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Dependability modeling of Software Defined Networking

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ABSTRACT

Software Defined Networking (SDN) is a new network design paradigm that aims at simplifying the implementation of complex networking infrastructures by separating the forwarding functionalities (data plane) from the network logical control (control plane). Network devices are used only for forwarding, while decisions about where data is sent are taken by a logically centralized yet physically distributed component, i.e., the SDN controller. From a quality of service (QoS) point of view, an SDN controller is a complex system whose operation can be highly dependent on a variety of parameters, e.g., its degree of distribution, the corresponding topology, the number of network devices to control, and so on. Dependability aspects are particularly critical in this context. In this work, we present a new analytical modeling technique that allows us to represent an SDN controller whose components are organized in a hierarchical topology, focusing on reliability and availability aspects and overcoming issues and limitations of Markovian models. In particular, our approach allows to capture changes in the operating conditions (e.g., in the number of managed devices) still allowing to represent the underlying phenomena through generally distributed events. The dependability of a use case on a two-layer hierarchical SDN control plane is investigated through the proposed technique providing numerical results to demonstrate the feasibility of the approach.

1. Introduction

The Software Defined Networking (SDN) paradigm [1,2] is an innovative network design philosophy that, by opportunely decoupling data and control plane, has the ambitious goal to simplify the application development as well as the network management tasks. The main idea is to use network devices (e.g., switches and routers) only for forwarding purposes and to implement all the network intelligence through a (logically) centralized software layer able to provide an abstracted view of the whole network. Such a component (the controller), representing the heart of the SDN architecture, is a logically centralized (but physically distributed) component that, on the one hand, is able to manage the heterogeneous ecosystem of network devices and, on the other hand, provides to upper layers a set of API to implement complex networking structures. In order to make effective the SDN approach, different issues have to be considered. In particular, the controller scalability has to be carefully investigated by examining and predicting its behavior under different operating conditions. Different solutions have been proposed to design scalable controllers (e.g., using replicated or hierarchical structures) even if only few works in the literature present performance evaluation studies [3,4]. However, due to the complex structure of such a component, to the high dynamics of the environments (in terms of both number/types of

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