Chapter 6
Traffic Analyses and Measurements: Technological Dependability

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ABSTRACT

Resource management schemes in current data centers, including cloud environments, are not well equipped to handle the dynamic variation in traffic caused by the large diversity of traffic sources, source mobility patterns, and underlying network characteristics. Part of the problem is lacking knowledge on the traffic source behaviour and its proper representation for development and operation. Inaccurate, static traffic models lead to incorrect estimation of traffic characteristics, making resource allocation, migration, and release schemes inefficient, and limit scalability. The end result is unsatisfied customers (due to service degradation) and operators (due to costly inefficient infrastructure use). The authors argue that developing appropriate methods and tools for traffic predictability requires carefully conducted and analysed traffic experiments. This chapter presents their measurements and statistical analyses on various traffic sources for two network settings, namely local Area Network (LAN) and 3G mobile network. LAN traffic is organised in DiffServ categories supported by MPLS to ensure Quality of Service (QoS) provisioning. 3G measurements are taken from a live network upon entering the IP domain. Passive monitoring was used to collect the measurements in order to be non-obtrusive for the networks. The analyses indicate that the gamma distribution has general applicability to represent various traffic sources by proper setting of the parameters. The findings allow the construction of traffic models and simulation tools to be used in the development and evaluation of flexible resource management schemes that meet the real-time needs of the users.

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INTRODUCTION

Information and communication services experience most vigorous advances in modern networks. The adoption of new technological paradigms such as cloud computing, opportunistic communication, delay tolerant networking, ubiquitous sensors networks and machine-to-machine communication only stressed the importance of ubiquitous connectivity and information availability at any place, time and quality. At the same time, users demand forever increasing diversity of services in a technology transparent manner. Often, these are services with high quality demands, i.e., according to Cisco (Cisco, 2013) and Ericsson (Ericsson, 2013) video and multicast services will dominate the mobile network traffic by 2020. The combined effects of the above phenomena on the network is a fluctuating demand for network capacity (bandwidth) caused by the large variety of applications and services and their corresponding needs to move data in the network, quickly and at high frequency.

Several factors contribute to the varied nature of current network traffic. On the one hand, novel services are no longer symmetric. Most services are implemented between devices without the direct influence of the end-user. For example, sensor networks offer high variety of applications ranging from body area monitoring to video surveillance with quadcopters. On the other hand, applications running on top of different technologies generate distinct traffic patterns – transactions (read, write and search) in the Fibre Channel Protocol (FCP) are rather different from transactions among sensors in Body Area Networks (BANs) or smart phones’ broadband applications. Video and voice traffic additionally cause variations in the traffic pattern, depending on the applied codecs for video and voice over IP, which codecs are able to adjust the packet length and rate to match the channel conditions. Similarly, TCP sessions adapt window size also depending on the end-to-end channel status.

Another factor with strong influence on traffic patterns is the network itself. As traffic flows pass network devices they become object of traffic policing and traffic shaping algorithms or simply stay in a queue. For some services, queues at the far-end are intentionally introduced to deal with delay jitter equalization. In other cases after waiting in a congested node, the traffic pattern is different due to the congested node’s behaviour. Therefore, there is a need for end-to-end traffic performance management and of distributed Quality of Service (QoS) algorithms that could be dynamic and react depending on the technology and the current circumstances (Rolla, & Curado, 2013).

As result of service diversification and network policing, current data traffic is characterized by a large diversity of traffic patterns. Current traffic tends to be bursty with video and voice traffic flooding. Traditional approaches towards traffic prediction fail to reflect the rapidly changing traffic characteristics. Traffic engineering approaches developed by Erlang and Engset are not directly applicable in this new service environment (Schwerdel, Reuther, Zinner, Müller, & Tran-Gia, 2014). Hence, the need for appropriate network traffic modelling occurs. Proper traffic modelling cannot be done in the lack of proper traffic measurements and analyses in the forward and backward directions as well as at the access, edge and core parts of the networks. Such measurements and the following statistical analyses of the flows’ behaviour are the starting point for on-the-fly resource configuration and dynamic management mechanisms (Mousicou, Mavromoustakis, Bourdena, Mastorakis, Pallis, 2013).

The aim of this chapter is to make traffic measurements and analyses at up-to-date traffic sources in IP and 3G networks and to find a distribution function that is flexible enough to map to different flows’ pattern by tuning the function’s parameters. The conducted research covers experimental analysis in two phases. During the first phase, measurements are performed in the lab, whereas the second phase is related to measurements in a UMTS network. The measured data are evaluated by three different sta-