	68.90	75.65	128.00	140.00	
	e) Books to be Published (Target)	--	03	04	06	08
	f) Technology Transfers g) Publication in high ranked journals/ Book Chapters h) Dissemination plans (National and International conferences, workshops and seminars)	130 National: 3	145 National: 4 Int'nal: 2	170 National:5 Int'nal: 3	210 National: 5 Int'nal: 4	National:7 Int'nal: 4
7.	Diversity (nos.) a) International Students b) Out of State Students.	 30 195	 45 240	 70 380	 110 540	
8.	Inclusivity	The Institute will continue to strengthen its practices and policies in providing equal opportunities and resources for people who are otherwise excluded or marginalized, such as students belonging to minority communities, economically and socially disadvantaged and physically challenged. This would be in the form of reservation of seats, relaxed admission criteria, tuition fee waiver in the form of post-matric scholarships and merit-cum-means scholarships and guidance and support in mobilizing financial support/scholarships from industry/public trusts and tuition free remedial/tutorial classes for those deficient students.				

8.0 CREATE A 21ST CENTURY RESOURCE CENTRE

8.1 Short-term strategy

To consolidate some of the key initiatives undertaken in recent years. The Resource Centre (RC) at DAIICT has played a pivotal role in providing critical information services to its users. Over the last few years, the RC has consciously embraced digital technology to enhance and extend its reach. It also facilitates knowledge archiving and sharing with the external institutions and individuals. This is to accelerate our vision to become one of the most digitally advanced information centres in India.

8.2 Long-term strategy

RC will extend its digital reach for the 3 key areas:

8.2.1 Strengthening Research Support and Research Ethics

RC has moved to electronic journals, books and databases to ensure location-agnostic access. This has helped online delivery of information quickly and efficiently. The various research projects have digital access to a variety of information tools in a safe and secure way. RC also collaborates with other institutions for mutually beneficial information sharing arrangements. The RC will also play a key role in sensitizing students towards research ethics and academic offences such as plagiarism by preparing instructional materials, organizing workshops and inviting diverse faculty members for expert guidance.

8.2.2 Knowledge Sharing

There is a significant amount of new knowledge creation from the faculty and the students. RC has digitized all the theses, dissertations and project reports for ease of access. This digitization has moved the RC into the next era of knowledge sharing where the information is disseminated with the wider user community.

RC organizes awareness and training sessions from time to time, inviting external experts on various information tools and services. This intervention not only improves the resources usage but also enhances research quality and academic performance.

8.2.3 Institutional Repository

RC has started to develop an institutional digital repository of its internally generated research information. These repository contents are shared with the National Digital Library of India as well as with INFLIBNET for its national project ‘shodhganga’. This is meant to reinforces our commitment to reach out to other institutions.The digital format provides a seamless access to research information to these external users.

9.0 DIGITAL CAMPUS

This is an important element of the overall infrastructure. It should not be limited to creating ICT enabled classrooms. We need to modernize internal systems and procedures.

The students of the current generation are “digital natives” brought up in the world of smartphones, high speed Wi-Fi and “technology on demand”. Students are increasingly dependent on both the traditional physical space - the Campus and non-traditional elements – digital environments, like digital library, e-learning and e-commerce.

To stay relevant to the student community and deliver quality educational experiences, it’s essential that Higher Education University/ Institutes (HEIs) that are respected across the globe, maintain their reputations and join in its journey of digital transformation. Today, it is crucial for any HEI to have a mobile, digital and social media presence, if the University/ Institute wishes to maintain its position in ranking and appeal to incoming students.

9.1 What is a Digital Campus?

Digital libraries, Electronic Learning and *Electronic Commerce* are three significant, distinct disciplines that grow increasingly important in higher education today. *The Digital Library* movement addresses how university and other library systems catalog and manage the vast content that they house using the high technology tools that have emerged in the last decade. *Electronic learning* (*e-learning*) focuses on how these technologies can be harnessed to create new and different learning pedagogies, and bring out comparable or better learning outcomes for the same or lesser cost. *Electronic Commerce* (*e-commerce*) addresses the “business side” of a campus, including such things as financial aid, payment of tuition and other fees, among others.

Historically, campus was considered as a physical space. However, in the modern education scenario, the campus can have different connotations. One use that applies in this case is a common space in which different groups of participants having different activities (different set of problems) work on different functional work spaces (entities – a set of platforms) for higher learning.

Digital campus is an integrated bundle of services, capabilities, and practices that enable the various stakeholders of a university to

electronically and seamlessly conduct transactions, acquire and provide content, and communicate with each other.

In today's environment, a working definition of a "Digital Campus" is one that provides a common set of platforms (infrastructure) that enable different users to seamlessly, electronically move from one functional area of the campus to another.

9.2 Why do we need a Digital campus?

Today's students being "digital natives" are increasingly dependent on both the physical and digital environment of the campus in which they study. Technology and on-line access to personalized digital tools to support their learning and teaching is a standard expectation of the student community from the university/institute.

There is no doubt that a student has to make a considerable financial investment to complete a university education. Students are very aware of long-term commitment they are making when choosing to go to a university. Consequently, they are discerning and have high expectations of what they expect their university experience to be and technological expectations are high on their list of requirements.

Students, more than other user groups, regularly rely on the different functional organization on a campus. For students, it is important to have the ability to traverse functional areas electronically without the need for multiple log-on.

As the world becomes increasingly digital & mobile and the growing dependence of students on both the physical and the digital environment, the Digital Campus is expected to provide end-to-end digital experience for all the stakeholders of the university/ institute.

Another area of growing importance is the non-traditional students. These include students taking professional education, programs, participants in continuing education and lifelong learning programs, and the tele-commuting student. Some of the newer and more aggressive universities cater primarily to these types of students, and have made the digital, and sometimes "virtual", campus their model for instruction and operations.

For universities / institutes to rise to their challenge, and ensure they satisfy this demand, it is essential that they embrace technology to digitally adopt campus experience that is worthy of their students'

investment. Hence, HEIs have started adopting technologies and strategies to become digital campuses and improve the student's user experience of and access to online systems and learning environments. This will be a necessity if these HEIs want to remain competitive and relevant in the modern education system.

9.3 Goals of a Digital Campus

Following are the goals of any digital campus

1. Digital will be at the core of all the things that a university/ institute undertakes;
2. To ensure that appropriate use of technology enhances our learning and teaching;
3. Digital will remove barriers to effective research by streamlining research support processes, enabling easy collaboration and support innovative research;
4. To improve the efficiency in the management and administrative activities;
5. To facilitate new ways of delivery and to expand the current offerings into new competitive education sector;
6. Provide rapid provision of appropriate technology tools;

9.4 How to build a Digital Campus?

In order to develop a digital campus, we need to address how to (i) assimilate, develop, manage, and deliver new types of content using new educational methodologies and curricula, (ii) integrate the various academic, library and administrative functions of the campus, (iii) archive and transfer institutional knowledge assets within the campus, and (iv) customize the delivery services to students' communities.

The digital campus ecosystem (getting in and around the digital campus) must be always active and the content found on the digital campus must stay "fresh" to be of value to the user community. In order to make the digital campus vibrant, we need to address three critical areas- (i) how to design a portal which serves as the point of entry to the digital campus by the user, regardless of what user community is form, (ii) how to setup a robust intra-campus connectivity, and (iii) how to design an agile retrieval of content and transactions system.

It’s important to remember during the digital transformation phase, the students who are “Digital natives” have high technological expectations. Hence, the key decision in rolling out a digital campus will be what types of devices/ clients will be supported initially and what will be serviced later. We need to plan more than a PC client environment keeping in view the student’s requirement. To support more clients/ wireless devices, the presentation layer will require multiple servers that are tuned to manage how the content retrieved can be most effectively displayed on the client device of choice. Creating a wireless campus environment also requires extensive analysis and planning, even if it is done in conjunction with one of the major service providers.

The Digital Campus design includes ubiquitous access via different types of devices, hence pan-campus security issues get more complex. A secure system for a browser based desktop environment may not be adequate for newly added environments, such as wireless device access, Similarly, the security requirements for a specific user have to be defined for the context in which they are accessing the digital campus. For example, a student’s profile will likely change each semester or academic year, based on the student's coursework and his / her activities at the campus.

Protection of intellectual property, as opposed to confidential data, poses some added challenges in setting up of a Digital Campus in a University. Funded academic projects are focused on delivery and collaborations not on digitizing the content. Protecting the content developed adds a dimension that injects at a minimum new practices, and possibly new people into the academic workflow. Overtime, the “Digital Rights Management” (DRM)- a meta tagging technique that can further control access and use of information within the Digital Campus environment, will become a normal component of developing new intellectual content which is not common in the current ecosystem.

9.5 Short term strategy

Digital campus as discussed above is based on the basic premise that “Digital is Personal” and “Digital safety and Data Security are assured”. The first proactive step an institute needs to take before designing a Digital Campus is to create an awareness among all staff members and to empower the student community by doing the following:

1. Introduce Hardship scheme to ensure all students have suitable technology to support their studies;
2. Encourage all staff members to use a mobile as their primary device e.g. Laptop, phone, tablet for official transactions;
3. Enhance the Digital literacy rates across the staff members and student community through training and uptake of the digital literacy online skills course;
4. Impart complete data protection training to all staff members and Postgraduate research scholars on appointment and annually thereafter;
5. Create a secured data archival and retrieval system to remove data breaches;

9.6 Long Term Strategy

The Digital Campus design includes ubiquitous access via different types of devices, hence pan-campus security issues get more complex. A secure system for a browser based desktop environment may not be adequate for newly added environments, such as wireless device access, Similarly, the security requirements for a specific user have to be defined for the context in which they are accessing the digital campus. For example, a student's profile will likely change each semester or academic year, based on the student's coursework and his/her activities at the campus.

Protection of intellectual property, as opposed to confidential data, poses some added challenges in setting up of a Digital Campus in a University. Funded academic projects are focused on delivery and collaborations not on digitizing the content. Protecting the content developed adds a dimension that injects at a minimum new practices, and possibly new people into the academic workflow. Overtime, the "Digital Rights Management" (DRM)- a meta tagging technique that can further control access and use of information within the Digital Campus environment, will become a normal component of developing new intellectual content which is not common in the current ecosystem.

We need to design a robust Digital Campus which will be i) secured, ii) expandable, and iii) will protect intellectual property rights for the academic and sponsored projects. This will call for deliberations among different stakeholders and work out a comprehensive user specifications before being implemented in the campus. The institute is committed to set up a Digital Campus.

10.0 CHANGES IN GOVERNANCE

DAIICT was started in early 2000 to foster interdisciplinary teaching and research. Thus, it was a university without the standard department structure so that faculty and students from all disciplines, computer science, electrical and electronics engineering, mathematics, physics, design, humanities, etc. can exchange their ideas and work jointly to foster the studies of the emerging discipline of information and communication technology.

However, the Institute has grown in the last twenty years. The size of the faculty has almost tripled and the number of students has doubled. The number of research and innovation activities has increased. Thus there is a need for restructuring the administrative structure so that teaching, research, innovation, outreach, faculty and staff welfare and student issues can be made more efficient and effective.

10.1 Short term strategy

Institute's goal is to expand both disciplinary and interdisciplinary specializations. This would however demand a restructuring of the organization of our faculty pool. Instead of the present flat structure which has served the Institute well over two decades, we would organize faculty already grouped in certain disciplinary or interdisciplinary research clusters into Centres or Schools. Each school would organize its teaching, research and outreach activities following the overall strategic plan of the Institute. Each school would have its own administrative and research staff members such as post-doctoral fellows and project research assistants.

This new structure will give our Institute more visibility and also help attract both quality faculty and students. DAIICT needs to follow a governance in accordance with internationally established best practices.

10.2 Long term Strategy

It is envisioned that in another 5-10 years the manpower of DAIICT would triple in size compared to what it is today. Then DAIICT would adopt the administrative structure of the IITs and other top research intensive universities of the world. There would be an office for faculty affairs to deal with a myriad of issues with faculty recruitment, benefits, promotion, faculty leave and other issues. There would

also be an office for planning and resource generation. This office would also maintain an attachment with the thousands of alumni scattered all over the world.

11.0 CAMPUS VIBRANCY AND STUDENTS' WELFARE

Academics are the most crucial part of an institute, but it is more than just academics. It is also about what students do outside the classroom—the things they do, the people they meet and the memories they make in the process. The DA-IICT campus has always served as the hub of multiple cultural/ technical activities, including several annual events that act as cornerstones of a vibrant campus community. With more than 25 different clubs and committees working together for the betterment of the students, the campus never sleeps.

Even in the pandemic, the Student Body has been actively trying to engage students in various activities by switching to virtual platforms and creating comprehensive digital infrastructure to connect with the students.

Starting with the IEEE student branch and technical clubs like the programming club, the Microsoft students club, the electronic hobby club and the developers' student club are aimed at providing the students with a space to meet people who are tech-enthusiasts. They come together to work on various projects and participate in events such as Hackathons and competitive coding.

Students have the Cultural committee and the cultural clubs – the DA-IICT theatre group, the dance club, the music club and the Khelaiya club. These clubs dedicate themselves to keeping the cultural aspect of the campus alive. They organise and take part in various intra and inter-college tournaments, proving time and again the will to work to win. The Sports committee and the chess club work together to define the sporting culture in DA-IICT. The teams of ten different sports are allowed to participate and win various inter-college competitions. They also coordinate various intra-college events for the non-team players.

Clubs like the cubing club, the quizzing club, the debate club, the research club and the business club allow students to come together and discuss ideas and expand their knowledge. On the other hand, the radio club and the photography club let students practice and perfect their skills. We also believe in working for the betterment of the society, which is where Sambhav comes in the picture.

The students also manage the annual fests – the annual cultural fest (Synapse), the annual sports fest (Concours) is organized by the sports committee and the i-fest organize the annual technical fest

(i.Fest). i-Fest committee that works closely with the IEEE student branch of DA-IICT. These fests allow students to get hands-on experience in working with professionals and help them learn from various other national universities.

While the initial idea behind the vast number of activities happening on campus was to get like-minded people together, it has now become a space for the students to grow and realise their best potential. As the technological domain moves from an isolated field to a rather all-embracing arena, these events give students a chance to explore various areas and serve as the core of student involvement. These activities, in both online and offline mode, are targeted at helping students by creating a collaborative environment among different interest groups, thus providing them with a diverse pool of experiences to learn. Many technical events are oriented toward helping students gain industry-level skills.

Such an outstanding level of participation can only be achieved if the needs of the students catered by the institute. Continuous efforts are made to ensure that students get the best possible treatment in every situation. With student counsellors and on-campus doctors, student safety and counselling are given utmost importance at DA-IICT.

The DA-IICT campus has always been more than a place where top-notch education is delivered. It is a place where students learn to transform their skills and abilities into social assets, making them complete citizens alongside their academic accomplishments. They get an opportunity to discover their potential through challenges while getting support from the enriching and healthy relationships they make in the process.

Appendix 1

A.1 Deep Space Networks

All deep-space missions—defined as those operating at or beyond the orbit of the Earth's Moon—require some form of telecommunications network with a ground system to transmit to and receive data from the spacecraft. The Deep Space Network or DSN is one of the largest and most sophisticated of such networks; it is a network of deep space satellites and ground facilities to support the communication with them. The ground segment of NASA's DSN has three antenna farms spaced approximately 120 degrees apart in longitude (at United States (California), Spain (Madrid), and Australia (Canberra)). India's DSN, operated by ISRO, has the main hub located near Bangalore, and it tracks and supports India's lunar mission (Chandrayaan-1) and Mars Orbiter Mission (Mangalayaan). Similar DSNs are also operated by Europe, Japan, Russia, etc.

NASA missions in low Earth orbit communicate through either the Near Earth Network (NEN) or the SN (Space Network), both operated by the NASA Goddard Space Flight Center (GSFC). The SN has of a number of Tracking and Data Relay Satellites (TDRS) in geosynchronous orbits. In addition, the European Space Agency operates a number of ground stations that may be used to track NASA deep space missions during the hours after launch. In addition, commercial companies operate ground stations that can communicate with NASA missions.

Deep Space Communications: Overview and Technological Challenges

There are primarily two elements that comprise deep space communications: transmitting and receiving signals first in space and then through the ionosphere and troposphere that surround Earth. Space is a vacuum, so signals within it are not reduced in strength and once transmitted, will theoretically continue to propagate to whomever (or whatever) might be listening. Unlike communication in space, communicating between deep space and Earth is far more difficult, as Earth is surrounded by an atmosphere that consists of five layers, each with different characteristics, but all forming an impediment to radio and optical communications. The atmospheric layers absorb and scatter signals within them, reducing

signal strength and limiting the specific portions of the electromagnetic spectrum that can be used for communication. Below 30 MHz, the ionosphere layer of the atmosphere absorbs and reflects signals, and above 30 GHz the lower atmosphere or troposphere absorbs them. As a result, the region between (roughly) 30 MHz and 30 GHz is chosen for communications from deep space to Earth. Having passed through the atmosphere, these signals are invariably reduced in strength and so weak that they can only be received by huge parabolic antennas that generate very high levels of gain, along with receivers with exceptionally low system noise levels. To increase sensitivity even further, these antennas can be combined to produce a single huge aperture that increases the likelihood of reception. Without them, communications form deep space would be impossible.

Design Requirement	***Technological* Challenge**
Long distance communication links (e.g., the two Voyager spacecraft are about 100 AUs away, where one astronomical unit AU equals the distance between the sun and the earth).	Spreading loss, which increases in proportion to the square of the distance between the transmitter and the receiver, is very large at multiple AUs of the distance. This results in a severe attenuation of the transmitted signal when it reaches the receiver.
Highly reliable communication link (since	Non-feasibility of reliable data transfer protocols such as ARQ (automatic repeat request) due to long delays involved
A long system life span (planetary missions have desired life spans in multiple tens of years)	Design of low-weight, low-power, space/radiation-hardened components that have a low MTTF (mean time to failure)
Low mass communication payload	The weight should ideally not exceed a few kilograms
Low power communications	Required power should ideally not exceed the power required to illuminate a refrigerator bulb

NASA's Mars Reconnaissance Orbiter (MRO), which is an example deep space communication satellite, has so far sent back to the Earth several hundreds of terabytes of data, e.g., in the form of HiRISE images. This requirement (e.g., as measured in the required throughput in Mbps) of deep space communications is projected to increase by a factor of ten in each of the next three decades.

For example, at a peak rate of 5.2 Mbps, the MRO requires more than 7 hours to send the entire data collected by its onboard receiver, and more than one hour to send one HiRISE image. More advanced method of hyperspectral imagery requires even a greater amount of data transmission. At the current capacity of the deep space channels, the time needed to transfer the hyperspectral image can exceed the reasonable limits, thus necessitating advanced methods to support the high data rates.

Following are some of the design challenges and potential technologies that are being envisioned for the deep space communications.

Following is a summary of potential technologies that are being envisioned for deep space communications, and associated challenges in the implementation of these technologies in deep space missions.

Potential Technology	***Associated Challenges***
Advanced communications technologies, along with reconfigurable (software-defined) radios, that have high spectral and energy efficiencies. These include advanced modulation schemes (Serially-concatenated Convolutionally-coded Pulse Position Modulation (SCPPM)) and advanced channel encoding schemes (LDPC and Turbo codes)	A challenge is to fit these techniques given the constraint on the payload and the available power/bandwidth.

Advanced antennas and beamforming methods	A challenge is to ensure a precise resolution of spacecraft angular tracking. Due to the large distances, a small angular error can translate to a significant loss in the Directivity of the antenna beam
Optical/laser based communication systems	● Lack of a mature technology with long life span, ● Presence of additive optical background noise during the daytime, and costly methods of its compensation (e.g., atmospheric correction techniques operating at ground receivers of DSN that require antennas with 8 to 12-meter aperture), ● Need of site diversity due to weather, clouds and atmospheric variability, etc.
Data and image compression	The conventional compressing techniques are often computationally too complex to be implemented on the deep space spacecraft.
Delay/disruption Tolerant Networks or DTNs (to withstand delays on the order of several hours to days)	Adoption of DTN techniques (e.g., store-and-forward, etc. within the network to compensate for intermittent link connectivity and delay) to the space networks with large delay variations

A.2. Fiber in the Sky Systems

- **Multi-layered HAPS architecture:** The GEO satellites are designed to provide connectivity over specific geographic areas and their coverage is wide but static. The GEO satellite orbital locations are governed by the International Telecommunication Union or ITU, with a typical separation. While the GEO systems

are well suited to meet the objective of concentrating the capacity over a fixed footprint on the earth, the LEO/MEO systems are better in meeting an alternate objective of providing a global coverage including at the poles. There are many system-level advantages offered by the the LEO/MEO systems compared to the GEO systems. One, the LEO satellites, because of their proximity to the Earth's surface, offer lower transmission delays than the GEOs. Two, unlike the GEO systems that require very high power Tubes as the power amplifiers to overcome the path loss, it is possible to deploy solid-state power amplifiers in LEO systems. This allows the LEO satellites to have smaller Size, Weight and Power (SWaP). Three, for the LEO systems, unlike the Medium Earth Orbit (MEO) and the GEO systems, the use of space-tolerant components rather than space-hardened components is feasible. The LEO systems come with the following design challenges that are not present in the GEO systems. One, due to their proximity to the earth, the LEOs have a smaller coverage area and multiple LEO satellites are needed to provide equivalent coverage to GEOs. Two, each ground terminal requires a tracking antenna to maintain directivity to a specific LEO satellite while under the satellite's coverage area. Three, multiple gateways are needed to support connectivity and the required number of these gateways depends on the availability of the Inter Satellite Links or ISLs. Four, the gateway and the user terminal coverage areas are typically non-congruent, and a given gateway provides feeder link connectivity to multiple satellites. Due to such merits and drawbacks of each type of system, there is no one answer that fits the diverse set of communication link QoS (Quality of Service) requirements. The futuristic multi-layered system architectures include not only the GEO, MEO and the LEO but also the platforms that operate at altitudes lower compared to the LEOs. The Unmanned Aerial Vehicles and the Balloons can provide lower latency and reduced power requirements, although their coverage area becomes geographically more localized. Such multi-layered hierarchical HAP-based communication systems are envisioned to be adaptive such that they offer targeted services depending on the geographic requirements (e.g., the GEOs can offer services to the sparsely-populated areas such as the oceans, the mountains and the deserts, whereas the LEOs and the UAVs can target regions with higher population densities).

- **Optical and mmWave Communication:** The links connecting the satellites or the HAPs to the gateway on the ground may use the high frequency Ka, V or Q bands, or they may utilize the optical links. The Intersatellite links (ISLs), when present, may use RF or laser links. The spot-beams from the HAPs to the ground become narrow and localized at these higher frequencies and they allow a denser placement of the co-channel (frequency-reuse) cells. When combined with spectrally efficient coding and modulation techniques, there is a potential for at least an order of magnitude increase in aggregate capacity. DA-IICT has expertise in the research and development on the high-frequency mmWave and optical wireless communication.

- **Baseband Technologies Inspired by Machine Learning and AI:** An HTS terminal employs waveforms comprising the latest signal processing advances and the state-of-the-art in the coding, modulation, and multi-access techniques. The use of carrier-on-carrier (or paired carrier multiple access) allows an overlay of the forward and the return links on the same spectral band. The use of adaptive coding and modulation (ACM) and Uplink Power Control (ULPC) provides a real-time adaptation of the throughput to the dynamic link status. A high Peak to Average Power Ratio (PAPR) of the feederlink signals from the gateway to the HAPs results in a loss of system capacity, since the on-board High Power Amplifier (HPA) cannot be operated close to its maximum output power (i.e., saturation) limit. The use of advanced techniques such as Single-Carrier FDMA (SC-FDMA), transmitter-side pre-distortion, and iterative detection techniques at the receiver that employ a model of the amplifier nonlinearity can compensate for the nonlinearity-induced signal distortion. Additional advanced technologies such as Ground Based Beamformer (GBBF) and Polarization diversity bring further increases in the spectral and energy efficiencies of the physical and the medium access control (MAC) layers of the wireless links.

- **Tracking Antennas:** LEO and MEO satellites and the UAVs and the Balloons, because of their relative movement with respect to a specific geographic location, require tracking antennas for user terminals. DA-IICT has expertise in the research and development on the RF antenna engineering and we plan to bring this expertise to the fore as this steerable beamforming antenna technology gains worldwide attention.

- **Software-Defined and Self-Organizing Networks (SDN and SON):** The relative motion between the ground terminals and a high number of fast-moving aerial “base stations” in the sky require a detailed and innovative design and implementation of the software networking principles including the mobility management and handover techniques. A unifying packet networking architecture provides an overall framework for transporting converged user traffic across various source and destination points covering a large geographical area. Associated dynamic addressing, routing, and traffic engineering techniques require an IP core network that resembles that of a 5G network, with provision for the subscription server (equivalent to the Home Subscription Server [HSS]); Management Server (equivalent to the Mobility Management Entity [MME]); and Security Server (equivalent to the Authentication Center (AuC))

- **Intersatellite Links and On-board Switching:** On-board switching can improve dynamic utilization of aggregate capacity. Intersatellite links (ISLs) are also needed to keep the number of gateways for the LEO and MEO systems (and the associated overall system costs) manageable. The ISLs can be added within a LEO plane or across the hierarchical layers of the HAPS network. As traffic can be exchanged across areas by employing ISLs, it is no longer necessary to provide a gateway terminal corresponding to each LEO/MEO or UAV coverage area. Employing ISLs also facilitates direct communication between the subscribers. The ISLs provide additional flexibility in backhauling traffic over MEO as well as LEO satellites.