

Networking and Internet Planning of a SMART Campus

Dr. Mukul Burghate¹ Dr. Nitin Kubde² and Prof. Mukund Madhav Tripathi³

¹HOD, Dr. Panjabrao Deshmukh Institute of Management Technology & Research, Dhanwate
National College, Nagpur

Email: mukulburghate@gmail.com

²Associate Professor, SIES College of Management Studies Navi Mumbai

Email: nakubde@gmail.com

³Assistant Professor, Vivekanand Education Society Institute of Management Studies and
Research, Mumbai

Email: mukund.m.tripathi@gmail.com

ABSTRACT-

This research paper is providing solution document for setting up network connectivity and procurement and implementing internet plan for 3 Institutes of ABC Trust. The research paper is structured such that it starts with brief introduction about the organization, details on the requirements and then solution proposed with Bills of Material. Further, the research paper also gives detailed implementation approach and methodology, policies to be implemented, provision for Operations & Support for the network landscape implemented. This research paper also gives broad considerations that have been made for future expansion and enhanced requirements. The scope of this research paper is to suggest the network implementation and management plan for 3 Institutes building of a Campus of ABC Trust.

KEY WORDS- Networking, Internet connectivity, Bills of Material, Network policy, Server, Personal computers, Wi-Fi, Router, Bandwidth, Network Diagram, Campus management, IT Management.

JEL CODE- O30 General, O31 Innovation and Invention: Process and Incentives, O32 Management of Technology Innovation and R&D

INTRODUCTION-

In IT there is constant enhancement and there are new / innovative products launched very frequently. The approach taken while planning and implementing the solution for Campus of ABC Trust is selecting state of the art technology products that would not have risk of obsolesce at least for next 5 years but at the same time venturing for most latest products that have not yet been proven in the industry are also avoided unless it is from the well-known and brands that can be surely relied upon for technology and quality.

ABC Educational Trust, established a recognized trust affiliated to Mumbai University. ABC Trust has grown into a flourishing Education Society, offering courses / programs across various disciplines, such as Management, Technology, Science, Pharmacy, Architecture, Commerce etc. Today, the Turst has around 5000 students and numerous faculty members. Today, ABC Trust is one of the fastest growing and the one of the top, private owned Education Society in the Mumbai. It has undergone a tremendous transformation since its commencement. Today, it stands as a large imposing.

Researchers are focusing on below mentioned Institutes of ABC Trust:

- Institute of Business Management
- Institute of Technology Management & Engineering
- Institute of Pharmacy & Technology Management

REVIEW OF LITERATURE-

Requirements

Broad layouts of the buildings are as below.

1st building of Management Institute

- 10 storied building. 11th and 12th Floor are under construction
- Floor 1 to 7 – class rooms
- Floor 8 to 10 Administration block, Management cabins, Faculty rooms, Library and other non-teaching rooms.
- Ground Floor – Canteen, Auditorium.
- No. of classrooms per floor: 10
- Total classrooms: 70
- No of Students in the year 2016-17: 3000
- Full time Faculty Cabins: 100
- Management Cabins: 15
- Seat Capacity of e-Library: 30

2nd building of Engineering Institute

- 5 storied building.
- Floor 2 to 4 – class rooms
- Floor 1 – Canteen, Library, Auditorium
- Floor 5 - Administrative block, Faculty rooms
- No. of classrooms per floor: 10
- Total classrooms: 30
- No of Students in the year 2016-17: 1000
- Full time Faculty Cabins: 25
- Management Cabins: 3
- Seat Capacity of e-Library: 10

3rd building of Pharmacy Institute

- 5 storied building.
- Floor 2 to 4 – class rooms
- Floor 1 – Canteen, Library, Auditorium
- Floor 5 - Administrative block, Faculty rooms
- No. of classrooms per floor: 10

- Total classrooms: 30
- No of Students in the year 2016-17: 1000
- Full time Faculty Cabins: 25
- Management Cabins: 3
- Seat Capacity of e-Library: 10

Requirements Estimation

Based on above details collected after physical survey and discussion with management representative below is the detailed requirement of network points, Wi-Fi, internet usage etc.

Requirement for Network Points:

Description	Management	Engineering	Pharmacy	Server Room	Total	With Redundancy
Class room - PC for Faculty	70	30	30		130	260
Faculty Rooms - PC / Laptop	100	25	25		150	300
Management Cabins	15	3	5		23	46
Seating capacity for e-Library	30	10	10		50	100
Canteen - Billing Terminals	2	2	2		6	12
Auditorium - No of Points	2	2	2		6	12
Admin Block - No of PCs	25	10	10		45	90
Network Points in Server Room				10	10	10
No of additional class rooms expected	20	0	0		20	40
No of additional faculty rooms expected	10	0	0		10	20
	274	82	84	10	450	890

Note: 100% redundancy/ provision for extra port is planned.

Requirement for WiFi connectivity

Description	Management	Engineering	Pharmacy	Total
No of Students	3000	1000	1000	5000
No of Students				

expected to increase	500	300	300	1100
Faculty Rooms	100	25	25	150
Management Cabins	15	3	5	23
Library Sitting capacity	200	50	50	300
	3815	1378	1380	6573

Access Points:

Access Points:	Management	Engineering	Pharmacy	Total
Ground Floor	6	2	2	10
1st Floor	2	2	2	6
2nd Floor	2	2	2	6
3rd Floor	2	2	2	6
4th Floor	2	2	2	6
5th Floor	2	2	2	6
6th Floor	2	0	0	2
7th Floor	2	0	0	2
8th Floor	2	0	0	2
9th Floor	2	0	0	2
10th floor	2	0	0	2
11th Floor - under construction	2	0	0	2
12th floor - under construction	2	0	0	2
				54

Internet Usage

Description	Management	Engineering	Pharmacy	Server Room	Total
Users –	3000	1000	1000		5000
Students	F1	L1	L1		
Users -	500	300	300		1100

Additional planned	F1	L1	L1		
Users –	100	25	25		150
Faculties	F2	F2	F2		
Users -	30	8	9		47
Visiting Faculties	F2	F2	F2		
User -	15	3	5		23
Management	F2	F2	F2		
Users -	25	10	10		45
Admin Staff	L1	L1	L1		
User -				5	
System Admin				F1	
	3670	1346	1349	5	6365

F1, F2 & L1 are policies for internet usage described further in this document.

Bandwidth calculation:

Considering 100 kbps per user on an average:

Quota per user	100	Kbps
No of users	6365	Users
Total requirements	636500	Kbps
	636.5	Mbps
Considering 25% concurrent users	155.39	Mbps
Proposed bandwidth	1	HTM (155 Mbps)

Considering above usage and requirement, researchers plan to have **2 connections of 100 Mbps each**. Both will be from different vendors. After evaluating several ISPs, researchers propose to procure connectivity from Airtel and TCL.

PROPOSED SOLUTION-

Based on detailed analysis of the above requirements detailed Bills of Materials has been worked out. Researchers have done good study of options available for each item.

Following factors have been considered while concluding on the final BOM after detailed analysis of the requirements.

- Technology
- Obsolesce
- Proven usage
- Warranty
- Support and service center in Mumbai
- One time Cost
- Maintenance cost
- Expertise required for installation and maintenance

Following design principles will be applied to develop the network architecture:

- Hierarchy
 - Clarifies the role of each device in each tier
 - Simpler to deploy, operate, and manage the network
 - Reduces fault domains at every tier
- Modularity
 - Enables growing the network on demand basis Resiliency
 - Meet user's expectation of network always being available.
- Flexibility
 - Allows intelligent traffic load-sharing by using all network resources

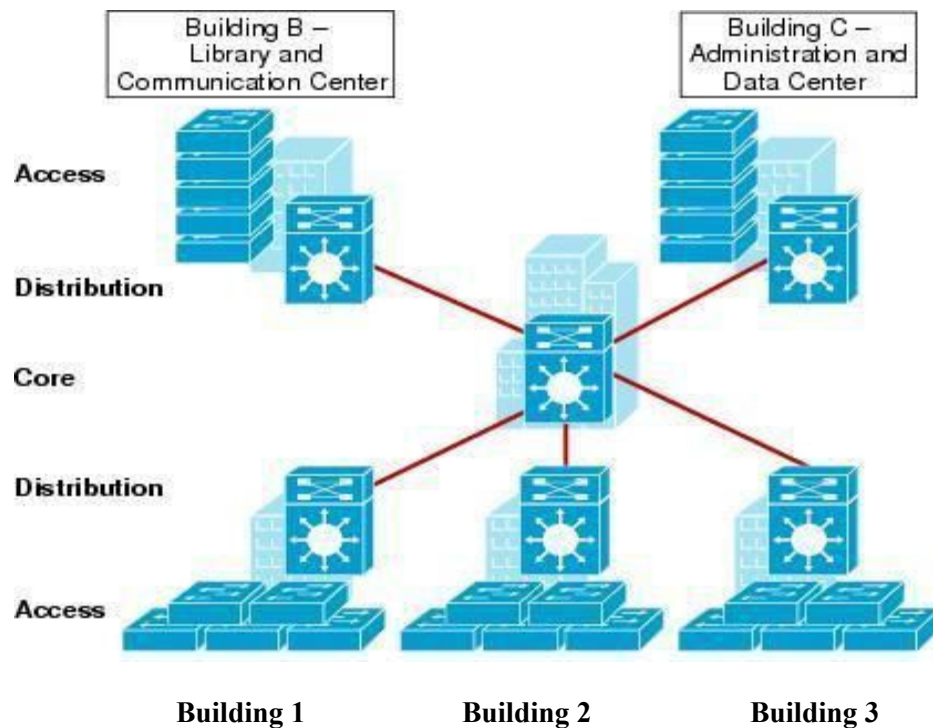
The network design includes the following key features;

- Hierarchical design with collapsed Core
- Quality-of-service (QoS) to ensure real-time data (telephony, video) are given higher priority
- Application of resilient design principles
- Multi cast
- Routed access
- Redundancy

Hierarchical Network Design

The three-tier hierarchical model is the approach typically employed to achieve a high performance, highly available, scalable network design. This design employs the four key design principles of

hierarchy, modularity, resiliency and flexibility.



Each layer in the three-tier hierarchical model has a unique role to perform:

- **Access Layer**—The primary function of an access-layer is to provide network access to the end user. This layer often performs OSI Layer-2 bridge function that interconnects logical Layer-2 broadcast domains and provides isolation to groups of users, applications, and other endpoints. The access-layer interconnects to the distribution layer.
- **Distribution Layer**—Multi-purpose system that interfaces between access layer and core layer. Some of the key functions for a distribution layer include the following:
 - Aggregate and terminate Layer-2 broadcast domains
 - Provide intelligent switching, routing, and network access policy function to access the rest of the network.
 - Redundant distribution layer switches provides high availability to the end-user and equal-cost paths to the core. It can provide differentiated services to various class-of-service applications at the edge of network.
- **Core Layer**—The core-layer provides high-speed, scalable, reliable and low-latency connectivity. The core layer aggregates several distribution switches that may be in different buildings. Backbone core routers are a central hub-point that provides transit function to access the internal and external network.

The three-tier hierarchical design maximizes performance, network availability, and the ability to scale the network design. Deploying a collapsed core network results in the distribution layer and core layer

functions being implemented in a single device. The collapsed core/distribution device provides the following:

- High speed physical and logical paths connecting to the network
- Layer-2 aggregation and demarcation point
- Define routing and network access policies
- Intelligent network services—QoS, Network virtualization, etc.

PROPOSED BILL OF MATERIALS:

Item Description	Qty.	Option 1	Option 2	Option 3
Server - Server Zeon 16 GB RAM, 1TB RAID 1	1	IBM	HP	NA
Stackable console	1	Rukus	Alcon	NA
Router	1	Rukus	Alcon	NA
Firewall	1	Cyberoam	Jupiter	Checkpoint
Access Points	54	Cisco	Alcon	NA
100 MBPS	2	AIRTEL	TCL	Vodafone
Fibre optic for backbone- between three buildings	300 Mts	Systimax	Molex	D-link
LIU = Fibre patch panel	12	Systimax	Molex	D-link
Pigtels	12	Systimax	Molex	D-link
Fibre Media converters	6	DCB	Optilink	NA

Cat-6 cable. (150 boxes+10 boxes for cascading cables)	44500 Mts	D-link	Molex	Optilink
Information Outlet plates	1780	Systimax	Molex	D-link
1 Mtrs Patch cords - switch side	890	Systimax	Molex	D-link
2 mtrs Patch cords - PC side	890	Systimax	Molex	D-link
24 port Patch panel	45	Systimax	Molex	D-link
Rack 6U	20	Val Rack	WQ	NA
42U Rack	1	Val Rack	WQ	D-link
L3 Main Switch	1	Cisco	D-link	NA
L2 (Mangable) Switch	45	Cisco	D-link	NA
Cable Manager	45	Local	NA	NA

Brand mentioned in option 1 will be used. In case there is any delay in supply, other options will be used.

Firewall will be configured for:

- Load Balancing
- Bandwidth management
- Failover
- URL filtering with group policy
- Gateway Antivirus and Anti-spam management
- IPS and IDS configuration

APs will be configured and maintained via Stackable console.

Implementation Plan

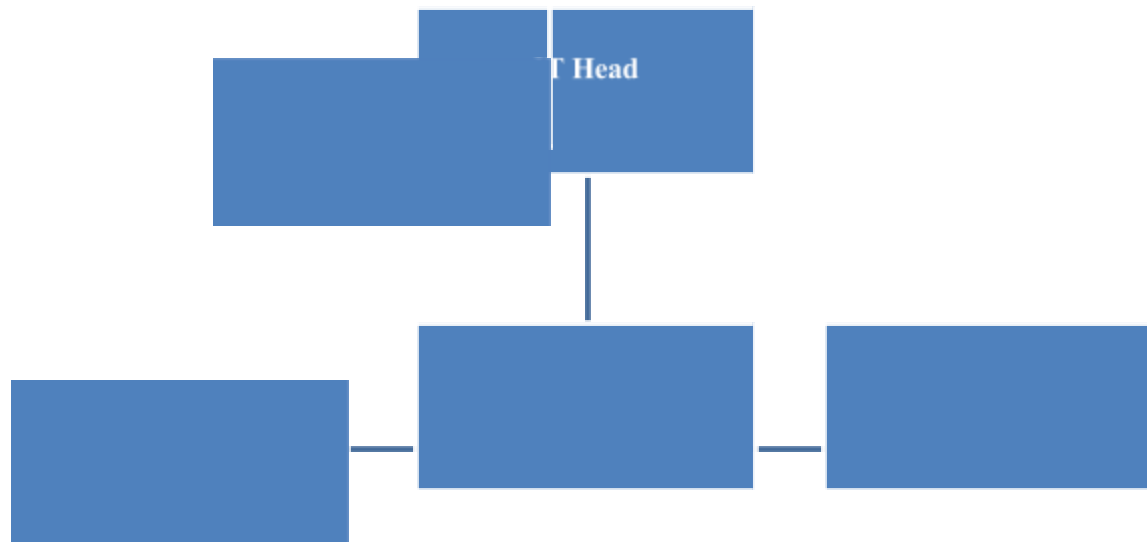
Implementation will be planned such that regular operation of the colleges does not get disturbed. Work would be outsourced to a single vendor. Broad scope of work document will be shared with different vendors. Minimum three quotations will be accepted and evaluated. Work will be awarded to the vendor that is technically Q1 and Commercially L1. Method of evaluation will be Quality and Cost based. 70%

weightage will be given to Technical scoring and 30% weightage will be given to commercials.

Method of Technical Evaluation:

Sr. No.	Evaluation Criteria	Marks	Max Marks
1.	No. of years the company is into IT and ITES services	Min 5 years = 5 marks 5-10 years = 10 marks 10+ years = 20 marks	20
2.	No. of similar projects successfully completed by the company	Min 10 projects = 10 marks 11 to 20 projects = 20 marks 20+ projects = 30 marks	30
3.	No. of technical employees the company has on rolls	50 employees = 10 marks 51- 100 employees = 20 marks 100+ employees = 30 marks	30
4.	Quality of presentation and technical proposal given by the company	Implementation Methodology Technology proposed Operations & Maintenance	20
		Total marks	100

ABC Trust will hire its own IT team that will overlook the work outsourced to the vendor. Following is the broad structure of the in-house IT team.



These employees will work in shifts. Following would be the shift for three colleges.

Management College:

- 1st shift would be from 7am to 3pm
- 2nd shift will be 10am to 6 pm and
- 3rd shift will be 3pm to 11pm.

Engineering & Pharmacy College

- 1st shift would be from 8am to 4pm
- 2nd shift will be 12noon to 8 pm

The work would be scheduled during summer holidays. Engineering and Pharmacy Institutes would not be operational during this period. Full time course in Management Institute too will be off. Only Part time and Executive course will be operational. These courses are conducted post 6pm and hence implementation team would have the entire facility available from morning till 5.30pm. This will help completing the work faster and without any disturbance.

Broad Implementation Schedule

The overall installation, configuration and testing is planned to be completed in about 2 months. Below is activity wise – week wise plan.

Sr. No	Activity	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9
1	Award of contract									
2	Place order for HTM line									
3	Cable Laying									
4	Termination of all wires									
5	Configuration of switches and firewall									
6	AP configuration									
7	Documentation									
8	Testing & troubleshooting									

Policies

Following internet usage policies will be implemented:

F1: Full access except video streaming

F2: Full access

L1: Social Media sites not allowed

OPERATIONS & MAINTENANCE SUPPORT

The setup that will be implemented will need to be maintained well. Appropriate budget and process for maintenance needs to be planned. Maintenance will be outsourced to the vendor that implements the networking in the campus. In addition to that, in-house team will also be involved.

Following is the resource requirements plan:

For 1st Year:

Teams	In-house	From Vendor	Total
Central Team	2	1	3
Management Institute	3	2	5
Engineering Institute	2	2	4
Pharmacy Institute	2	2	4
Total	9	7	16

For subsequent years:

Teams	In-house	From Vendor	Total
Central Team	2	1	3
Management Institute	3	1	4
Engineering Institute	2	1	3
Pharmacy Institute	2	1	3
Total	9	4	13

The idea is that more support will be required from vendor in the first year. Once in-house team works along with outsourced team and gets experience for a year, then more responsibilities can be given to in-house team and outsourced team can be reduced.

Preventive maintenance schedule will be prepared and maintenance will be done accordingly. Regular audits will be performed to ensure that this is being implemented well. Cross team audits (by IT team of other institute) and external audits will be conducted. Audit team will also review the documentation and check if the same is being updated regularly as per the changes implemented from time to time. Up-to-date documentation on is the most important and critical aspect

HELP DESK

Help Desk will be setup for the support. Helpdesk infrastructure will be setup along with network implementation. Helpdesk management tool will be used to log the calls and track it to the closure.

The incident reporting channels could be the following:

- Online incident reporting from via web-login
- Specific E-Mail account
- Telephone

Some important activities by Help Desk

- Creation of knowledge base on frequently asked questions to assist users in resolving basic issues themselves
- Track each incident / call to resolution
- Provide feedback to callers
- Analyze the call statistics
- Escalate the calls, to the appropriate levels, if necessary as per the escalation matrix agreed

Process:

Helpdesk would be manned by in-house people depending upon the workload.

- It will operate during the official working hours of the college.
- Support would be given in English or Hindi.
- Each query/ request received by Help Desk would be assigned a unique ID and it will be tracked using the same.
- Call would be categorized based on the severity and urgency required for its resolution.
- Helpdesk team may directly reply to calls received if the resolution is within their knowledge or may send calls to Support.
- If Helpdesk team not replying in decided period then Calls will get escalated as per mutually agreed escalation matrix.
- If technical team needs any input from other stakeholder for any particular calls then they will contact them. In such scenarios reply will depend on the stakeholder's feedback.
- Helpdesk team will publish the reports as per decided frequency – fortnightly or monthly with the

details of calls received, calls closed and pending calls along with their severity.

SERVICE LEVEL AGREEMENT

Service Level Agreement (SLA) will be discussed and finalized. Broad SLAs proposed at this stage are as below:

SLA Parameter	Definition & Target	Service Level	Penalty
Availability of network and Wi-Fi connection	Availability is defined as: $\frac{\{(Scheduled\ Operation\ Time - System\ Downtime\}/(Scheduled\ Operation\ Time)\}}{100\%}$ *	Minimum 99.5% measured on a monthly basis	1 point per 1% drop in monthly availability (beyond 99.5%) or part thereof. Total points would be calculated by adding Network and Wi-Fi Connectivity.
	Target 99.95%		
Helpdesk ticket/ Incident Response time	Average Time taken to acknowledge and respond once a ticket/incident is logged through one of the agreed channels. This is calculated for all tickets/incidents reported within the reporting month (24x7x365). Target: 95% of the tickets must be responded to within 15 Minutes of receipt	100% within the defined target	For each additional drop of 1% in performance below 95%, liquidated damages of 1% will be levied as additional liquidated damages
Time to Resolve – Severity 1	Time taken to resolve the reported problem. Target: 100% of the incidents should be resolved within 2 hours of problem reporting	100% within the defined target	For each incident not resolved within 2 hours, 1 point for each 30 minutes delay beyond 2 hours
Time to Resolve –	Time taken to resolve	100% within the	For each incident

Severity 2	the reported problem. Target: 100% of the incidents should be resolved within 8 hours of problem reporting	defined target	not resolved within 8 hours , 0.5 point for each 2 hours delay beyond 8 hours
Time to Resolve – Severity 3	Time taken to resolve the reported problem. Target: 100% of the incidents should be resolved within 24 hours of problem reporting	For each incident not resolved within 24 hours , 0.25 point for each 8 hours delay beyond 24 hours	For each incident not resolved within 24 hours , 0.5 point for each 2 hours delay beyond 24 hours
Percentage of reopened incidents	For all incidents which are designated resolved by the SI, but are re-opened by the client. This is calculated for all incidents reported within the quarter. Target: <= 2%	<=2% incidents	1 point for each additional 1% of reopened incidents beyond 2%