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Active Queue Management in network  
communication node based on non-integer  
order PID controller

Rozprawa doktorska napisana pod kierunkiem  
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# Abstract in English

The purpose of the dissertation is to evaluate the use of the non-integer order  $PI^\alpha D^\beta$  controller as an Active Queue Management (AQM) mechanism implemented in a communication node. Obtained results allow to evaluate the effectiveness of proposed method and compare them to existent and used AQM mechanisms. The planned research experiments were performed based on simulation and analytical methods: Fluid-Flow approximation and diffusion approximation. The simulation model was created using the discrete event simulator SimPy and was written in Python language. The analytics models were written in Python and C languages. The  $PI^\alpha D^\beta$  computations are complex. To accelerate the computation the implementation in GPU structures was proposed.

This dissertation is a collection of five peer-reviewed research publications that present a detailed description of the proposed models and performed research experiments.

The chapter 1 introduces the topic of the dissertation and presents the selected research techniques. It also describes the aim and thesis of the dissertation.

The chapter 2 discusses Fractional Calculus, directly related to the computation of the response from non-integer order  $PI^\alpha D^\beta$  controller. It also presents definitions and properties of continuous and discrete systems. This chapter provides the theoretical basis for the model presented in this dissertation.

The chapter 3 defines an Active Queue Management mechanism based on the non-integer order  $PI^\alpha D^\beta$  controller.

The chapter 4 describes two analytical methods: Fluid-Flow approximation and diffusion approximation used to evaluate models of Active Queue Management mechanisms.

The chapter 5 describes the most important research results and presents the author's contributions.

The chapters 6-10 presents the publications included in the dissertation. The obtained results proves thesis stated in this work. Creating an Active Queue Ma-

nagement mechanism based on non-integer order  $PI^\alpha D^\beta$  controller it is possible to obtain an increase in the bandwidth in computer networks. Furthermore, the diffusion approximation model allows for assessment of the cooperation of TCP and UDP flows with the mechanisms of Active Queue Management. It allows for obtaining more detailed results of the queue behaviour than the classical method of Fluid-Flow approximation. It also enables the modeling of more complex Wide Area Network (WAN) structures.

The chapter 11 summarizes the scope of the work, presents final conclusions and proposes future works.