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On selecting a technology evolution path for broadband access networks

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Abstract

The rapid growth in the number of Internet users has accelerated the use of high-speed Internet access services, including broadband multimedia services. In the delivery of broadband multimedia services to end-users, it is necessary to build a high-speed backbone and access network. To construct a broadband access network, several alternative technologies including xDSL, CATV, and FTTx have been suggested and implemented in telecommunication networks. However, even if a technology is proven to be optimal for the current environment, it can be deteriorated by the elapse of time or the advent of new challenging technologies in the future. In this article, we concentrate on the selection of an evolution path for broadband access networks. We developed an optimization model for selecting the best technology and evolution path with the minimum total cost. The problem can be formulated as a mixed integer programming model. With a scenario for demands and cost factors, we find the optimal evolution path by solving our model with the CPLEX program and illustrate some sample paths for the

Abbreviations: ADSL, asymmetric digital subscriber line; CATV, community antenna television/cable TV; DSL, digital subscriber line; DWDM, dense wavelength division multiplexing; FSS, fiber single star; FTTO, fiber to the office; FTTC, fiber to the curb; FTTH, fiber to the home; HDSL, high-bit-rate digital subscriber line; HFC, hybrid fiber coaxial; LMDS, local multipoint distribution service; OPTIMUM, optimized network architectures for multimedia services; PDS, passive double star; PON, passive optical network; RACE, Research For Advanced Communications in Europe; SDSL, single-line digital subscriber line; SHDSL, symmetric high-bit-rate digital subscriber line; TITAN, tool for introduction scenario and techno-economic evaluation of access network; VDSL, very high-speed digital subscriber line; WDM, wavelength division multiplexing.

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broadband access network evolution plan. Once the cost and the demand are defined in detail to reflect the real-world case, our model can be useful to generate a practical technology evolution plan for broadband access networks in real-world applications.

Keywords: Broadband access network; Network evolution; Mixed integer programming model; Multicommodity network flow problem

1. Introduction

The advent of the Internet has had a significant impact on access networks, particularly in the provision of various communication services. The increase of Internet usage has accelerated the transformation of traditional voice-based networks to data-based networks, which are effective in delivering Internet traffic. For instance, VoIP (Voice over Internet Protocol) and e-mail have been rapidly replacing voice communication services, while numerous other services based on the Internet are penetrating various areas, such as an entertainment, education, electronic commerce, etc. As the use of the Internet increases, users require high-speed network capability and seamless service provided by a convergence between fixed and mobile networks. Access networks remain one of the major obstacles to the deployment of a broadband telecommunications network. Services such as fast Internet access are emerging as likely broadband market drivers, and enhanced copper technologies and coaxial cable modems are enabling early entry for many of the telecommunication operators.

To provide broadband services, an access network should be evolved from the current narrowband to broadband connectivity. The evolution of broadband access networks will be accomplished by the upgrading of existing networks or the deployment of new technologies, which may change the economics of broadband services. The best way to provide broadband services in an access network is to set up an optical fiber cable to each user. However, this requires a huge investment to install the fiber transmission system. Alternatively, some broadband architectures based on upgrading the existing access network have been suggested. With rapid advances in computer and communication technologies, communication networks are evolving from narrowband to broadband networks employing emerging technologies. For broadband services, different types of technologies have arisen based on copper cable, optical transmission, wireless technologies, and satellite systems. Among these technologies, there is no dominant alternative in terms of economic and technological advantages.

In this article, we focus on the problem of selecting an optimal evolution path for a broadband access network. First, an optimization model to select the evolution path from the existing networks to a broadband network is suggested as a mixed IP Model. The model generates a cost-effective technology to accommodate the demand for broadband services, and provides information about when such a technology is introduced. Despite that a broadband access network is important for providing advanced services, there is apparently no literature on the problem of selecting an evolution path for access networks.

Since a communication network is composed of various equipment and has a complicated cost structure, it is difficult to analyze the effectiveness of technological investment on an access network with a simple model. Furthermore, for broadband access networks, we have to consider various