Generalized Net Model of Common Internet Payment Gateway

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Abstract: A payment gateway is a service that authorizes and processes debit/credit card or other payments for online merchants it facilitates these transactions by encrypting sensitive data and transferring it between a payment portal (a website or a mobile device) and the bank/front end processor. In this paper we examine the transaction process, even though it takes only a few seconds, several steps are accomplished during that brief window of time. Here we present a generalized net model of such an internet payment gateway.
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1 Introduction

The current paper examines Generalized Net (GN) [1, 2] model of a common payment gateway since there many payment systems [3], we are going to use a common one and will show all the parallel processes that go through such system.

Here we have to mention that all the processes (transactions) are encrypted [9, 11] for security reasons. The security [9, 10, 12] is the key factor for flawless work, the GN [6] model helps us easily analyze the payment gateway and solve possible gaps in the systems. Nowadays customers and merchants are forced to use multiple systems, mobiles or website for payments to pay for goods and the payment gateways are these that interconnect [7] these systems. The way that payment systems work [4], is explained in a few steps in order to simplify the process these are: The customer must have a "user account" created with a personal data in order to be able to make purchases through the website or a mobile phone. He will also need a valid credit or debit card. Payment details are encrypted [9, 11] via the electronic payment system. Then there is a

check of the user account database, if ok it continues to check the cards database. There is an initial merchant account validation too, if ok, the process continues to present the customer a choice of the merchandise or the service that the customer wants to buy. Here we can put a note that at all the different stages if there is problem with any of the described processes the system halts and exits, and the process can start from the begging. The next hop after success is the credit card balance check followed by the merchant account check, if a success the funds are withdrawn from the card. The goods then are send to the customer and a confirmation of successful transaction is being sent to the person responsible for the transaction. In this paper we are generally looking at a common payment model [4, 8] The GN – model [1, 2] will help us easily and clearly understand the main mode of operation stages of the gateway so then we may be able to improve security, troubleshoot and analyze better.

2 Common internet payment gateway

Ultimately, payment gateways facilitate communication between a website or a brick and mortar stores, the payment processor and the bank that issued the credit card being used to complete the purchase.

Initially the following tokens enter in the generalized net:
- in place L_1 - A - token with characteristic "Customer";
- in place L_2 - B - token with characteristic "Credit Cards Database Info";
- in place L_3 - B_1 - token with characteristic "User Account Database Info";
- in place L_4 - B_2 - token with characteristic "Merchant account Database Info";
- in place L_7 - S - token with characteristic "Merchandise/services";
- in place L_9 - B_3 - token with characteristic "Acount balance";
- in place L_{10} - B_4- token with characteristic "Merchant account verify";
- in place L_{16} - G- token with characteristic "Merchandise delivery ";
- in place L_{17} - G_1- token with characteristic "Confirmation delivery ";

3 GN - model

The GN model of common payment gateway (Figure 1) is introduced by the set of transitions:

$$A = \{Z_1, Z_2, Z_3, Z_4, Z_5\},$$

where the transitions describe the following processes:
- $Z_1 =$ „Initial authorization";
- $Z_2 =$ „Choice of merchandise/services";
- $Z_3 =$ „Payment processing";
- $Z_4 =$ „Holding funds";
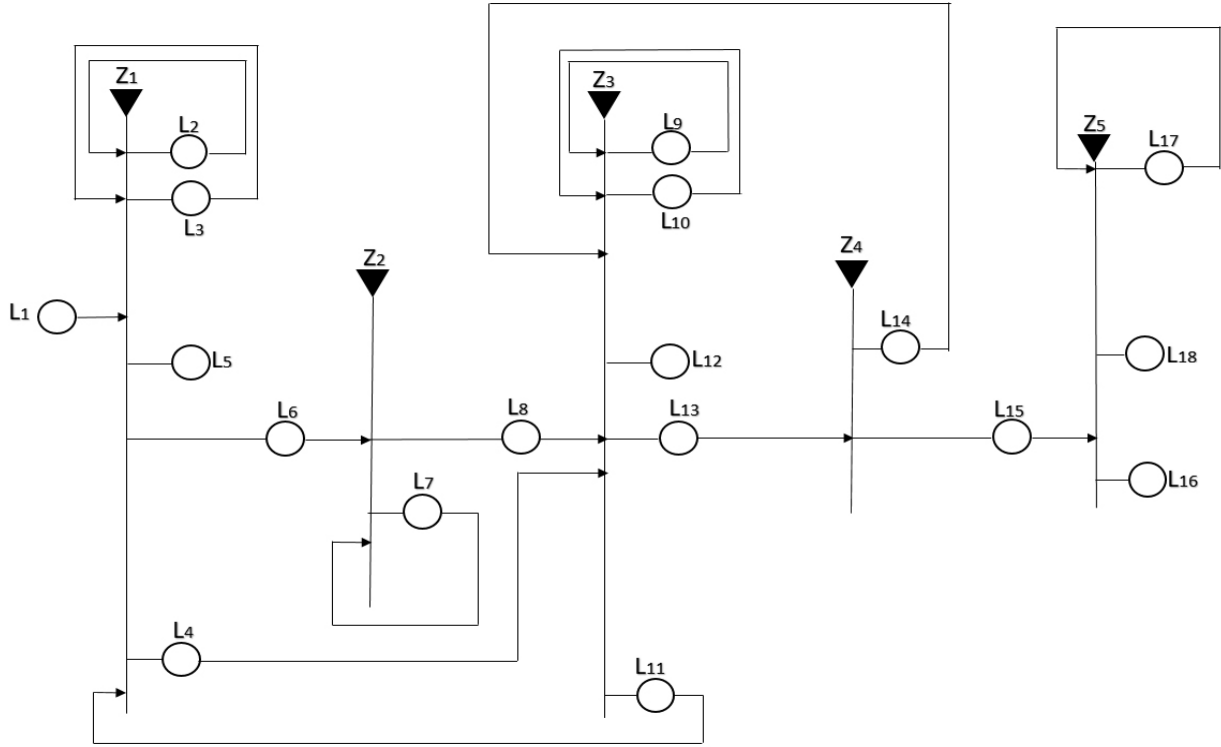- $Z_5 =$ „Delivering of goods & Confirmation Services".

Figure 1. GN model of common payment gateway

$$Z_1 = \langle \{L_1, L_{11}, L_2, L_3\} \{L_6, L_3, L_2, L_4, L_5\}, R_1, \vee (L_1, L_{11}, L_2, L_3) \rangle$$

$$R_1 = \begin{array}{c|ccccc} & L_2 & L_3 & L_4 & L_5 & L_6 \\ \hline L_1 & true & false & true & false & false \\ L_2 & true & W_{2,3} & false & W_{2,5} & W_{2,6} \\ L_3 & false & true & false & W_{3,5} & W_{3,6} \\ L_{11} & false & false & W_{11,4} & false & false \end{array}$$

where:

$W_{2,3} =$ „There is a customer account";

$W_{2,5} = \neg \, W_{2,3}$;

$W_{2,6} =$ „L_2, L_3, L_4 have been successfully completed";

$W_{3,5} =$ „A problem with the debit/credit card";

$W_{3,6} = W_{2,6}$;

$W_{11,4} =$ „Merchant account verified".

The token that enters place L_2 obtains the characteristic "Credit Cards Database info".
The token that enters place L_3 obtains the characteristic "User Accounts Database info".
The token that enters place L_4 obtains the characteristic "Merchant account Database info".
The token that enters place L_5 obtains the characteristic "Error Exit".
The token that enters place L_6 obtains the characteristic "Customer/visitor".

$$Z_2 = \langle \{L_6, L_7\}\{L_7, L_8\}, R_2, \wedge (L_6, L_7)\rangle$$

$$R_2 = \begin{array}{c|cc} & L_7 & L_8 \\ \hline L_6 & true & false \\ L_7 & true & true \end{array}$$

The token that enters place L_7 obtains the characteristic "merchandise/services".
The token that enters place L_8 obtains the characteristic "customer/visitor".

$$Z_3 = \langle \{L_8, L_9, L_{10}, L_4, L_{14}\}\ \{L_{12}, L_9, L_{10}, L_{13}\}, R_3, \vee (L_8, L_9, L_{10}, L_4, L_{14})\rangle$$

$$R_3 = \begin{array}{c|cccc} & L_{12} & L_9 & L_{10} & L_{13} \\ \hline L_8 & false & true & false & false \\ L_9 & W_{9,12} & true & W_{9,10} & false \\ L_{10} & W_{10,12} & false & true & W_{10,13} \\ L_4 & false & false & true & false \\ L_{14} & false & true & false & false \end{array}$$

where:
$W_{9,12}$ = „Insufficient Funds";
$W_{9,10} = \neg W_{9,12}$;
$W_{10,12}$ = „There is a problem with the merchant's account";
$W_{10,13} = \neg W_{10,12}$.

The token that enters place L_9 obtains the characteristic "Acount balance".
The token that enters place L_{10} obtains the characteristic "Merchant account database info".
The token that enters place L_{11} obtains the characteristic "Answer to „L_4"".
The token that enters place L_{12} obtains the characteristic "Error Exit".
The token that enters place L_{13} obtains the characteristic "Customer/visitor".

$$Z_4 = \langle \{L_{13}\}\ \{L_{14}, L_{15}\}, R_4, \wedge (L_{13})\rangle$$

$$R_4 = \begin{array}{c|cc} & L_{14} & L_{15} \\ \hline L_{13} & true & true \end{array}$$

The token that enters place L_{14} obtains the characteristic "Credit/Debit card funds withdrawal".
The token that enters place L_{15} obtains the characteristic "Customer/visitor".

$$Z_5 = \langle \{ L_{15}, L_{17}\} \ \{L_{16}, L_{17}, L_{18}\}, R_5, \vee (L_{15}, L_{17})\rangle$$

$$R_5 = \begin{array}{c|ccc} & L_{16} & L_{17} & L_{18} \\ \hline L_{15} & true & true & false \\ L_{17} & false & true & true \end{array}$$

The token that enters place L_{16} obtains the characteristic "Merchandise/services delivery".
The token that enters place L_{17} obtains the characteristic "Confirmation delivery".
The token that enters place L_{18} obtains the characteristic "Exit".

4   Conclusion

The payment gateway is used for facilitating online transactions and lets them get approved. It is also the first place the transaction goes when a customer submits an order online. The model is presented with generalized net and shows the transaction flows through the payment gateway, and through different checks and approvals and possible declines. So the GN model helps us to look further in the gateway, and correct possible problems or simulate other problems or just use it for optimization of the behavior of the payment gateway.

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