

SMART CAMPUS INITIATIVES AND IMPLEMENTATION IN CUTN

“It is not the strongest species that survive, nor the most intelligent, but the ones most responsive to change” Charles Darwin

The mission of the Smart Campus initiative is bringing sustainable, eco-friendly and energy efficient development. Smart Campus, we mean a campus that is an efficient, safe, sustainable, responsive and enjoyable place to live and work, underpinned and enhanced by digital / internet based technologies. In addition to the obvious benefits of a more efficient, connected and responsive campus, such a campus would also enhance and reinforce the University's reputation as a progressive academic institution, something strongly supported by our Vice Chancellor.

Emergence of Smart Campus will result in several benefits. It will provide complete control over resource utilization; ask for reforms and integration among various academic and administrative operations, bring discipline in delivery of services, create a positive culture of collaborative research and innovation.

Smart Campus provides a centralized framework that links systems and makes it easy to identify limitations, problems and opportunities to do things better. It tracks students' experiences and monitors campus efficiency to enhance learning and improve university operations. With the development of new information technologies such as cloud computing, Internet of things, mobile Internet, big data, knowledge management and social network applications, etc. the university information is about to enter a new stage. Smart campus through information technology to the university physical environment as well as digital virtual space linked to the wisdom of teachers and students work characteristics and needs, provide them with a more intelligent and open education and teaching, more humane learning environment, comfortable and convenient life service. It is now clear that, as a result of this ubiquitous information environment and the sheer volume of their interaction with it, today's students think and process information fundamentally different from their predecessors. Technological innovation and student demand for new ways of learning are dramatically changing the nature of education. So, the education system will change more in the next five years than it has since ever.

Smart campus design philosophy is that through the application of the first generation of information technology with more sophisticated and dynamic approach administrators, teachers and students make various management. In smart campus, through embedded sensors loaded to the campus building, water supply systems, power supply systems and equipment between the various objects one can achieve the integration between campus life

and physical systems. Along with these the Internet of things and the Internet connection, management systems, learning systems and office systems into the "campus cloud", one can achieve real-time capture of largescale data. The in-depth analysis of such big data provide a more effective basis for decision-making and ultimately achieve the purpose of service information construction.

Smart campus is a further improvement and perfection of the digital campus. It utilizes new information technology to perceive the physical environment of the campus so as to realize the work, learning and personal characteristics of teachers and students. The digital space and physical space of the departments and centres are connected with each other to create a convenient and comfortable educational environment and living environment for teachers and students to realize the interaction between teachers and students, department environment and resources to realize humanized innovation service.

Despite such irrefutable benefits however, the reality of developing a Smart Campus is a highly complex and challenging undertaking. The term 'Smart Campus' itself, can have a wide range of meanings for different University stakeholders e.g. Estates, Establishment, Administration, Security, Sustainability, Planning and Strategy, not to mention the staff and students. Understandably the motivations and goals are, in pursuing a Smart Campus, also vary enormously e.g. identifying student / pedestrian movement as the basis for locating key services; identifying campus bus use as the basis for more efficient demand-driven provision, and/or monitoring building occupancy to reduce potential energy consumption. When one formulate a smart campus ask for the following: Are there enough lecture theatres, meeting rooms, parking spaces and food outlets to support the future growth of the University? Will the WiFi bandwidth, air conditioning and transport options be adequate a decade from now? Are the right services in the right places, at the right times? While certain technologies that optimise operations and benefit staff, students and visitors to the campus are already in place, online booking of meeting rooms and swipe cards that simplify building access and security - all of these systems to be implemented.

The potential for and interest in developing the Central University of Tamil Nadu as a Smart Campus is considerable and growing. Understanding our campus operations and building utilization has become a major factor in CUTN's smart campus initiative. This said, before we can address the complexity of challenges that developing a Smart Campus poses, it is crucial that we first formalize what the key issues are, and for who; what we need to do as opposed to what we can do (i.e. have the technology and data to do); and identify what has already been done. Indeed, there are already a number of ventures currently in place on campus, addressing key issues relating to transport, energy, water supply, learning provision and environmental management. As indicated above, there has already been a variety of work undertaken at CUTN to support the development of a Smart Campus, either directly or

indirectly. For example, the impact that 'timetabling' upon a range of other services, e.g. bus provision and overall staff / student experience.

In order to make Higher Educational Institutions such as CUTN as smart campus, we should focus on cleanliness as well as waste management. Save water, save electricity, promote cleanliness and manage waste to become smart campus. Parameters for a clean campus were formulated, like student/toilet ratio, kitchen hygiene, availability of running water, modernity of toilet & kitchen equipment, campus green cover, garbage disposal in hostels and academic/residence buildings, disposal techniques, water supply systems. It is key to have innovative power management in smart campuses, integrating local renewable energy sources, battery banks and controllable loads and supporting Demand Response interactions with the electricity grid operators. Buildings "smart" by integrating innovative Information and Communication Technologies (ICT) in domestic applications is envisioned as a pivotal requirement for a widespread diffusion of local Renewable Energy Sources, such as solar panels, solar steam generator, solar water heater, solar powered AC etc. In turn, the massive adoption of "green" energy sources and their integration in a Smart Grid ecosystem can foster the reduction of carbon emissions and increase efficiency in energy usage. We have committed to have a green campus and hence followed GRIKA norms when we constructed buildings. The application of the concept of Nearly Zero Energy Building plays a fundamental role in the achievement of environmental sustainability objectives.

The traditional system of energy consumptions includes huge amount of energy wastage as well as huge cost. Several proposals for Energy Management Systems for smart buildings and microgrids have recently been discussed and the implementation details of some demonstrative deployments have been described. However, the peculiarities of an academic campus environment require methodological solutions capable of flexibly adapting to different typologies of buildings, according to their specific use (e.g., teaching rooms, laboratories, offices and dormitories), to the presence of controllable loads (e.g., water pumps, sewage treatment plant, Ventilating and Air Conditioning plants).

Automation has become a necessity over the years. Now we are living in an era where it is important to keep on improving the automation techniques in order to reduce the threats to security. Automation is properly defined as the technique to improve the work performance without a manual support. Energy conservation has started to become a mandatory feature of every automation product. Room automation are designed to maintain the smart automation of the rooms using IoT alongside controlling the energy consumption to reduce the amount of energy consumed compared to the traditional Rooms.

Focusing on the "Smart Office" scenario, one should design different algorithms for the control of solar shadings, electric lighting and AC equipment. For that, the building to be

extensively monitored through sensor networks and also the weather statistics to be recorded. We can collect data using a variety of sensors to gather information on building trends, study patterns, and course attendance that can ultimately be used to improve student experience and enhance learning. Ultimately, these data insights allow CUTN to generate contextual information about the lifecycle of the student, the day to day reality of a staff member, the activity pattern of a lecture theater, and the dynamics and environmental health of a library.

Concepts to be implemented to Achieve Smart Campus

The Internet of Things (IoT): - The Internet of Things integrates sensors, controllers, machines, people, and things in a new way to realize intelligent identification, location, tracking, monitoring, and management through the integration of intelligent sensing, identification technology, wired network and mobile Internet. Everything is becoming connected Offering Educators unprecedented opportunities to address challenges and transform. IoT is network of devices communicating with each over internet or some other communication to make the system smart. A smart system created using the concepts of IoT can become helpful for automation, data management, retail, green energy, etc

Big data technologies include mass data acquisition, mining, storage and processing. Big data technology in the wisdom of the campus in all aspects of the application will make its management services to a higher level. Smart campus is through a variety of intelligent terminal equipment, information systems and sensing devices to obtain a large number of activities and status data, and in order to collect data analysis to grasp the law of things, to carry out intelligent applications.

Cloud Computing: Cloud computing requires a combination of grid computing, parallel computing, distributed computing, powerful integrated computing, only the use of open, integrated, collaborative information architecture and dynamically configurable resources, high scalability, on-demand service cloud computing model can provide good infrastructure support.

Business Intelligence : Business intelligence utilizes data warehousing and data mining techniques to systematically store and manage user data, analyze user data through various statistical analysis tools, provide analysis reports, provide decision-making information for a variety of university activities, basis.

Knowledge Management: Knowledge management is the key technology of smart campus. It is the most important and the most common activity of knowledgeable person and university. Knowledge management is the planning and management of knowledge, knowledge creation process and knowledge application.

Social Networking: The social network covers all forms of network services with the core of human society. It is a social or social characteristics of the network services. It is an interactive platform that can communicate with each other and interact with each other, and is therefore the key to achieve a smart campus. In the construction of smart campus, social network has the characteristics of openness and low cost, so that students can better accept and promote its rapid development.

All the above services should be integration with CUTN high performance computing infrastructure and this will result in a new technical architecture. To realise the above, laying a campus wide infrastructure of sensors of various types will be necessary. It would be prudent to leverage emerging technology in solar power, low-power processors, sensors, smart cameras, smart meters and cloud computing to build powerful and reliable sensor nodes and smart trees across the campus.

It would be possible to deploy of various smart applications (viz. monitoring water flow, electricity consumption and pollution etc.) and also provide WiFi hot spots for CUTN community around key locations in the campus. Once smart infrastructure is put in place, will open up opportunities variety of research and innovation across the campus. Faculty and students at all levels; UG, PG and PhD would be encouraged to come up with ideas that can be tested as pilot projects using these sensors. They could target any domain from security & surveillance to transportation to waste management. In fact such an infrastructure could trigger innovation and solutions for future smart cities. For users (students & employees), a mobile interface for all service should be conceived. This will eventually drive complete integration of the back office systems (Academic, Finance, Establishment etc.). In view of this, role of 'High Performance Computing Center (HPC)' with enhanced responsibility will become extremely crucial and may appropriately be designated as 'Smart Computing Services Centre (SCSC)'

Smart Campus Implementations:

- Ø Electricity: Uninterrupted electricity supply is given in both academic and residential campus through the main grid with backup of generator supply. For essential applications UPS power is also given. A substation is created which draw power from national grid and step down to 33 KVA. Once it is operational a 24x7 power supply will be guaranteed.
- Ø Transportation: University bus service is given to students and also ambulance service is provided 24x7 for emergency needs.

- Ø **Medical:** A Medical center is created with one male and one female doctors with supporting staffs. Preventive measures were made to protect the residence from vector borne diseases such as dengue, malaria etc.
- Ø Both academic and residential campus are fully protected from grazing animals through compound wall.
- Ø **Telephone:** BSNL outlet with tower is established within the campus to have good connectivity.
- Ø **Roads:** All buildings and both campuses were connected through broad roads with foot paths in important places.
- Ø **Access to facilities / Kiosk for External services:** Canteen, Food kiosk, ATM , SBI bank, Post office are established.
- Ø A multipurpose hall with indoor auditorium and students playground are established.
- Ø **Green campus initiative :** A committee is constituted to make the campus clean and green and several initiatives were done through this. Also motivated students and staffs to involve in making the campus green and clean. The NSS students were actively involved - each department also taken initiative in the plantation drive around their building. The bigger challenge is to convert the water logging areas into green corridors by innovative technologies.
- Ø Free Open Source Software as policy wherever possible.
- Ø Harnessing the solar energy by installing solar modules in building roofs, solar powered street lights, procured solar steam generator for cooking need of hostel etc.
- Ø Energy saving measures were introduced wherever possible including usage of LED lights, natural lighting in almost all rooms, high energy rating electronic appliances etc.
- Ø Established IT infrastructure (PCs, telephones, WiFi, printing and scanning) in each needed places and the process of making WiFi and broad band internet connection to the whole campus.
- Ø Created paperless environment wherever possible and most of the official communications are done electronically.
- Ø Introduced Rainwater harvesting by creating artificial ponds and all the sewage water generated in both residential and academic campus were treated through sewage treatment plants.

Ø Further projects like smart security (CCTVs for Video Surveillance, etc), biometric attendance system for staffs are enabled and it will be extended to faculties and students.

Smart Campus Suggestions:

- 1) Smart cards for all students and employees where card based/biometric attendance system for students to be enabled, access to services (library, lab, hospital, printing, etc) to be enabled, and Cycle dock (Bicycle sharing system) to be enabled through Smart Cards.
- 2) Projects like smart security (CCTVs for Video Surveillance, etc), sensor based doors for entry in departments and labs, bus tracking using GPS, smart speed sensors across campus, video conferencing facility in all departments and motion sensing lights and fans could be initiated.
- 3) Digital display panels at key locations and smart navigable notice boards may be implemented. Further SMS Alert facility for all notices/circulars to user groups based on title of content may be planned. Mobile portability for complete CUTN website and smart interactive features using Web 2.0 in all website within CUTN domain may be planned.
- 4) For ensuring sustainability, smart management of electricity, smart management of water resources, smart maintenance scheduling and mechanized cleaning and sensor based waste management (degradable vs non-degradable waste) may be planned for.
- 5) To enhance focus on sustainability, green / nongreen garbage collection, green trucking practices inside the campus and noise control mechanisms near road walls may be planned.
- 6) Transport or travel support for travel outside the campus may be planned for. Separate bicycle path besides roads may be planned to encourage usage of bicycles.
- 7) Dashboards may enable online booking institute resources (classrooms, halls, guest house, and online book recommendation). Searchable key notifications (pdfs) repository and searchable telephone directory may be planned.
- 8) To enhance sustainability, projects like energy generation from the solid waste management, solar water heaters to be installed in hostels and residences, shaded footpaths with solar panels on top, building integrated solar panels, regenerative systems across footpaths (generate power when people walk on the footpath) and waste water management to prevent direct/indirect communicable diseases may be planned.
- 9) A digital map of underground infrastructure (electrical/internet wirings, pipes) may need to be created so that infrastructure development does not damage existing services.

- 10) To enhance the sustainability of changes, a bio-gas plant could be developed to generate energy. Initiatives could be planned to monitor carbon footprint of the campus. Further rainwater harvesting for all buildings on campus may be planned for to enhance usage of key water resources.
- 11) Lab access through campus cards only
- 12) Smart printers in campus, access using campus cards
- 13) Biometric/card based attendance system for students
- 14) Payment for transportation facility
- 15) Wi-Fi facility in hostels and residential areas
- 16) Motion sensing lights, fans, ACs
- 17) Smart maintenance scheduling system for buildings/labs/office/houses.
- 18) Smart security across the campus (e.g. Sensor based CCTVs)
- 19) Sensor based safety solutions (labs & across the campus)
- 20) Solar cell enabled lighting using LEDs in Classrooms
- 21) Smart electronic switches for classes and departments.
- 22) Smart meters for water consumption across campus
- 23) Drip irrigation, springler with timer control to be implemented to have efficient water management.
- 24) All overhead tankers should be connected with a flow controller such that water pumpings can be done without human interference.
- 25) Facility for video conference calls/classes in each department
- 26) Entry to all departments/labs using sensor based sliding doors
- 27) Online booking facility for hall and classrooms.
- 28) Online booking of guest house.
- 29) Online leave application and tracking.
- 30) Online book recommendation from library for the faculty. e- Notice facilities over intranet.

- 31) Waste management (degradable vs non-degradable waste)
- 32) Mechanized cleaning for all open areas to reduce the dust pollution.
- 33) Smart monitoring of Gas leakage in residences / flats
- 34) Planting trees as much as possible in a holistic manner.
- 35) Cycle dock (Bicycle sharing system)
- 36) Washing facilities in the hostels
- 37) Facility of lockers for all students in the academic area. Sitting facilities around multipurpose hall, main entrance, etc
- 38) Provide automatic washing machine to each floor in all hostels
- 39) Library Family members may be allowed to access library but issue of books only on employee/student card for the library management.
- 40) Establishment of a shopping mall within the campus
- 41) Well managed crèche for children of employees.

Looking Beyond

The Smart Campus initiative would become a reference model for many organizations with residential campus as well as academic campus such as CUTN. This initiative would pave the path for further research opportunities across domains like electronic governance, administration, internet of things, smart technologies and process re-engineering, to name a few. This would also foster collaboration through Public Private Partnership models for the deployment of solutions, which could also empower entrepreneurship initiatives surrounding these smart technology enabled ecosystems. In the days to come, successful implementation of the smart campus initiative would also improve the CUTN ecosystem in general, which may help in attracting foreign students and faculty members, and thus affect the global rankings of CUTN. Further, this could also enable formulation of sponsored research projects and international collaboration with reputed organizations and government bodies.