Chapter 3
Cross Layer QoS Implementations: The Clean-Slate Approach

Virgil Dobrota
Technical University of Cluj-Napoca, Romania

Andrei Bogdan Rus
Technical University of Cluj-Napoca, Romania

ABSTRACT

Quality of service has been an open issue from the beginning, due to the Internet paradigm of delivering the datagrams as simple as possible, on a hop-by-hop basis. As an answer to the inefficiency of the legacy solutions, rethinking of Internet principles brought among other ideas the self-management. Based on a clean-slate approach applied within FP7-4WARD project, this chapter proposes preliminary design and implementation of a key management capability of the near Future Internet, i.e. Cross-Layer QoS. Its applications are focused on congestion control (triggering activation of network-coding techniques) and QoS-aware routing based on a modified Dijkstra's algorithm.

INTRODUCTION

Although quality of service in IP-based networks is still an important research topic in IT community, with a significant effort towards standardization for almost two decades, there is no widespread study of such techniques in commercial applications and infrastructures. As a result, the end user is still receiving best effort services. A major explanation of this situation is that the implementation of classical QoS mechanisms supposes an increased operational cost. Moreover it demands strong expertise, thus the operators rather prefer over-provisioning solutions. This approach might be suitable for wired networks, but it definitely wastes the resources when it is implemented in wireless environment. Nowadays, real time services are becoming very popular but the classical

DOI: 10.4018/978-1-4666-0960-0.ch003

approach for QoS guaranteeing is not suitable anymore. The traffic parameters cannot be always maintained in a strict range of values. Thus, the Quality of Experience (QoE) is very often not acceptable. The cross-layer paradigm was proposed to be a solution for this challenging issue. Thus the entities could exchange management information, obtaining a global view of the networks performances in real-time. Consequently, optimal decisions are expected to be taken. Thus, communication protocols from upper layers are able to adapt their behaviour according to the variation of the traffic parameters from lower ones.

Following the legacy solutions for guaranteeing the quality of service, the main focus of this chapter is to propose a clean-slate design and a preliminary implementation of cross-layer QoS architecture. The results are based on experience obtained within FP7-"4WARD—Architecture and Design for the Future Internet," during 2008-2010. According to Correia, Abramowicz, Johnsson, and Wünstel, 2011, the term "clean-slate approach stands for a coherent solution that breaks the current network's stagnation imposed by the need to support current technologies and solutions; it is the answer to the following question: with what we know today, if we were to start again from scratch, how would we design a global communications infrastructure?"

The original results presented herein reflect the authors view and not necessarily the position of the project. However, several publications, such as Rus et al. (2010), Rus, Dobrota, Vedinas, Boanea, and Barabas (2010), and Rus (2011), include parts of the proposed implementation, validating the ideas. The two major applications covered by this chapter are congestion control and QoS-aware routing. None of them would have been possible to be demonstrated with the existing solutions, because they involve the Cross-Layer QoS (CLQ) with self-management. First, a real-time implementation of a six-node testbed in a butterfly topology was deployed. Whenever congestion occurs on an existing link and over-provisioning and/or re-routing are not possible, the management capability could trigger the activation/de-activation of cooperative techniques, such as Network Coding. This application does not solve the congestion but it allows the network to face the situation and to improve dramatically the quality of experience. The second application is an OMNET++-based simulation of a 13-node topology. The Dijkstra's algorithm, used by the OSPF (Open Shortest Path First) routing protocol, can be modified due to CLQ self-management information exchanged permanently between the nodes. Note that the traffic parameters are obtained in real-time, and only the QoS-aware routing based on this modified algorithm has been simulated. The conclusions at the end of this chapter are followed by future work and references.

BACKGROUND

The classical approach where the communication protocols worked independently from each other was suitable for non real-time applications running over wired networks. In what concerns real-time services, the previously mentioned paradigm proved to be unsatisfying. A certain degree of adaptation is necessary to optimize the execution of high-level applications or protocols, using information received from the lower layers. In this section, we discuss first about the information exchanged between the layers through cross-layer techniques. Examples according to evolutionary approach are accompanying the survey, the material being organized with respect to the OSI Layer the information is acquired from. Later we commented the role of the clean-slate approach with respect to the step-by-step strategy of progress is this field.