A reliability model for design and operation of telecommunication network considering disaster conditions

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I. INTRODUCTIO

The telephone network of Japan experienced many natural disasters and has developed its countermeasures against disasters and a reliability model of network has also been developed. Then, these countermeasures are systemized by using above reliability model. This article presents the past experience of disaster in Japanese network and describes the design principle. Moreover, an idea for establish new model for network management in disaster conditions is presented.

II. PAST EXPERIENCES

Many disasters such as strong wind, heavy rain, severe shake, brought the progress of countermeasures against natural disasters in Japan. In particularly, physical strength of facilities has improved. Then, at least the backbone network has the adequate strength against disaster which is supposed in Japan. On the contrary, the new knowledge has been obtained from Hanshin Earthquake in 1995 and Tohoku Earthquake in 2011. The first is that access areas have been suffered the great damage as to lose their original form. Secondly, the back bone networks lose their functions about one day or more after the earthquake occurrence due to the lack of fuel of stand-by generators. The third is that severe call congestions have occurred and the network performance have been degraded. These points still retain as the unsolved problems.

The goals of countermeasures are to reduce the degradation of network performance and the social disorder. The countermeasures are classified to reliability design in usual condition and operations in the disaster conditions. Because the both countermeasures take cost, the appropriate design method taking into account the cost effectiveness should be carried out. Constructing the reliability model which connects the countermeasures and its effect enables to assist the decision-making. Such model has been established for telephone network in Japan. In this model, the severity of service outage is quantified based on the social influences. The severities are defined by degradation of performance in transit network and defined by the number of users in access area. From this approach, the design principle that higher reliability is required for equipment which causes the more sever social loss is obtained.

The other point of view to design is the hierarchical structures of networks. For examples, a speech channel is consisting by using some transmission channels and a telephone office has exchanges and transmission terminals and so on. These structures relate to common cause failures in networks. By using the above defined severity and considering the hierarchical structure, the decision-making about the network structure, i.e. whether the exchanges should concentrate in an office or divided into two offices can be carried out. Other many reliability models have been established to design in usual condition.

Because unpredictable phenomenon may occur in disaster conditions, the predetermined countermeasures are not dependable. The important is to establish the decision-making organization and the principle to restoration of network and services beforehand of disasters. The main principles are, keeping emergency call, preventing isolation of areas, and keeping public telephones. The concrete restoration operations are carried out to achieve these principles.

III. THE NEW MODEL

It is thought that the past approach mentioned above is still useful for future networks, but there are problems to be considered. The following three factors should be contained in the new model. The first is to modify the network model to be suitable for the new architecture of telecommunication networks. For examples, so called NGN in which the various services are provided by under the control of control layer network is one of network architecture. Under those circumstances, the new ideas for reliability design in usual conditions are required. The second is the renovation of the concept of users. In the traditional network, the users are human being. However, right now, the users are not only human being but also the machine or network. For example, a cloud network is the customer of carrier network. In these circumstances, the idea of quantified loss should be renovated. The third is contribution to the reduction of social damage in disaster. The conventional idea for network in disaster concentrates how to protect network itself. As the result, it is intended to thought that networks should be designed at least as same strength as another social infrastructures. However, there is the possibility to reduce social damage by using the high reliable network in disaster. In activate this idea, the disaster restoration process and the communication needs in each restoration phase is considered as important.

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