



POLITECHNIKA WROCLAWSKA

Wydział Informatyki i Telekomunikacji

Katedra Systemów i Sieci Komputerowych

Traffic forecasting in optical networks with predefined traffic levels

Prognozowanie ruchu w sieciach optycznych
posiadających ustalone poziomy ruchu

mgr inż. Daniel Szostak

Promotor: prof. dr hab. inż. Krzysztof Walkowiak

Słowa kluczowe:

- Uczenie maszynowe
- Sieci optyczne
- Szeregi czasowe
- Klasyfikacja
- Regresja
- Prognozowanie ruchu sieciowego

Wrocław, październik 2022

Abstract

Quick and global development of network technologies and services reflects in traffic increase in backbone networks. Nowadays means of communication, carrying voluminous, aggregated user data traffic, are optical networks. They use fibers linked into one physical cable as a transmission medium. Using the wavelength division multiplexing technique, data are transported using optical channels transmitted at different wavelengths. A next-generation optical networks architecture called Elastic Optical Networks allows to optimize network operation and management. It uses orthogonal frequency division multiplexing technology, which distributes data in a multicarrier system, where each sub-carrier is orthogonally modulated. A single optical channel supported by a single transceiver can carry a fixed amount of data. As a result, the information required to establish a connection is the number of optical channels required to carry a transmission. Additionally, most of the transport network technologies such as an Optical Transport Network, various versions of Ethernet, satellite networks, different generations of mobile networks or computer networks where transmission medium is twisted pair cable are also provisioned in some granularities of the bitrate.

This dissertation focuses on network traffic forecasting. Due to physical network characteristics, the task is realized by predicting future traffic levels rather than the exact traffic volume. Two main problems are considered, namely a one-step ahead prediction, which is referred as a *short-term* traffic forecasting and a multi-steps ahead prediction, which is also called a *long-term* traffic forecasting. Information from each forecasting type can improve various network management tasks, i.e., routing, failure detection, network expansion planning. For both problems this work checks possibility of traffic levels forecast by statistical analysis, application of machine learning algorithms and application of time series algorithms. All algorithms were tested using three proposed forecast approaches. Methods that obtained the best results were examined under various real network scenarios. To estimate performance of algorithms, thus final traffic level forecasting quality, this work proposes new quality metric, which can be adjusted to operator expectations.

According to the obtained results, machine learning algorithms allow to forecast traffic levels with high quality. Additionally, their performance outperforms naïve statistical analysis methods.