Scheduling Algorithms for Different Approaches to Quality of Service Provisioning

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Abstract. IP network provides only best effort delivery meaning, that data is transmitted at unspecified variable bit rate and delivery time is unknown, depending on the current traffic load. Nowadays, real-time traffic occupies significant percentage of the available bandwidth and Internet must evolve to support new applications. Therefore one of the main and crucial objective of the future Internet is to change best effort network into Quality of Service controlled network.

Authors believe that virtualization may be an important component of the Future Internet architecture as well, therefore we search for scheduling policy, that will be implementable as a physical network adapter scheduler in virtual monitor, capable of QoS provisioning. The main purpose of this paper is to review the existing scheduling algorithms and to consider their usage in virtual monitor with the aforementioned assumptions.

Keywords: quality of service, scheduling, hierarchical scheduling, service curve.

1 Introduction

IP network provides only best effort delivery meaning, that data is transmitted at unspecified variable bit rate and delivery time is unknown, depending on the current traffic load. For newly developed applications and services such as VoD (Video on Demand), VoIP (Voice over IP), VTC (Video-Teleconferencing), interactive games etc., such delivery is unacceptable, since in case of congestion the Quality of Experience (QoE) may decline to unsatisfactory level.

Nowadays, real-time traffic occupies significant percentage of the available bandwidth and Internet must evolve to support new applications. Therefore one of the main and crucial objective of the future Internet is to change best effort network into Quality of Service controlled network. Various applications may have different, sometimes stringent requirements in terms of packet losses and delays. The simplest way to provide different transmission parameters for each application, is to deliver a separate network for each new application or to strictly dedicate part of the existing network to it.

Although the idea to build a new, dedicated network sounds unrealistic, the practical solution may be feasible – virtualization. Virtualization of networking
resources has several advantages. The most important is, that several overlay networks can use the same underlying physical infrastructure, being unaware of it. Virtualization allows coexistence of multiple networking technologies in the network layer and offers a possibility to deploy new architectures, protocols and services. As a matter of fact, it is considered a key component of the Future Internet architecture.

Unfortunately, available virtualization techniques do not provide resource virtualization mechanisms required for Future Internet needs, namely for QoS provisioning. Virtual links may require supporting the services with different Quality of Services requirements ranging form best-effort to fixed loss and delay. To satisfy those guarantees and provide isolated and dedicated virtual network, effective and adequate scheduling algorithms are necessary for each network element.

Network virtualization allows sharing hardware and software resources by several independent, isolated networks – virtual networks. Network virtualization requires virtualization platform, which provides resource virtualization. The most common software virtualization platforms are Xen (OracleVM, Citrix), KVM, VmWare ESX. In those platforms, access to each physical device is provided by a scheduler responsible for allocating device to the virtual machines.

Virtual network consists of virtual nodes and links. Virtual links require provisioning of services with different Quality of Service requirements. Therefore, the problem of scheduling traffic coming from different virtual networks into one physical adapter, is similar to the problem of scheduling packets in the network supporting differentiated services.

The main goal of the scheduler is to divide the total output link capacity between existing virtual networks with the assumption of the optimal usage of link capacity and providing defined QoS requirements. Aforementioned platforms does not provide suitable network card virtualization mechanisms, since they offer only basic sharing parameters. Therefore to enable QoS provisioning in network virtualization, designing schedulers that allow achieving the desired parameters and optimal resources usage is required. The problem of scheduling mechanisms in virtual networks is widely discussed in [1][2][3][4]. Authors indicate the lack of the performance isolation, underutilization of the resources and high cost of the context switching. The presented work concerns the overall problem of scheduling.

The rest of this paper focuses on the existing schedulers, designed to support QoS in network with different traffic classes and considering their application for network card scheduler in virtual monitor. The rest of the paper is organized as follows. Section 2 reviews the Quality of Service related issues and architectures for QoS provisioning. In Sect. 3 different scheduling algorithms are presented, designed for real-time service, link-sharing service provisioning or for both. Finally, the paper is concluded in Sect. 4.

2 Quality of Service in IP Network

When it comes to providing Quality of Service, the first question is “how to define the QoS”? Term Quality of Service refers to the network capability of providing