Chapter 18

Performance Modeling of IEEE 802.11 WLAN using OPNET:
A Tutorial

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ABSTRACT

Computer simulation is becoming increasingly popular among computer network researchers for performance modeling and evaluation of computer and telecommunication networks. This popularity is due to the availability of various sophisticated and powerful simulators, and also because of the flexibility in model construction and validation offered by simulation. While various network simulators (both open source and commercial) exist for modeling and performance evaluation of communication networks, OPNET is becoming popular network simulator as the package is available to academic institutions at no cost, especially OPNET IT Guru. This chapter aims to provide a tutorial on OPNET focusing on the simulation and performance modeling of IEEE 802.11 wireless local area networks (WLANs). Results obtained show that OPNET provides credible simulation results close to a real system.

INTRODUCTION

The IEEE 802.11 is one of the most popular WLAN technologies in use today worldwide. This popularity results from the simplicity in operation, low-cost, high-speed, and user mobility offered by the technology. Computer simulation is becoming one of the most important tools for performance modeling and evaluation of telecommunication networks. It is often used to verify analytical models

and generalization of propagation measurement results. Although a real network testbed allows maximum integrity for performance testing and prediction, it is however, more economical to use simulation for performance evaluation purposes. Moreover, simulation can be performed in a very early stage of the system design and can therefore be very helpful in the design process. However, simulation can never be as accurate as a real system and there are intrinsic drawbacks that network researchers/developers need to be aware of when using network simulators.

There are several issues that need to be considered when selecting a network simulation package for simulation studies. For example, use of reliable pseudo-random number generators, an appropriate method for analysis of simulation output data, and statistical accuracy of the simulation results (i.e., desired relative precision of errors and confidence interval). These aspects of credible simulation studies are recommended by leading network researchers (Law & Kelton, 2000; Pawlikowski, Jeong, & Lee, 2002; N.I. Sarkar & Halim, 2008; Schmeiser, 2004).

OPNET (*OPNET Technologies*, 2008) is becoming one of the most popular network simulators as the package is available to academic institutions at no cost under OPNET academic program. It contains numerous models of commercially available network elements, and has various real-life network configuration capabilities. This makes the simulation of a real-life network environment close to reality. However, network researchers are often reluctant to use this package because they may not aware of the potential strengths of this package and also because of the lack of good tutorial on wireless network simulation using OPNET. To overcome this problem we provide a walk-through tutorial on OPNET focusing on the modeling and performance evaluation of IEEE 802.11 WLANs. This tutorial may be useful to both undergraduate and postgraduate students or professionals who are interested in using a credible network simulator for wireless network simulations.

The remainder of this document is organized as follows. We first provide a review of literature on network simulations, including OPNET. We then highlight strengths and weaknesses of OPNET. A tutorial on modelling and simulation of 802.11 WLAN using OPNET is provided. The simulation results are presented for a realistic network scenario. Finally the chapter concludes with a brief summary and direction for future work.

LITERATURE REVIEW

Computer network design and implementation involves interaction of various networking devices including Servers, network interface cards (NICs), switches, routers, and firewalls. In most cases it is ineffective with respect to time, money, and effort to test the performance of a live network. Computer network simulators are often used to evaluate the system performance without building a real network. However, the operation of a network simulator relies on various stochastic processes, including random number generators. Therefore the accuracy of simulation results and model validation is an important issue. A main concern in wireless network simulations or any simulation efforts is to ensure a model is credible and represents reality. If this can't be guaranteed, the model has no real value and can't be used to answer desired questions (McHaney, 1991; Sargent, 2004). For selecting an appropriate network simulator for a particular application, it is important to have good knowledge of the simulator tools available, along with their strengths and weaknesses.

However, selecting the right level of detail for the simulation is a non-trivial task (Heidemann et al., 2001). For example, if simulating a large company intranet the elements in the network are so complex that it would be a large overhead to simulate each single instruction that is being executed on a node. This, however, may be necessary if simulating a wireless sensor network where energy consumption is one of the main concerns for the system developer (Shnayder, Hempstead, Chen, Allen, & Welsh, 2004).

While some simulation tools are multi-protocol and can be use for multi-purposes, another class of simulation tools can be highly specialized and use for specific purposes. This is why research groups of different network (cellular networks, ad-hoc networks, sensor networks, IP networks) have developed simulators to meet specific requirements with respect to the level of detail. But even

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