ABSTRACT

The concept of reliability engineering is highly useful for designing, operating and validating many real-world systems. Reliability is a birth-to-death process and is concern of everyone. There are many networks in the real world systems which are designed to perform their required tasks in a given environment. This thesis analyzes the performance of such networks acknowledged by a technique called Universal Generating Function Technique (UGFT).

The main objective of this research is to study the performability of different networks based on the application of probability theory. Its research agenda includes analysis of certain reliability models, discussions on real life application of stochastic models in areas as diverse as Stochastic Flow Networks (SFN), Mobile Adhoc NETworks (MANET) and Vehicular Adhoc NETworks (VANET). This novelty research helps to find the performance measures of various real world networks. The ultimate aim is to offer a new design that realizes a highly reliable network that still conforms to other constraints like time and cost towards the systems' development.

Systems that are characterized by different levels of performance are known as Multi State Systems (MSS). In a MSS, both the system and its components are allowed to experience more than two performance states with various effects on the performance of the entire system. Due to the fluctuation of data or lack of accuracy, it is impossible to assess the performability of MSS with precise value. This thesis provides a platform for such models and analyzes the reliability of a MSS based on Universal Generating Function approach.

Chapter 1 expounds the origin and history of reliability concepts. Also it deals with the objectives and various measures related to reliability. It clearly depicts the different kinds of MSS, various types of paths, the UGFT and basic concepts related to MANETs and VANETs.

Chapter 2 deals with reliability analysis of a Stochastic-Flow Network (SFN). The reliability of a SFN is analyzed by considering a time-based multistate network composed of multistate edges. An algorithm based on Minimal Paths (MP) has been modelled to enhance the network reliability. The reliability of a SFN is studied by the capability of the system in transmitting data through m number of minimal paths simultaneously with time and budget constraints. They are allowed to transmit via m number of MPs with the purpose of reducing the transmission time. The flow model is characterized in terms of the capacity vector and the flow vector. The lower boundary points (LBP) are collected to obtain the network reliability. These points represent the minimal capacity vector of a path that meets the demand constraints. Finally the network reliability is computed using principle of inclusion and exclusion. The optimal pair of MPs with highest system reliability is further obtained. Reliability of the network in case of both unreliable nodes and branches is also reported in this chapter.

The assessment of MANET reliability using the UGFT is expounded in Chapter 3. A MANET is an autonomous and a dynamic collection of mobile nodes that communicate over wireless link without any fixed infrastructure.

An algorithm based on UGF has been proposed to execute the system reliability. The first step in the process is to model the node UGF for the source and sub source nodes of the network. The traffic via a member node is modelled using the node UGF. The successful transformation between the source node and target node via a member node is proposed by the path

UGF. State Dependent Probabilities are built for each node and path in the MANET. MANET reliability is executed by combining the path UGFs. In a MANET environment, the time and cost play an important role. Hence the performance of the MANET is studied with respect to time and budget constraints.

Chapter 4 emphasizes on executing the MANET reliability using UGFT with Cluster Head Gate way Routing (CGSR) protocol. In order to facilitate communication within the network, a routing protocol is used to control the traffic. One of the prominent routing protocols for MANET is CGSR. Most applications of MANETs integrate a group membership service with a reliable multicasting service. Gateway node UGF is introduced in this chapter to boost the communication effectively between the networks. Apart from this, an efficient algorithm that guarantees the optimum reliability of the MANET with CGSR routing protocol has been proposed. The proposed algorithm is validated with a case study. Reliability Ratio (RR) is also included to support the selection of the reliable optimum network.

Chapter 5 discusses the novel algorithm for performance assessment of a MANET using weighted Universal Generating Function Technique (WUGFT). The computation procedure will become cumbersome if the number of nodes in the network increases. Random weights are introduced in this chapter based on the flow of information to reduce the computational complexity. A novel algorithm has been designed to assess the reliability using WUGFT and is validated.

In Chapter 6, MANET reliability is enhanced with RCFP: (Reliable Cluster Formation Protocol) in terms of data transmission among mobile nodes. RCFP works in two phases. Finding the transmission range of nodes is done during phase I whereas grouping the nodes as clusters and electing a Cluster Head (CH) is done in phase II. Transmission Probabilities are defined

within the clusters, between the clusters and are used to calculate the MANET reliability. Simulation results show that the proposed protocol RCFP outperforms compared to the existing protocol DDM (Differential Destination Multicast), MAODV (Multicast Adhoc On Demand Vector Routing Protocol), EGMP (Efficient Geographic Multicast Protocol) in terms of packet delivery, delay, bandwidth consumption, control overhead and throughput.

Chapter 7 considers the VANET reliability using the UGFT. VANET is a subset of MANET where the moving vehicles are considered as nodes to make a communication between vehicles. The primary goal of VANET is to disseminate road safety messages including vehicles current speed, location, traffic alert messages, drivers behaviours etc. in an efficient manner. In this work, one of the source vehicles in VANET 1 forwards the traffic message to RSU_D which in turn routes the message to the nearest RSU (either RSU_S or $RSU_{D\&S}$). This RSU_S disseminates the information to the group of vehicles in VANET 2. This enables the users of different location to exchange traffic safety messages. The performance is simulated using NS-2. This enhances the robustness, security and reliability in the VANET environment.

Chapter 8 is intended to provide a reliable path discovery in VANET for transmitting road safety information among the vehicular nodes using RCPF. An algorithm is proposed in order to calculate the link reliability from the vehicular node to other ongoing vehicles on the roadside.

Chapter 9 summarize the work that has been done to analyse the performability of different kinds of networks. It addresses certain future research directions in executing the reliability of stochastic flow networks, MANETs and VANET.