

Optimized Design of a Wireless Infrastructure for ICT enabled Education in Developing Country

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Abstract

Developing countries have got a lot of restrictions in carrying the ICT to the most possible end point of the society. This is basically due to the weak economy, increasing nature of the population, technological dependency on others, and prevalence of comparatively lesser advanced infrastructure. In this paper, a scheme has been presented to effectively plan and implement an ICT enabled educational infrastructure, keeping in view the different significant parameters corresponding to developing countries. The present study covers the analysis of a hypothetical spanning of servers, endpoints, heterogeneous traffics to be served, and also assignments of different quality of services and priority queues. The parameters that might have direct or indirect effect for establishing the system and keeping it up have been defined. The simulated model is supposed to serve as the prototype of a network infrastructure for ICT enabled services in a comparatively lesser technologically advanced situation and to act as the best fitted design for delivering optimum services.

Introduction

The two-way communication facilities in most of the developing countries are centered around the metropolis or urban areas. Although it has been observed during last one decade that the normal two-way voice communication infrastructure is

penetrating into the countryside, still in most of the cases it is unreliable, restricted, and facilitates very limited bandwidth connectivity. In such a situation, carrying the education to the masses using the ICT in many countries is still in its initial stage. The present study deals with designing and developing a scheme for implementation in building a wide area network for ICT enabled service delivery with limited system resources. The system resource considered here mostly signifies the channel resources and connectivity spanning. While developing the design of the system, the wireless technology has been considered as the media as it may be the most convenient and flexible technology to facilitate two way communications, irrespective of the geography, weather, remoteness, accessibility etc. The whole spanning is mapped as a nonlinear distribution, and imposing the limitations, requirements, and available conditions, the bandwidth allocation has been designed as a dynamic parameter. This may result in some technical complexity, but would contribute towards the optimized use of the available channel resources in a priority basis. Emphasis has been given in the development of the designed scheme so that it best fit for the socio economic conditions of any developing country. For a developing economy, utilization of available and minimum resources for best possible output is always expected. Optimization techniques have been used to extract for the best cost effective and sustainable model for the designed infrastructure so that technological

and available infrastructure limitations have least possible effect.

Background

ICT enabled educational systems supposed to deliver a wide range of services starting from shared access to centralized resources, to telecommuting, videoconferencing, virtual classrooms etc. As each category of services has its own quality of service requirements, and needs utilization of total system resources with different magnitudes, it is expected that the channel from the vertex of the network to the remotest node be arranged for maximum requirement. But at the same time this results in un-utilization of the allotted channel resources, when used for service deliveries other than that which uses the maximum channel resources. This has significant affects in overall network performance particularly in situation where the total channel capacity is limited due to variety of reasons. Particularly in countries where technological resource mobilization is still a difficult and time consuming task, the network system resource generation, development, maintenance and utilization become critical issues to deliver optimum services. On above considerations it is expected that the available system resources be utilized in a manner which corresponds to the optimum service delivery and such scheme be deployed for the network architecture and performance so that maximum service delivery is achieved.

Design Considerations

A hypothetical spanning tree network has been considered and different parameters based on the limitations, requirements and applications are imposed to extract the optimized utility. Total fixed bandwidth is considered as the highest priority parameter which is limited. The architecture is mapped as a nonlinear distribution, as may be in practical network expansion. The network is to serve different categories of traffic for carrying the ICT enabled education from the vertex, which is the master hub of the entire

network. The different nodes of the network are distributed with multiple tree structure with first level expansion from the central hub as a star configuration and subsequent expansions as nonlinear tree topologies. It is presumed that the nodes of the network are with different service requirements and demands and with heterogeneous priorities. This consideration leads to the proposed concept of dynamic bandwidth allotment for the branches of the network. This dynamism is proposed to be dependent on the node demands, service priorities and availabilities, and is a parameter under sole discretion of the master server station. This is to be served by an automated and self configuring control unit with predefined scheme.

The Scheme

P_0 is defined as the vertex of the architecture and the second level of expansion starts with a star extension with P_i nodes. The subsequent tree expansion of the spanning is defined as $P_i \dots\dots P_n$. For a level P_j , P_j might have any distribution of P_{jk} , with $k(1\dots\dots m)$. Since the expansion of branches in such an educational network may not necessarily be predefined, for any branch the endpoint may be P_{jk} or it may extend in some other case to P_{nk} . The path length from P_0 to P_{jk} or P_{nk} is thus a non-fixed parameter and based on the path length, the total number of serviceable nodes in that branch is also a variable. In this consequence, it is proposed that the channel bandwidth allotment for any branch in the expansion be taken care of as a dependant parameter on the depth of j , and also on another variable N_{rp} which corresponds to the requirements and priorities of the service requested or delivered by/to any node. N_{rp} is defined as a time varying quantity which signifies the real time requirements for any node in the network and also the priority of the service. The entire operation would be monitored and performed by the master server station control unit. The real time assignments for this unit are proposed as: enhancing multilink with optimum services by

dynamically adding or dropping links on demand. This will lead to the bandwidth on demand functionality. This implementation would be through a Link Control Protocol (LCP). The main function of this unit is to provide a mechanism for link and bandwidth management. Link management allows for learning and aging of links. This includes providing access to physical hardware of the additional available links or to disable such resources for a particular node or branch not in demand, to share for others. Bandwidth management decides when to add and drop links or paths based on link utilization. Thus for a node P_{jk} ($j=1\dots n; k=1\dots m$), the real time service delivery would be a function of: i) path length of P_{jk} , ii) the $[N_{rp}$ for $P_{jk}]$, and iii) the available sharable system resources upto the depth of j . The scheme has been simulated for a limited expansion of a hypothetical network infrastructure imposing the optimization theory concepts, and is considered to be a optimum service delivery model. This model is expected to be a best fitted prototype for implementation of a wide area educational network in situation where economy, geography, population and requirements are critical issues for developing infrastructures.

Conclusion

Network resource management, including served resources and system resources,

needs efficient control mechanisms to allocate network resources in such a way as to design traffic flows according to the various service characteristics. This paper presents a scheme as a tool for effective designing of ICT enabled educational network infrastructure for optimized performance. The real world situations are simulated and the scheme is expected to serve with maximum throughput for a limited resource situation. Though the result cannot be claimed with maximum perfections, as the present study deals only considering few maximum effective parameters, still the scheme attempts to serve for optimum performance.

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