Performance Modeling of Hierarchical List Structures

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Sequential Lists are widely used in the filed of telecommunication. These lists are exist in firewall systems, in Access Control Lists (ACLs) in routers, or in filter lists in personal computers (for example in LINUX or BSD). With the aid of lists we can filter the incomming/outgoing traffic of our PC or router. In base list-structures, when a packet arrives into the router or PC, the processor matches it against the rules of the list. For long lists this searching time plays a significant role in the packet delay.

In different platforms and in different systems the searching method in these lists can be different. The Access Control Lists in IP routers use simple sequential searching method, or hash structures. The BSD in personal computers use some trick to reduce the execution time of searching. It creates groups from the list-rules and it decides in which group is the searched match. Other systems use balanced tree structures for reducing the searching time. In our work we created a mathematical model, which can describe these hierarchical list structures. From the proposed model we also want to derive performance indices, such as packet delay and packet loss, what packets suffer in the list.

The proposed model uses a Markovian structure, called the Discrete-time Quasi Birth-Death (DQBD) process. That can be described and solved in a matrix-geometrical way. With the aid of this type of process we can also calculate parameters that other structures are unable to handle, e.g. state-distribution or the effect of a finite buffer. Since

using DQBDs the model can derive performance parameters, like packet delay and packet loss ratio, from a parameterized hierarchical list. In our model parameters are the rule system of the hierarchical list together with the matching probabilities and the description of the incoming traffic. The input/output traffic can be described by a Markovian Arrival Processes (MAP) or by a Phase-Type (PH) distribution, which are widely used in the field of Markovian performance modelling.

With the aid of our model, lots of performance parameters can be calculated. Because of this fact the model can be used efficiently in testing and development of filter systems.