# Studies of Some Mathematical Problems in Protean Telecommunication Networks





by

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# Abstract

In this thesis, some investigations are carried out regarding the performance of telecommunication network systems when such networks undergo physical and logical changes. The problem of the utilisation of the enormous bandwidth of optical-fibre links and related optimization problems and solutions are described. The state of the art of high-speed electronics and electro-optics is continually advancing, but their speed will always be much lower than the bandwidth of the optical medium itself. Different technical aspects of telecommunication networks are described in terms of protean communication networks. A system that changes due to environmental and technical changes is known as a protean system. Graph theory results are applied in order to determine all the alternative paths between two nodes in a communication network. An algorithm is developed to solve the problem of congestion or the failure of connectivity on the recommended path between any two given stations. A stochastic approach of obtaining alternative paths in a changing network with two different collections of links not in communication state is investigated and also telecommunication networks are analysed when each link is in two possible states, namely, communication state and no-communication state. The no-communication state is then realistically divided into two, the failed state and the saturation state. Hence three possible states of each link are also investigated. Markov's stochastic approach is used to find the probability of obtaining alternative paths when a system is in a given state. The number of operable circuits is determined when a link or a number of links fail in a network and this work is extended for protean networks.

Results of the above are applied to the proposed Bulawayo telecommunication network, which is in the form of two rings connected to each other by a common node. Some modifications have been suggested and computations have been carried out to show how the sustainability of the communication system can be increased. The consequences of a link failure, if no alternative paths can be found, is more important. Thus it is important to keep track of failed links which we propose to call specified links. This investigation is done in order to distinguish those circuits which are operable from those which are not operable using the given algorithm. When a link fails, it will fail to transmit flow. This also means that all of the given flow may not reach the destination intended for the time period that the failed link remains unrepaired. We analyse the behaviour of such a two-state communication flow network with respect to terminal flow capacity matrices.