The correct and fast operation of large IT systems that support thousands of users every day is crucial in many types of corporate operations. Limiting the speed of the computer network and the processing power of data processing servers significantly affects the response time of the application during communication, e.g. with the database server. In most cases, every hindrance causes a decrease in the productivity of employees of the company, which has a fundamental impact on the costs incurred.

The paper presents a comparison of various methods of analysing the efficiency of an IT system on the example of a separate part of the system implemented in the largest Polish insurance company. The data on the network applications operating within it was collected during the system monitoring.

The aim of the dissertation is to create a queuing model of the tested part of a computer network in which interactive applications operate and to use this model to examine the system's efficiency, including the prediction of its response time with an increasing number of users or an extended configuration. This is the practical purpose of the dissertation.

The proposed queuing model is solved by means of simulations of discrete events and by means of several analytical methods, which gives the opportunity to examine the suitability of individual methods in terms of errors and necessary computational effort, as well as the simplifications necessary for a given method and their impact on the accuracy of results. This is the theoretical goal of this paper.

Analytical methods taken into account are: Markov chains, medium value analysis and diffusion approximation. The results of analytical models are compared with the results of the simulation model, which is considered here as a reference model. The system described consists of a database server and many hosts connected to each other via a local computer network.

Employees of the company use the system by entering specific documents into the system and by analysing and searching them. Based on the measurements, a model of activity of individual applications and activities of clients using database resources was created. All measurements were collected in a working system.

The system was analysed using a simulation model and three analytical models: successively based on Markov chains, mean value analysis and diffusion approximation. The purpose of the analysis is to determine the time needed to service the client during one session between the server and the client and to determine how this time will change if the number of clients increases. This time is composed of many operations performed on the database server. In the system, all users can work in parallel and independently using interactive applications that enable employees to retrieve data from a database or send documents that have been already changed. It has been assumed that each server supports access to a specific application. Each application has its own characteristics and form of presenting the received data from the database. Each application also contains other mechanisms for processing the received data.
The analysis started with measurements of the actual system during its normal operation. Data was collected during users' work in the business hours. The collected data allowed to construct a synthetic model of activity of each application, which was used to later examine the behaviour of the system in the event of an increase in the number of users. In this work, complex computer network simulators are not used, the work is based on queue theory models.

The basic model considered here is as follows: clients arrive at the service station at intervals, which are a known (described by a certain probability distribution) random variable, next they are scheduled in anticipation of service; the service time is also random. In models of computer systems, clients are processes and service stations are elements of the system necessary at a given stage of the process. Service time is the time that a given item is allocated once to the process.

Analytical queuing models, despite numerous simplifications, are able to capture the dependencies between the basic parameters of the system, indicate its bottlenecks and predict the response time in the function of the load. This is already shown by decades of practice. Using the model, one can predict in the system design phase whether its selected variant can perform tasks in a timely manner and whether the bandwidth of its individual parts is well-chosen. For systems already in operation, modelling allows for a quantitative assessment of changes in their operational parameters in the function of planned changes in configuration or load.

A natural complement to the analytical models are simulation models using simulation of discrete events that recreate events occurring in the queue network. Simulation models are much more flexible than analytical models: they are able to describe more complex mechanisms of customer circulation in the network and mutual relationships between clients; they include the principles of communication protocols and traffic control mechanisms; it is also easy to include random time distribution generators. Their disadvantage is a longer execution time --- the simulation of network operation must be carried out long enough for the results to be reliable, i.e. that a sufficiently narrow confidence interval can be determined with a high level of confidence. Therefore, analytical models can be used to examine many variants of the designed system, so that later, after narrowing the search area, a more accurate simulation model can be built.

Chapter 2 presents the characteristics of the network under study and briefly discusses each of the interactive applications studied. The description shows the problems related to network performance when using interactive applications. The influence of the application's work on the operation of the network is also presented. Chapter 3 presents the method of collecting information that was used later in the analysis of the system. The collected data was described and a preliminary analysis of the results obtained was made. Chapter 4 describes the queuing model adopted in the work. Chapter 5 presents information on the measurement data and the method of carrying out the simulation. A description of the selected distribution parameters was presented and an analysis of their results and modelling was presented. Further, the OMNET ++ simulation tool was described. Chapter 6 presents the Markov model used in the extended and simplified version. Chapter 7 describes the model based on diffusive approximation. Chapter 8 presents the model associated with the mean values analysis (MVA). Chapter 9 shows how the time distributions are obtained based on the calculated queue distributions and the results of individual methods were compared.