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Analysis of Technical and Managerial Issues Involved in Designing a Conceptual Framework for University Campus-Wide Network System

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ABSTRACT

Technological innovations have not only brought benefits to business sector but significant changes in higher education system especially at universities and colleges level. The Information and Communication Technology (ICT) has provided an integrated platform for three main categories of users- students, teachers and researchers to create, share and dissemination information in the form of knowledge. The introduction of Internet and its allied technologies have revolutionised the whole education system in terms of wider and convenient accessibility of information, reduced cost and less managerial efforts as compared to legacy educational technologies. In this paper an attempt is made to analyse various issues involved in designing a conceptual framework to interconnect all teaching departments and administrative blocks of Himachal Pradesh University. The major technical and managerial issues observed during research were bureaucratic delays, unawareness at users' end, fluctuations in users' requirements, shortage of expert manpower, lack of complete and authentic information, etc.

Keywords: ICT, Electronic Resources, Intranet, Internet, Network, Optical Fiber Cable, UTP.

1. INTRODUCTION

The rapid developments in technology have made tremendous changes in our life, as well as the demands of the society. Recognizing the impact of new technologies on the workplace and everyday life, today's educational institutions are trying to restructure their education programs and classroom facilities, in order to minimize the teaching and learning technology gap between today and the future [7]. Network technology has made it possible for the universities to create, share and access their electronic resources 24 hrs in a day and at any place. It enables the exploitation of the rich diversity of resources at the end of the privileged institutes to meet the requirements of other needy ones in a cost effective and speedy manner. Nowadays, researchers utilise a substantial amount of web information resources in their formal or informal scholarly communications [6]. Teaching and research staff are the creators of digital resources. A flexible information environment allows them not only to create resources that are accessible within their own institution but also allows them to contribute and manipulate electronic resources to enhance their learning, teaching and research potential. Information and Communication Technologies (ICTs) are crucial in facilitating communication and access to information for teaching and research works. The Internet has become a very significant and indispensable learning and business tool for information dissemination for both education purposes and business transactions. Utilising the Internet to deliver electronic learning has created expectations both in the business market and in the higher education institutions [2]. The fast expansion of the Internet and related technological advancements, in conjunction with limited budgets and social demands for improved access to higher education, has produced a substantial incentive for universities to introduce e-resources [8]. It has become essential to consider not only access to education but also exploit the technology where computers have become an indispensable element of present education system [4]. Traditional universities should also compete with other independent education providers in relation to social demands for 'life long learning' and globalised education services [3]. If universities do not embrace e-learning technology that is readily available, they will be left behind in the pursuit for globalisation [8]. The existing approach to tackle this challenge is to increase technology capacity in terms of infrastructure building and enhance awareness level among users to utilise harness the full potential of Information Technology as electronic resources in higher education system to become a strong knowledge economy in the world map.

2. ORGANIZATIONAL BACKGROUND

Himachal Pradesh University, Summer Hill Shimla is the only state university of Himachal Pradesh which was established in the year 1970. This university has 12 faculties and 30 teaching departments. As many as two

hundred seventy colleges/institutions (government/ private) from within the state are affiliated to this university in addition to International Centre for Distance Education and Open Learning, Evening Studies, Legal Studies and Regional Centre, Dharamshala. The following points highlight why the university needed the state-of-the–art campus-wide networking system:

- Some of the departments of the university had self financial resource generation schemes in addition to their share in the university budget. The concept of resource sharing was almost missing; individual departments were spending a lot of budget on buying individual electronic resources. But there were also other departments who were solely dependent upon the budgetary provisions allocated to them by the university. This leads to both underutilization of resources and inappropriate utilization of university finances.
- There was neither a concrete ICT policy in place nor a centralized IT resource management, which led to high level of resources underutilization.
- No centralized databases were available from where one could access the information about the university, its staff or its working.
- Every department was using individual Internet connections, antivirus software, etc. which was making a dent on the limited financial resources of the university.
- Easy and sufficient access to Internet was not available to the vast majority of students, teachers and non-teaching staff.
- There were no official mail-ids for employees or students which they could use for their intra-university or other communication needs.
- E-Journals facility (more than 4000 journals free of cost) which was being provided by the University Grants Commission InfoNet Consortia through INFLIBNET was available only at the Cyber Café located in the Central Library.

The total cost of the available hardware and software resources is about Rs.1.5 crores. To manage a system of this worth, the university needs a robust, secure, cost-effective and state-of-the-art ICT infrastructure and policy. The university decided to establish a campus-wide network system to share its underutilized resources such as electronic journals, students and teachers database through Internet and Intranet by involving all departments and administrative blocks within the campus. So the main focus of this paper is to analyse various technical and managerial issues emerged during designing of conceptual framework for university campus-wide network system.

3. OBJECTIVES

1. To analyse technical and managerial issues involved in designing conceptual framework for a University Campus-Wide Network System.
2. To choose an appropriate network technology suitable for University Campus-Wide Network System.

4. SIGNIFICANCE OF RESEARCH

1. The findings of this research will help the organizations to share their electronic resources in optimal way and control their underutilization also.
2. To provide deep insight into network implementation issues.
3. To frame network establishment policies within the university.
4. The project managers or engineers involved in establishing such networks may have better idea about what should they have and what precautions are needed while handling such types of project?

5. RESEARCH DESIGN AND METHODOLOGY

The study was conducted in Himachal Pradesh University, Summer Hill, Shimla. The first author of this paper was actively involved in implementation of network solutions in International Centre for Distance Education and Open Learning, a distance learning centre within the campus of the university with the members of main technical team whereas the second author is a supporting engineer in the university campus at the end of the network solutions implementing agency.

- To achieve the first objective, information was obtained using interviews with concerned officers and officials. The interviews attempted to identify the technical and managerial issues in designing conceptual framework of a network system. Observations were also made by the researchers during the interviews in order to capture some additional information which could not be revealed using interviews.
- To achieve the second objective, a small self designed questionnaire was administrated on all the seven technical members of the committee. This questionnaire had two parts: the first part was used to rate the importance of each feature desirable in any university network system,

whereas the second part was used to observe their opinions on wired versus wireless technology. A 5-point Likert Scale (5 = highly important and 1 = not important at all) was used to observe the opinions of the technical experts. To build an initial list of important features, the members of the committee discussed the pro and cones of wired versus wireless technology using brainstorming sessions. The usage of questionnaires, interviews and observations provided the grounds for thorough and constant analysis of the data and opinions.

6. RESULTS AND DISCUSSION

The university decided to execute the work by developing a network monitoring system. There was one main committee which was further divided into four subcommittees: 1) technical committee, 2) active work monitoring committee, 3) passive work monitoring committee, and 4) finance committee. The members of the committee were selected by keeping in view their expertise in different areas. The main committee was responsible for each and every aspect of the project. The technical committee was constituted to look after the technical issues related to the project. The passive work monitoring committee was responsible to monitor and supervise civil works. The active work monitoring committee had the responsibility to decide various types of network management issue such as security and access policies in addition to check the active implementation of network. The finance committee was responsible to manage financial activities and resolve any financial complicacy, etc. The designing of conceptual framework for a university network system includes the following steps which were executed serially: 1) study of existing system and users' requirement gathering, and 2) basic network design issues. The problems faced during above phases are discussed briefly.

6.1. Study of Existing System and Users' Requirement Gathering

A team was constituted under the leadership of one team leader to study the existing system and collect department-wise users' requirements. The major considerations involved in the study of existing infrastructure were: 1) how much life could be of the existing hardware equipments? 2) could these be upgraded or not and cost involved? 3) whether fulfilling the current requirements or not? 4) could be the part of new infrastructure or not? etc. Similarly the collection of users' requirement involved: 1) importance and need of proposed requirements, 2) future scope, 3) feasibility of proposed requirements, etc. The following problems were faced during this phase:

6.1.1. Lack of Authentic Information

It became very difficult for the team to have information on existing system due to the non-availability of the documentation and manuals on installed hardware equipments. The consequences of this problem were: 1) difficult to check the life of existing infrastructure, 2) difficult to assess the efficiency level, and 3) difficult to analyse the compatibility with new system.

Solution: Two basic kinds of solution were performed to resolve above problems: 1) to get information from Internet on the basis of model numbers and serial numbers of the equipments, 2) concerned officers/officials were requested to provide information regarding existing infrastructure under whose guidance the infrastructure was installed.

Outcome: This helped the team to get basic information on: 1) when the infrastructure was established? 2) who was the vendor or implementing agency? 3) what was the cost involved? 4) whether the product covered under warranty or not? 4) whether the vendor could be asked for restoring the services on AMC (annual maintenance contract) basis or not? 5) whether product providing desirable services or not? 6) whether the users satisfied with the services provided by the product vendor or not?

6.1.2. Non Co-operative Attitude of Concerned Officials/Officers

People were trying to hide the information may be due to the secrecy of official information or due to unawareness.

Solution: The team tried to convince the people about the usage of ICT applications in their daily workings through: 1) repeated interactions, and 2) involvement of senior authorities to get the authentic information.

Outcome: This strategy helped a lot to get: 1) quantitative value of existing hardware, 2) first instance information on existing infrastructure and its cost, 3) supporting level of existing infrastructure, vendor or implementing agency, 4) equipments needed for newer installation, 5) implementation and post implantation issues, etc.

6.1.3. Users' Unawarenesss

Initially it was decided to analyse users' requirement or information outlet requirements by circulating a proforma at the university's level. But this move did not provide the exact requirements. The main reason was unawareness at users' end. Users were not able to get the view, such as what could be the advantages of this system or what type of the services could they have after implementing? This was observed as one the major

problems. The users were not aware about their present and future network requirements and how the ICT could help them to improve their efficiency, productivity, etc.

Solution: It was decided that technical committee would visit each and every department personally not only to enhance awareness level among users about ICT usage but also to fix or suggest requirements of the concerned department in consultation with head of the department.

Outcome: The team got success to have exact department-wise requirements in addition to make people aware about the benefits of ICTs in their daily working and a general consent over the implementation of new system. Later on, this also helped in generating the funds for the implementation of new system.

6.1.4. Fluctuations in Users' Requirements

Fluctuation in users' requirements is one the biggest problems that the team faced in designing of conceptual framework of a network system. This wasted lots of valuable time of team in requirement gathering. The consequences of this were: 1) delay in execution of project, 2) revisits to users' site for analysing their proposed requirements, 3) ripple effect caused multiple changes in reports, 4) additional involvement of labour, time and cost, etc.

Solution: It was decided to declare the dead line to make changes in users' requirement.

Outcome: The team got success to get first hand information of users' requirement to finalize the solution. At the end of this phase, the team got information on existing infrastructure and required hardware as follows:

- Network connectivity was required to support 714 computer systems in which 330 computer systems were already on existing individual local area networks being maintained by various departments at their own level whereas additional requirement of 384 network access points was observed.
- The switches installed for connectivity were of the D-link make.
- These switches could support new infrastructure but up to some limited extent. The maximum back bone connectivity could be up to 100mbps.
- Need to remove various hubs installed at the different locations in the University to avoid any performance or management related problems in future.

6.2. Basic Network Design Issues

After going through the analysis of existing system and requirement gathering at users' end, the next step was to design a conceptual framework for a University Campus-wide Network system. The problems faced during this phase are discussed below:

6.2.1. Lack of Specialized Manpower

The designing of network requires specialized manpower to complete this job in an efficient and time bound manner. Since the university had very limited kind of specialized manpower, so this problem could affect whole of the project.

Solution: It was decided to take consultancy from DIT (Department of Information Technology) and NIC (National Informatics Centre), Government of Himachal Pradesh because these departments had enough experience to setup campus-wide network system within the Secretariat of Himachal Pradesh Government and State Wide Area Network (SWAN) system at the state level.

Outcome: The university got success to constitute a strong team of technical experts by involving experts from DIT and NIC. The output provided by the committee helped a lot to have an insight of various technical and managerial issues involved in pre and post implementation of networking solutions.

6.2.2. Evaluation of Technological Solutions

Two types of network solutions emerged: 1) wireless network technology, and 2) wired network technology. Both solutions have their own advantages and disadvantages. A comparison matrix [1], [5] & [9] has been designed as shown in table 1 to compare the features of wired and wireless technology before final selection.

The table 2 displays the summary averages for weighted and unweighted data sets. Firstly, the Average Importance shows the rating done by the seven technical experts for each desirable feature in a University Campus-wide Network system. Secondly, the maximum weight is obtained by multiplying Average Importance with maximum Likert Scale rating value i.e. 5. Thirdly, the average scores per data item for each feature are given corresponding to wireless and wired technology. This is displayed in two modes: 1) raw score (RS) as unweighted ratings (with a theoretical Likert Scale range of 1 to 5), and 2) weighted score (WS). The weighted score (theoretically ranging from 1 to 25) is obtained by multiplying the unweighted score by the importance score for each respondent. The features considered most important by the experts were security (5.00) follwed by performance (4.86) and management (4.86), connectivity (4.71), interference (4.43) and flexibility (4.29). Further, the wired technology scored highest points (97.48) as compared to wireless technology (73.04) points.

Table 1
Comparison Matrix

Features	*Required Solutions*	*Wireless Network Technology*	*Wired Network Technology*
Flexibility	Higher level of flexibility is required.	Network services can be accessed very easily from anywhere within the campus without any restrictions.	Network services are accessible only through network access points subject to the length of the network cable.
Security	Highest level of security is required. No compromise on this feature.	Data transmitted over a wireless network can be intercepted using appropriate receiver equipment without users' prior knowledge.	Data transmissions are very rarely intercepted over a cabled network.
Performance	Need of high bandwidth to support data base server, file server, mailing and videoconferencing, etc.	Wireless technology offer lower bandwidth and less functionality.	Cabled networks offer higher bandwidth and more advanced management functionality.
Interference	No interference is acceptable to maintain quality of service.	Wireless connectivity is adversely affected by existing electronic equipments.	Cabling technology is designed to avoid this problem.
Connectivity	Should be easy to connect new users (authentic)	New users can join an existing wireless network without delay but vulnerability of security exists.	The connectivity is provided to new users in a secure and closed user environment.
Management	Should be easy to manage the whole network.	Network incidents and performance issues are difficult to traceable, making it harder to target remedial actions.	Network registration system (IP addresses) allows for easy management of network incidents and performance issues.
Cost	Cost-effective network solution is needed	Extension to a new wireless network system is less expensive.	Cost of wired network is generally greater than wireless network.

Table 2
Summary Averages for Weighted and Unweighted Data Sets

Factors	*Average Importance*	*Maximum Weight*	*Wireless Technology*		*Wired Technology*	
			Rated Score	*Weighted Score*	*Rated Score*	*Weighted Score*
			(RS)	(WS)	(RS)	(WS)
Flexibility	4.29	21.45	3.86	16.56	2.29	09.82
Security	5.00	25.00	1.57	07.85	4.57	22.85
Performance	4.86	24.30	2.57	12.49	4.14	20.12
Interference	4.43	22.15	2.14	9.48	3.29	14.57
Connectivity	4.71	23.55	2.71	12.76	3.00	14.13
Management	4.86	24.30	2.86	13.90	3.29	15.99
Total Score	*28.15*	*140.75*	*15.71*	*73.04*	*20.58*	*97.48*

The figure 1 shows the comparison of wired and wireless technology on various desirable features for a University Campus-Wide Network System. The wired technology makes a clear circle around the wireless technology on all features excluding one i.e. flexibility.

From the above comparison we can see that most of our requirements are fulfilled by wired network technology. So the team decided to implement wired technology especially Optical Fiber Cable as backbone and UTP (unshielded twisted pair) cable within the buildings to satisfy the three most important requirements of network. i.e. security, performance and management.

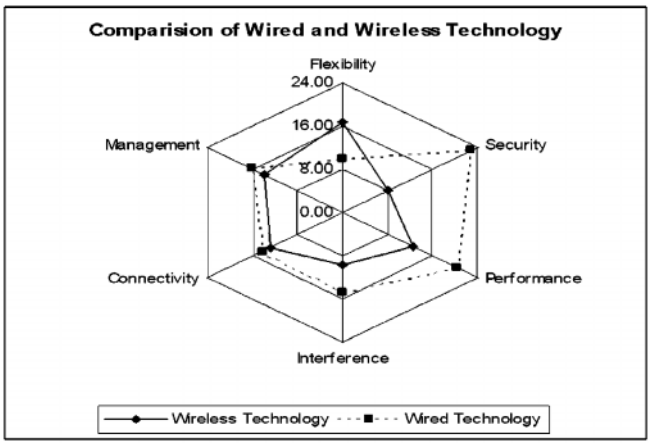

Fig. 1

In addition to above technical and managerial problems, there were also some other issues which hampered the progress. These are discussed as:

6.3. Bureaucratic Delays

This is a very basic kind of problem which every body faces while dealing with government agencies. The consequences of this problem were: 1) frustration in the team members, 2) delay in project implementation, 3) rise in cost, and 4) technological changes with passage of time. Though this problem has non – solvable nature, but some precautions helped a lot to get solutions. The team tried to discuss the matter informally with the authorities before putting it in a formal way wherever got opportunity. This provided some positive results and also save valuable time by avoiding unnecessary objections which generally arises due to non-understanding of some facts and technical concepts. Secondly, a follow up the files was kept in using both formal and informal ways.

6.4. How much Cost is Involved?

A survey of users' requirement and basic design phase helped us a lot to answer this question. But even this was not very much sufficient, so it was decided to call for EOI (Expression of Interest) at national Level. Then after the proper screening, eligible vendors were called to make presentations. This actually benefited the university to have an exact idea about the cost of project, evaluation of the solutions proposed by the university, latest trends in market and other possibilities of solutions.

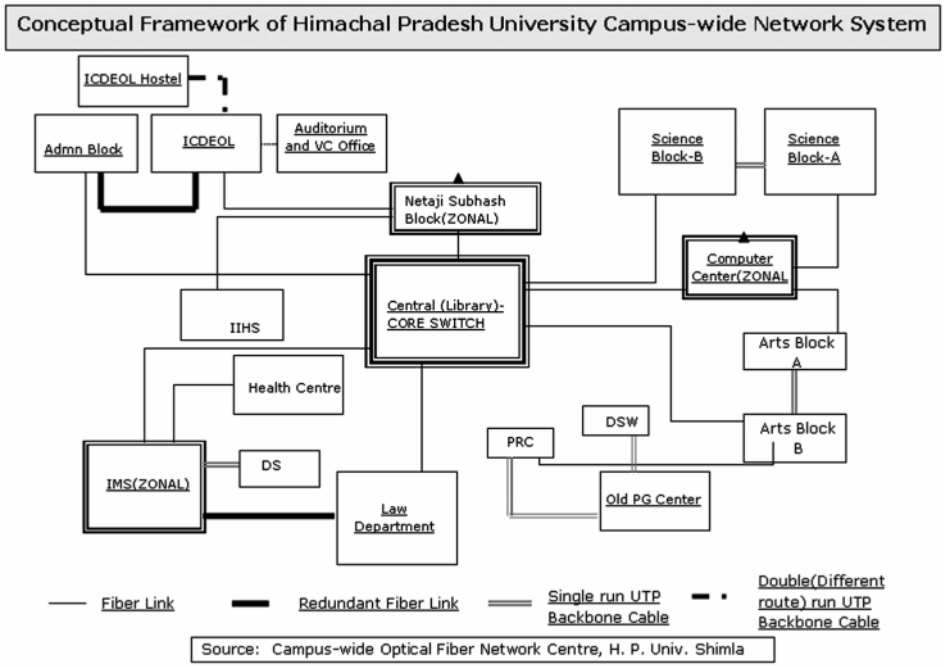

Fig. 2

6.5. How to Meet Out the Project Expenditure?

From the above, the approximate cost came around 90 lacks. As it was a big amount and financial status of the university was also not very good, so this became a big question that from where the amount would come? Then it was decided to pool the money from each department of the University. Further, some departments were identified having enough funds to contribute as much as possible. By doing this university got success to arrange funds.

6.6. Timeframe for Completion of Project?

This was one of the most important questions which needed to be answered very carefully. It was decided to fix a dead line for the each of the task involved in this project. After proper analysis of tasks to be done, the university decided that the implementing agency would complete the network installation work with in five months after receiving of supply order.

6.7. How the System Would be Maintained?

Maintenance is also most important part of project. It was decided to give AMC (annual maintenance contract) of this project to the implementing agency. The implementing agency would depute an engineer on permanent basis in university campus to look after the project. And from university side, one person would be deputed as Incharge to act as intermediary between implementing agency and university and to take care of post implementation issues.

7. PROPOSED NETWORK SOLUTION

After going through the above processes, the team came up with a conceptual framework of University Campus-wide Network System as shown in figure 2. The main characteristics of this system are: 1) A hierarchical star network topology, 2) Usage of Optical Fiber Cable for longer life, high bandwidth, high performance, high reliability and lesser number of errors. The Optical Fiber Cable for outdoor connectivity and UTP for internal connectivity within the departments and administrative blocks, 3) Redundant network system to provide all times connectivity, 4) Division of whole network system into zones for better management and troubleshooting, 5) Core switch was proposed to take care of all the traffic related to zone-wise, 6) Installation of server room at central place of the University, 7) Provision of extensibility to extend existing network system easily in future, 8) Usage of wired connectivity to provide restricted access to genuine users only within university campus.

8. CONCLUSIONS AND RECOMMENDATIONS

In this paper, we analysed how a conceptual framework for designing a University Campus-Wide Network System came out in a government sector environment. There were two phases: 1) study of existing system and users' requirement gathering, and 2) basic design of network. In all two phases, there were several managerial and technical issues which were resolved at various stages before proceeding further. Some of the major problems observed during designing of conceptual framework were: non- availability of required information, documentations or manuals of existing infrastructure, users' resentment and unawareness, fluctuations in users' requirement, bureaucratic delay, shortage of technical manpower and support, financial crunches, proper monitoring system, etc.

To take care of all these issues, it is suggested that there is need to: 1) maintain proper documentation of installed infrastructure, 2) store manuals and CDs at secure place, 3) always registered product with OEM (original equipment manufacturer), 4) try to maintain good relations with vendors. To deal with technical issues, it is better to have discussions with experts within the university and outside, involve experts from different areas in a team and appoint one team leader and one convenor, if necessary divided team into sub-teams keeping in view their expertise required in different areas, take members of the team into confidence to resolve various technical, managerial and financial issues. The nominees at the end of the government help to resolve various issues at the end of the government such as administrative approval, avoidance of bureaucratic delays, meet financial requirements, etc. This is also a need to put all facts in clear cut manner with supporting documents. To avoid bureaucratic delay, it is better to keep track of files both in formal and informal ways. Further, there is also a need to have good managerial skills in addition to technical skills to deal with such projects especially in public sector undertaking. In the end, it is concluded that generally the problem lies at the end of the management not at the part of the technology.

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