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GN Model of the Process of Serving Transport Flow in the Ports

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Abstract: The present paper describes the process of serving transport flow in the terminals. The model can be used for process optimization.

Keywords: Generalized nets, Transport flows, Port.

1 Introduction

The outage of the transport flows has a major place in the analysis of the process in ports. The incoming flow of vehicles, which have to be serviced (load or unload) in terminal is presented in this model.

On the incoming of vehicles in transport terminal there is a succession of operations, characteristic with technological times. Their continuance is influenced by many factors such as:

- Entering of the vehicles;
- Control of documents and goods;
- Position of the vehicles for load or unload;
- Load or unload of the vehicles with truck (carrier);
- Preparation of the primary documentation;
- Control operation;
- Exiting of the vehicles.

Using the order of technological operation, we can define all of the servicing continuance of vehicles in port terminal – **T**.

$$T = t_{en} + t_{con1} + t_{mv1} + t_{l(u)} + t_{mv2} + t_{con2} + t_{ex} \text{ , h} \quad (1)$$

- t_{en} – time for passing of vehicles through terminal entrance;
- t_{con1} – time for execution of controlling operation;
- t_{mv1} – time for motion of vehicles in terminal and positioning for load or unload;
- t_{mv2} – time for motion of vehicles to control point exit;
- t_{con2} – time for execution of the controlling operation of the vehicles and goods before exiting the terminal;
- $t_{l(u)}$ – time for load or unload of vehicles;
- t_{ex} – time for passing of vehicles through terminal exit.

Many factors like technical equipment of terminal, control and coordination of each ports activity, using information system, competence of personal, meteorological circumstances have influence on the continuance of these times. This define probable characteristic of the servicing continuance of vehicles in port terminal - T.

2 A GN-model

The generalized net model [1, 2, 3] constructed in Figure 1 describes the process of serving transport flow in the ports.

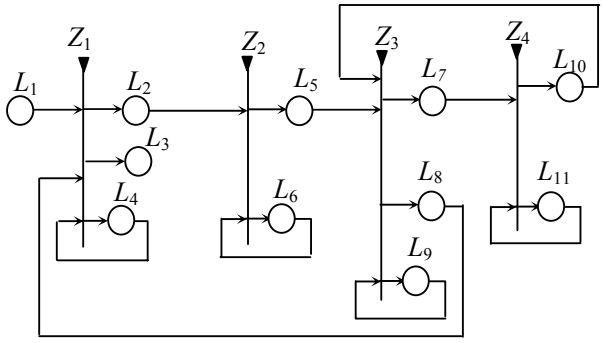

Figure 1: A GN-Model of the process of serving transport flow in the ports

Sequentially, α_0-tokens enter the net through place L_1 in some time-moments. These moments will be determined stochastically, when the model is simulated, or they will correspond to real events, when the GN is used for observation of real processes. These tokens have initial characteristic "vehicle i", $i = 1, 2, \ldots, n$.

The net initially can contain the following tokens:

- α_1-token with characteristic "vehicles for leading and discharge in front of the port" in place L_4;
- α_2-token with characteristic "vehicles waiting for passing the input control" in place L_6;
- α_3-token with characteristic "vehicles waiting for document control" in place L_9;
- α_4-token with characteristic "vehicles waiting for leading and discharge" in place L_{11};

For brevity, we shall use the notation α-tokens instead of α_j-tokens, where j is numeration of the respective tokens.

3 The Generalized Net in Action

The Generalized Net contains the following set of transitions:

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

where the following transitions represent:

- Z_1 - coming the vehicles on parking;
- Z_2 – process of the passing;
- Z_3 – process of the control of the documents;
- Z_4 - the processes of leading and discharge.

The transitions have the following forms.

$$Z_1 = <\{L_1, L_8, L_3\}, \{L_2, L_3, L_4\}, R_1, \vee (L_1, L_8, L_3)>$$

where

$$R_1 = \begin{array}{c|ccc} & L_2 & L_3 & L_4 \\ \hline L_1 & false & false & true \\ L_8 & false & false & true \\ L_4 & W_{4,2} & W_{4,3} & false \end{array},$$

and

- $W_{4,2}$ = *"There is a vacant place in the parking lot"*;
- $W_{4,3} = \neg W_{4,2}$

The α–tokens, entering place L_2 do not obtain new characteristics.

$$Z_2 = <\{L_2, L_6\}, \{L_5, L_6\}, R_2, \vee (L_2, L_6)>.$$

where

$$R_2 = \begin{array}{c|cc} & L_5 & L_6 \\ \hline L_2 & false & true \\ L_6 & W_{6,5} & false \end{array},$$

and $W_{6,5}$ = *"The vehicle is passed the procedure"*;

The tokens, entering place L_5 do not obtain new characteristics.

$$Z_3 = <\{L_5, L_{10}\}, \{L_7, L_8, L_9, L_{10}\}, R_3, \vee (L_5, L_{10})>$$

where

$$R_3 = \begin{array}{c|ccc} & L_7 & L_8 & L_9 \\ \hline L_5 & false & false & true \\ L_9 & W_{9,7} & W_{9,8} & false \\ L_{10} & false & false & true \end{array},$$

and

- $W_{9,7}$= *"The vehicles passed the control of the documents"*;
- $W_{9,8} = \neg W_{9,7}$.

The tokens, entering place L_5 do not obtain new characteristics.

$$Z_4 = <\{L_7, L_{11}\}, \{L_{10}, L_{11}\}, R_4, \vee (L_7, L_{11})>$$

where

$$R_4 = \begin{array}{c|cc} & L_{10} & L_{11} \\ \hline L_7 & false & true \\ L_{11} & W_{11,10} & false \end{array},$$

and $W_{11,10}$= *"The vehicle is passed the procedure"*.

The tokens, entering place L_{10} not obtain characteristics "full vehicle/empty vehicle".

Conclusion

The Generalized Net model described here is a possible model for the process of serving transport flow in the ports. Most of the model parameters can also be regarded as characteristics of tokens from an additional contour, thus achieving optimization with respect to our given aim. Statistical information would need to be collected in order to monitor the development of the process.

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