Throughput optimization in real-time payment systems

Degree programme: BSc in Computer Science | Specialisation: Distributed Systems and IoT
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Industrial partner: SIX Payment Services, Zürich

SIX Payment Services processes millions of cashless transactions every day. Managing that amount of payments does not come without challenges. One of the biggest is to optimize the applications network in which the transactions are processed.

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Introduction

Imagine: It's the last Saturday before Christmas. You would like to pay as quickly as possible at the cash desk and go home to wrap the gifts. You want to pay with your card as usual, but the payment terminal refuses to accept your payment. Not because you have too little money but because the payment system is very busy before Christmas. Unfortunately, you do not have any cash with you and therefore cannot buy the presents. Very soon, a lot of people have the same problem and are queuing. This situation is an absolute nightmare and should be avoided.

The simulation tool

PathSim is a tool that simulates a payment service system. This payment service system should be available 24/7, and if a payment transaction is sent to the system multiple times, repeatable responses should be sent back, based on payment acceptance criteria of the executing bank. The system behaves reliable and repeatable. But in case the system is very busy, a queuing situation can accrue and transactions can be refused.
PathSim helps to analyze these queuing situations. It shows the detailed state of the payment network for any simulated step. The foundation of the simulation is a static network, which can be modeled as a graph with edges and nodes. This graph defines which transaction can be passed along which edge. The nodes represent task steps for transaction processing. Multiple transaction processes are implemented in one node when processing the transaction (this allows parallelization within one node). In figure 2 below, each transaction process is a cylinder. The edges are the grey lines on the ground and the nodes are the base circles of the cylinder. The edges are the grey lines on the ground.
When the first transaction enters the first node, the simulation decides based on the edge definitions, where the transaction has to go next. Then a link to one of the target node transaction-processes will be created. The link is the realization of an edge. When a link was created, it persists. Every following transaction will first check if there exists already a link that can be used and if it is available. The transaction is transported from the entry node to the addressed end node (the card issuer). After an external process at the issuer a confirmation is returned. The links and transaction-processes are blocked until the confirmation returns. If a transaction can not be confirmed in a reasonable time, it is aborted, and the links and transaction-processes are unblocked. If this happens too often, a queuing situation occurs.

Results

The main result of this thesis is the simulation tool PathSim with a GUI, which allows to analyze various transaction-scenarios. With the help of PathSim, queuing situations should be reduced.

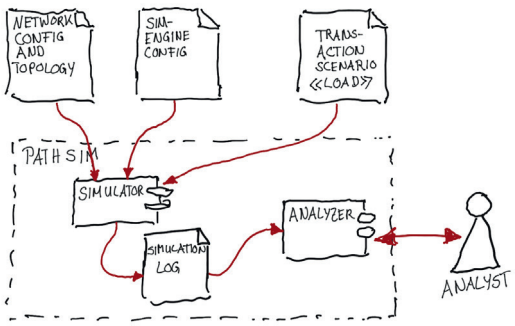

Figure 1: Structure of the program

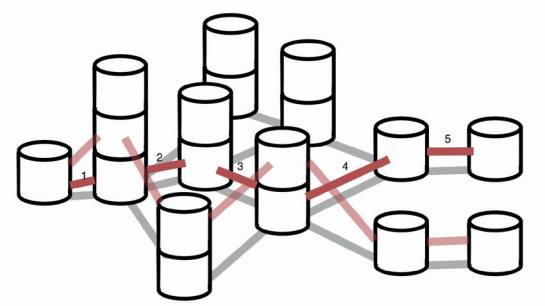

Figure 2: Simple illustration of the system