

Building the State-of-the-Art IT Infrastructure for ICT enabled Higher Educational Institutions

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Strength and quality of a higher education institute leverage on the state-of-the-art IT infrastructure which works as the technical backbone for the activities carried out by the institute and skilled manpower to handle the IT services of the Institute. Planning, analysing, designing, implementing and testing of such low voltage IT solutions which covers networking with virtualisation switches and structured gigabit cabling, IP telephony, Building Management System (BMS), sophisticated Data Centre with high-end servers, UTM, Public Addressing System, Surveillance System, Video conferencing etc. are challenging tasks. This article introduces the concept of various components required for such a planning, designing and implementation of such a low voltage IT Solution.



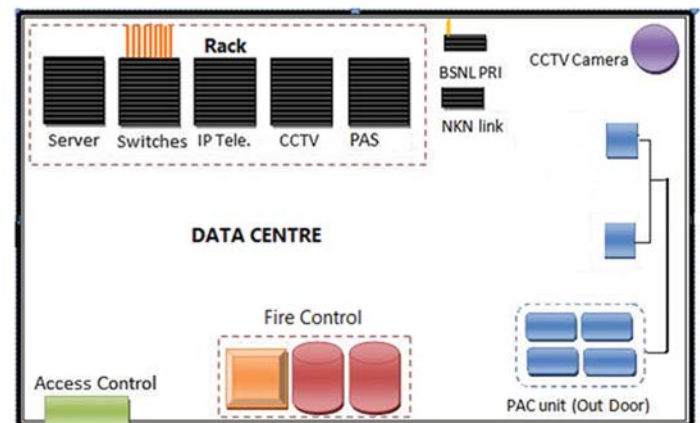
1. Introduction

Dedicated and sophisticated Information Technology (IT) are basic ingredient as well as basic infrastructure requirement for the overall development of a modern organisation. Activities in an educational institutions leverage on the ICT set up to deliver services and educational content to the students, faculty members and research scholars. Paradigm shift in the use of services of ICT for teaching and learning is of paramount importance for interaction and knowledge generation. Entry of computers in 1980s into the organisations and its use in education have paved way for many automated tasks as well as service re-engineering in educational institutions. Introduction of network and Internet has multiplied the speed and accuracy of information reach and sharing. Network setup is a critical component in an organisation with dedicated bandwidth for the users and seamless access to the resources available on Internet. To make use of proper IT services, Institutes have to be equipped with sophisticated ICT equipment and specialized devices within affordable budget of the organisation. Energy saving is a global concern and use of old and outdated equipment would not only cause the energy loss but also lead towards serious health hazards. In order to meet the requirement of users, organisation has to judiciously plan its ICT requirement and infrastructure based on the budget, trends in latest

technology, economical and technical feasibility. This paper discusses network requirement and design of ICT infrastructure, in general, for a higher education institution and implementation of such a solution as a case study at INFLIBNET Centre in its new building near to Infocity, Gandhinagar, Gujarat.

2. State-of-the-Art Data Centre

Creation of content and hosting it in a secured place, with access privileges for different levels of users, is a challenging task. Any educational institution would prefer to host its own content in its campus and preserve it by protecting it from external as well as internal threats. Normal PCs and laptops are sufficient for day to day work of users, but prone to hardware failures and other



malfunctioning errors. Data is to be secured and shared for effective use. As such, computers called “servers” are required as centralized computers to store common services and data storage. Apart from its relatively high configurations in terms of memory, processor, storage etc, servers should also have redundancy in power and processor, provision for data storage and backup, tailor-made access policies for the users, sharing of common resources etc. Many small servers can be stacked together in a chassis with common redundant power supply, shared Internet connectivity and storage units. One such stacking of servers are called blade servers. Blade servers are classified depending upon the size of the rack such as 1U, 2U, 7U and as large as 14 U. Number of servers depends on the unit size, a 7U chassis can accommodate 7-8 servers.

All these servers, devices and computers are to be placed in a dedicated and protected environment called Data Centre. To define uptime of data centre, Tier-3 standardized methodology is used for designing to provide optimum performance, feasible investment and ROI (return on investment). Data centre at INFLIBNET Centre is designed as the most robust setup and less prone to failures and also to host mission critical servers and computer systems, with fully redundant subsystems, wherever possible, such as cooling, network links, storage, etc. and compartmentalized security zones controlled by biometric access controls methods. All components are fully fault-tolerant including uplinks, storage, chillers, HVAC systems, servers etc. Everything is to be dual-powered in a Tier 4 standard data centre.

2.1. Modular Servers and Chassis

Modularity is the keyword when it comes to server design in contrast to traditional stand alone servers. Modular server is a blade system consists of modular server chassis



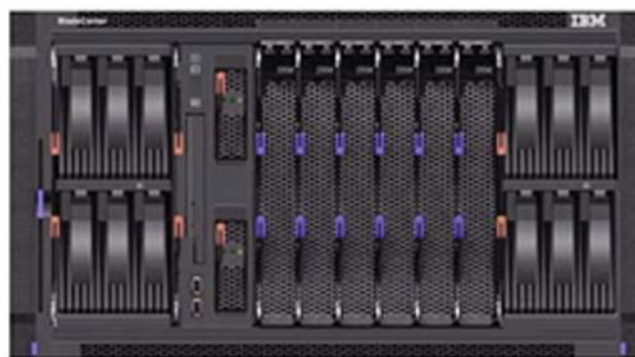
HP Blade Server C3000

with enclosure computer blades, and integrated storage area network (SAN) and three to five service modules. The service modules are storage control module, Gigabit Ethernet switch module and chassis management. These are in addition to its own motherboard and processors. Storage control module support RAID (Redundant array of Independent Disks) and manages RAID partitions of the HDDs in the integrated bay. These kinds of servers are sufficient for educational institutions with 100 to 500 faculty members. Few popular modules of chassis available in the market are Blade Centre (S, E, H, HT) of IBM, Blade System (C3000, C7000, x..x..) of HP, Power Edge of Dell, UCS 5108 of Cisco.

The INFLIBNET Centre uses HP Blade System C 3000 Enclosure for hosting Web Services, INFLIBNET website, Shodhganga, OJAS, NLIST, InfoPort, e-PG Pathshala, IndCat, DNS server, Intranet server, etc. IBM Blade Centre S chassis is used for Web co-location services at BSNL, which host mirror sites of INFLIBNET Centre for the services such as UGC website, NLIST Proxy Server, Online UGC Scholarship scheme and other important services.

2.2 Virtual Core Switching Technology and Intelligent Edge Switches

The core switches have to be selected based on design principles which support virtualization, efficient power and cooling, hi-density and scalability for efficient data centre infrastructure growth and designed for enhanced manageability, comprehensive security, delivery optimization, fault tolerant, and later, need to optimize network infrastructure. Virtual core switching technology at INFLIBNET Centre is used in the data centre for increase bandwidth, reduce complexity and create an active mesh between server and switches in the LAN.



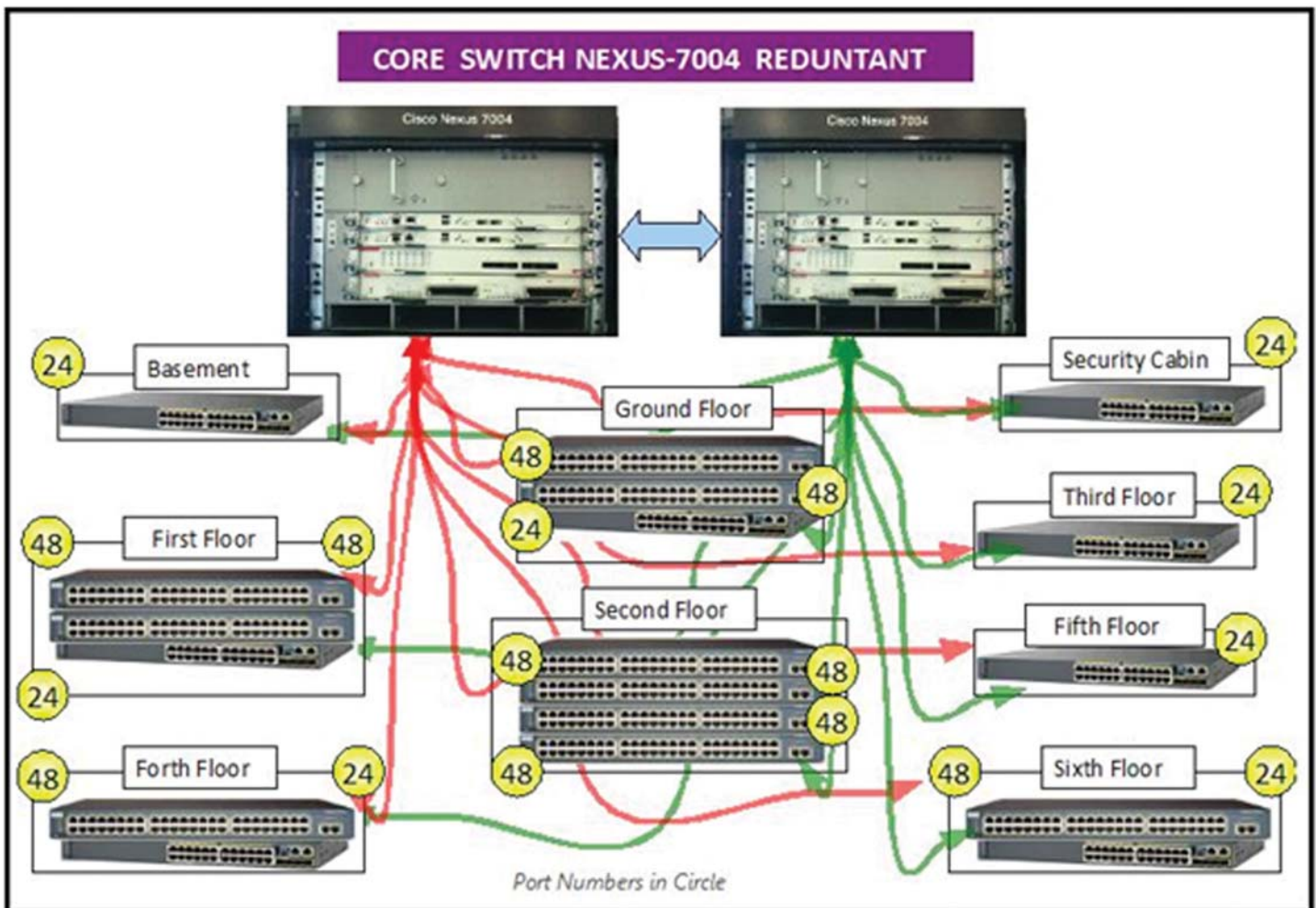
IBM Blade S Chassis S

Layer 2 based edge switches (ie. CISCO Catalyst 2960s) are used in INFLIBNET's Data Centre to improve security, sustainability and borderless network experience which include new flex and data stacking capability provides a unified data plane, configuration, and single IP address management for a group of switches with 1 to 100 Gigabit of throughput connectivity and PoE+ (Power over Ethernet Plus) by offering fast Ethernet access connectivity and removes the need for wall power to each PoE-enabled devices. These switches also support Virtual Local Area Network (VLAN) and DMZ (demilitarized zone) between private network and the public network through UTM.

2.3. Structured cabling backbone network (CAT 7A & Optical Fiber)

The INFLIBNET Centre would be using structured cabling with 40G ready network, 100G road map

backbone network built with CAT 7A and Optical Fiber wiring that can carry and accommodate data, voice, multimedia, security data, VoIP, PoE and wireless connections throughout the building in the campus. There are two areas in the Centre vis-a-vis technical / administration block and residential blocks. Well planned and designed CAT 7A structured cabling backbone network system empower performance of up to 1000 MHz continuous flow of information, support the sharing of resources and promotes smooth operations. Optical Fiber uplinks would be used to connect various Switch rooms. The whole network will be centralised on a core switch (ie. CISCO NEXUS 7004) to manage its network operations. The switch offer high-density 10, 40, and 100 Gigabit Ethernet with application awareness and comprehensive performance analytics for the data centre. It would also deliver high performance and density for core, aggregation, end-of-row, and top-of-rack server deployments in a highly



Schematic diagram showing Core and Edge switches distributions in all 7 floors in INFLIBNET Centre

resilient modular platform. A switch which is designed for the most mission-critical enterprise and service provider data centre deployments is chosen for the INFLIBNET Centre. Core switch and edge switches distribution are shown below in a schematic diagram:

2.4. Firewall and UTM

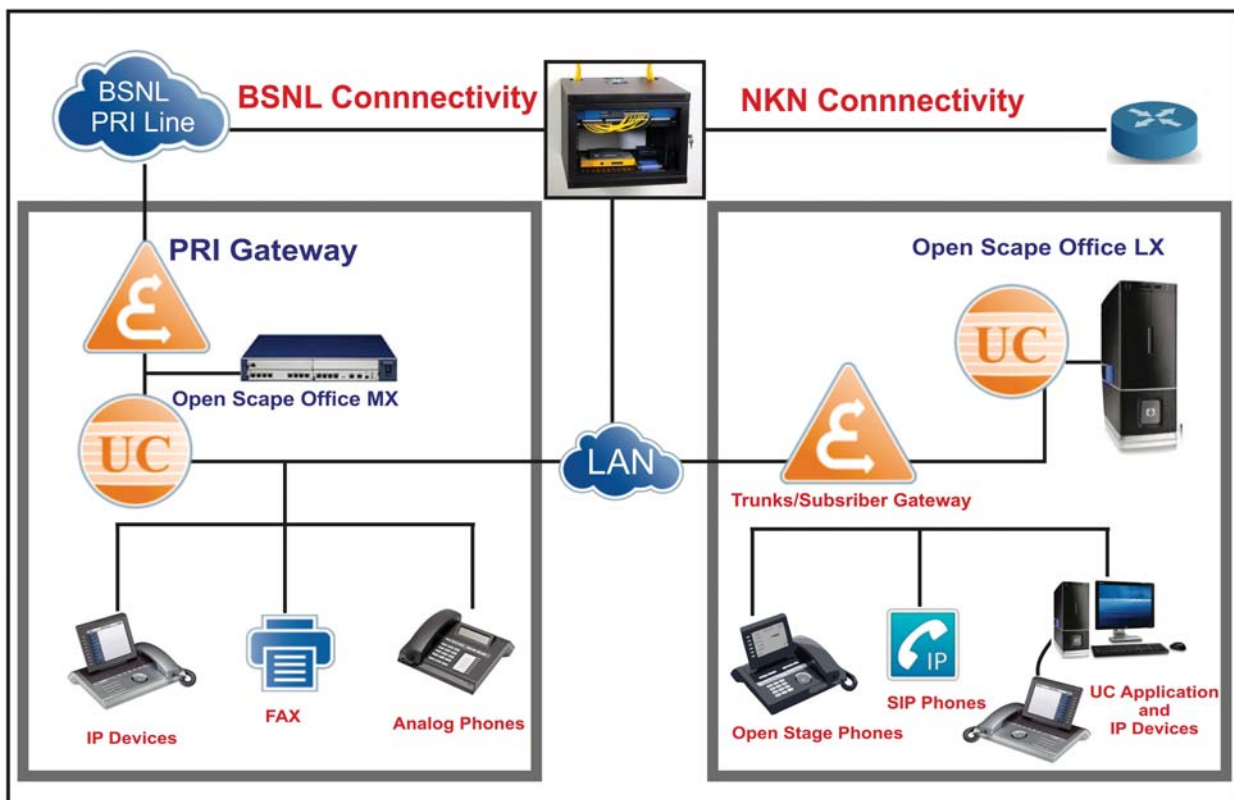
The INFLIBNET Centre is proposed high-performance and reliable Unified Threat Management (UTM) as Firewall equipment. The firewall proposed is a UTM based firewall equipment from FortiGate which has built-in hardware and software that helps to screen out the network with the fastest firewall technology to provide protection from hackers, viruses, and worms over the Internet and dynamic network environment. Firewall is also capable of Layer 4 functionality of the OSI Model, which are capable of packet-forwarding and identifying which application protocols are included with each packet, and it uses this information to send the packet to appropriate client/node and also provide an effective security and flow control by traffic filtering and forwarding the packets.

The INFLIBNET Centre host lots of important services as mention above which need security protection against attackers/hackers and vulnerabilities in OS and software. By default, 65,535 ports are opened for various services and applications in computers including servers. Services and data transmissions are to be closely monitored, patch up and timely updates are to be done at regular intervals in protected network location under port controlled security tools. The hosting server placed in a zone call DMZ (Demilitarised Zone) area by creating virtual hosts with private and local IPs. The Firewall technologies proposed has an integrated high performance protection system against wide range of threats, creating VPN technology, ensuring data privacy between multiple networks and host using SSL VPN protocols, Anti-Virus, Web application filtering, Intrusions Detection and Prevention System (IDS/IPS), anti-spam and traffic shaping to deliver multi layer security.

3. IP Telephony

IP Telephony system at INFLIBNET Centre is an Internet Protocol (based) phones, which can help to improve

INFLIBNET Data Centre IP Telephony Connectivity



Schematic diagram showing the IP Telephony System @ INFLIBNET Centre



OpenStage 60



OpenStage 40



OpenStage 15

productivity of telephony services with specialised software and hardware. Hardware based systems use a regular phone instrument to be used as Internet phones. Software system provides IP phone service through an application that allows phone calls to be made from any computer with a sound card. The whole telephone system is part of low voltage solution offered by M/s Siemens to INFLIBNET Centre. It uses proprietary software called 'My portal' which is installed in all PCs connected with IP phones through RJ 45 connector and Ethernet cables.

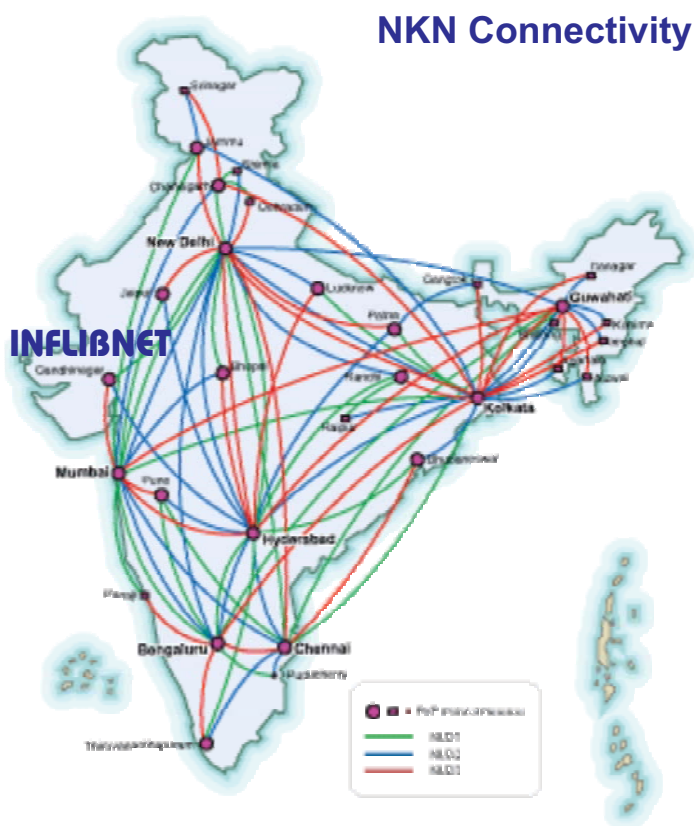
by the Centre. NKN is established by National Informatics Centre with technical support of Powergrid. STM (Synchronous Transfer Mode) equipment at Centre is connected through Fiber to Gandhinagar node of NKN on ring topology. This gives redundancy of NKN links and the architecture of the NKN is enabled to reach all universities with minimum hops. As shown in figure above, any university can be reached with minimum nodes on NKN and this gives INFLIBNET an advantage of serving the universities with speed and higher data transfer.

The INFLIBNET Centre use three different categories of phones i.e. Siemens Open Stage 60 for Scientists, Open Stage 40 for other staff member and Open Stage 15 for security & residences. This OpenStage family phones are designed to be user-friendly and simplify implementation. Sensorial interfaces based on advanced technology solutions (touch keys, embedded color LEDs, touch slider for volume control and touch guide navigator) as well as large, tiltable, backlit color graphical displays in TFT technology facilitate user interaction.

4. Gigabit bandwidth under NKN

The INFLIBNET Centre is connected to the National Knowledge Network (NKN)/NME-ICT project that provides 1 Gbps MPLS (Multi Protocol Layer Switching) connectivity to all universities in India. The bandwidth is currently restricted to 100-150 Mbps, but it can be increased on demand based on bandwidth intensive application upto 1 Gbps. INFLIBNET Centre is having two Internet connections i.e. one from NKN and other from BSNL for standby purpose. This gives redundancy to Internet links which is essential in an organisation which has a Tier 3 Data Centre. It is ensured that access to e-resources is enabled on all sets of IP addresses used

NKN Connectivity



5. Building Management System (BMS)

Energy conservation and the management is a global issue to be tackled at various levels in a organisation with proper planning and energy can be optimally saved which can lead to "Green Building" and the design perspective of a building should leverage on IT infrastructure requirement. Building Management System (BMS) integrates the mechanical and electrical equipment used for various services such as ventilation, lighting, power system, fire system and security system. BMS consists of software and hardware in a computer-based control system installed in a building that controls and monitors the above mentioned equipment. INFLIBNET Centre uses HVAC (Heating, Ventilation and Air Conditioning) for indoor environmental comfort based on the principle of thermo dynamics, fluid mechanics and heat transfer, ensuring maximum levels of efficiency and economy. This is achieved by maintaining the optimum balance between environmental conditions, energy usage and operating requirements. a DDC controllers (Digital Direct Controls) distributed with field devices such as voltage sensors, temperature sensors, smoke dictators, fire dictators, etc. INFLIBNET Centre uses Honeywell Trend for the BMS Solutions.

6. Surveillance System using CCTVs

Surveillance is the monitoring of the activities, behavior and other field conditions for managing, directing or protecting employees as well as outsiders. This is done generally by observing with the use of an electronic equipment such as CCTVs (Closed-Circuit Television) cameras. This also helps to maintain the security of the building. CCTV cameras are generally attached to a storage device which can archive video captures of all cameras and preserve it for later use. The number of CCTV cameras to be used depends upon the size, magnitude, layout and orientation of the building. 28 CCTV cameras from M/s. Honeywell are proposed by categorizing into three types. PTZ security cameras allow to control the Pan, Tilt and Zoom operations of the camera lens remotely or through programming. PTZ camera have ability to move up, down, right, left and even zoom. Other two cameras are Box types cameras and Dome type cameras. Dome cameras are usually installed indoor which has IR facility for night vision. Box cameras are not generally IR sensitive. All cameras proposed are IP-based, advanced and PoE (Power on Ethernet) enabled.



7. Audio-Video Integration and Public Addressing System (PAS)

A Public Addressing System (PAS) is required in various places in any organisation. Soothing music played lightly in the background in the premises of a building would give pleasant ambiance for working professionals. Such audio should have centralized control for the sound management and local control to mute the music in silence zones, if required. The entire building can be divided into various zones. Zone wise announcement is also possible with centralized control. In addition to audio, video conferencing and video projectors are also important in an organisation to deliver video content remotely and locally. The technology should be able to

control light, sound, video projection in an integrated environment by using a touch panel. Remote controlled pop-up projection screen, windows curtain controller, touch sensitive and sound activated microphone and a pop-up box fitted on the table with HDMI, VGA port, USB port, Ethernet socket, etc. could be made available for each speaker. Boardroom integrated solution with all these facilities can be controlled with a wireless touchpad/i-Pad in conference rooms and meeting rooms.

A well-equipped auditorium having professional sound system with an advanced dynamic mixer is yet another necessity. As such, auditorium of INFLIBNET Centre is equipped with professional sound system with premium ultra high headroom analog mixer and state-of-art mic preamps with DSP with 100 presets including reverb, chorus, flanger, delay, pitch shifter and various multi effects with atleast 12 channels for audio devices like mics (i.e. collar, hand-help, audio mike, cordless and vocal instrumental), laptop, CD/DVD player or music instruments, media players, etc. The mixer is connected with sufficient amplifiers for Base (Woofers), FOH (Front of the House), surround speakers, cross over amplifier for balancing the gain of audio and stage monitor speaker with plug and play facility. The auditorium would also be equipped with Wi-Fi hotspot.

This audio system would be synchronized with proper video projection facility having high quality projector (7000+ ANSI luminance, ceiling mounted projector with remote controlled dropdown lift). The motorised projection screen is wide enough (22 x 12 ft) to display the video projection for the clear view of all the people from various angle in the auditorium.

8. Video Conferencing Facility

Now a day, it is essential to communicate with other institutions not only on data transfer mode but also video mode. If an institutes is having high Internet bandwidth such as NKN, desktop video conferencing is possible. It is desirable to have a dedicated to video conferencing setup with sound proof room to have multi party conferencing. The same set up in an academic institution can also be used for delivering live video lecture. For these purposes, a dedicated ISDN PRI line or shared lease line with dedicated bandwidth (min. 384 kbps) can be used. High definition resolution camera with codec, multi point control unit and HD LCD/LED TV for display.

9. Conclusion

The INFLIBNET Centre designed and planned the ICT requirements based on the requirements and objectives of the Centre. In order to get competitive price, all IT related components are integrated and placed order is placed to a System Integrator for effective integration work for passive and active state-of-the-art low voltage infrastructure solution for the INFLIBNET Centre's new building at Infocity, Gandhinagar. As discussed above, the solution includes layer 3 core switching with virtualisation and 40G/100G ready network with POE+ edge switches along with 10G uplink, IP telephony with high and mid range of IP phones, surveillance system, boardroom solutions, public addressing system & AV solution, high resolution video conferencing solution, state-of-the-art auditorium, visitor management system, dedicated and sophisticated tier-3 Data Centre with precision A/C, CAT 7A cabling with OM4/OM2 Grade Fibre, Building Management System (BMS) with automated fire detection, fire suppression, access control, biometric access control, sophisticated UTM (Unified Thread Management System).

State-of-the-art IT infrastructure depends upon the state of the institutions, its objective, requirement and available budget. It also levy upon the technical prowess who plan and design it. Proper planning, aggressive market survey of available products, keeping abreast with the technology trends, time scheduling of execution of each task and coordination with the architect/contractor of the building are some of the important parameters to be considered before planning and designing the IT infrastructure for an institution. Demands from academic community for seamless access to the knowledge databases and e-resources are increasing day-by-day. New technologies and solutions are introduced in the competitive market. The scalability of such a infrastructure for next 10 years is to be assured without much technical changes and financial constraints.

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