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Generalized net model of the container terminal

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Abstract

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

Keywords: generalized nets, transport flows, port.

1 Introduction

In this research we choose the port of Burgas container terminal. Althought every container terminal is unique, all terminals have similar characteristic. Consequently this method can be used in other container terminals.

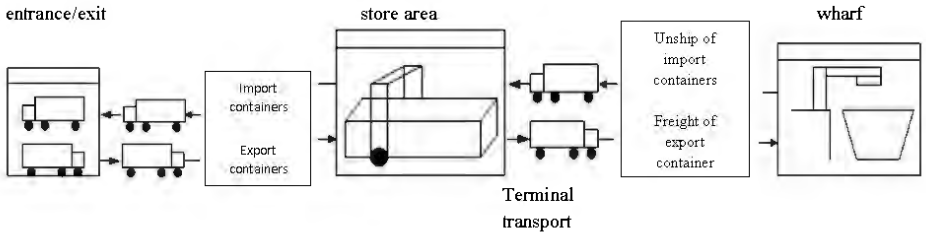

Figure 1: Processes in container terminal

In the previous papers [4–12] we describe many transport processes. In this paper the major parameter is operations in container terminal. The incoming flow of vehicles, which have to be serviced (load or unload) in terminal is presented in [3]. Fig. 1 displays three major belowsystems of container terminal: ship – wharf; store; lorries – store. A transport flow departed across terminal is also indicated.

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The vehicles are being serviced by stevedores according to their entering the terminal. The stevedore operator receives information about the incoming vehicle, immediately after its attendance in the terminal.

- Processing of the vehicles entering the terminal: After the initial check-up of the documents of the cargo container is done, the following processing depends on the fact whether the container is for export or for import. The control of the former will be at the entrance while the control of the latter will be at the exit;
- Processing of the vehicles in the yard: The vehicles must move nearer the yard on the shortest possible way. Some directions of movement in the yard are not allowed;
- Processing of the vehicles under load or unload: The vehicle arrives at the place and waits for loading or unloading. The time for unloading is longer than this for loading. After the container is loaded on the vechicle it must be stabilized and after that it can go to the exit;
- Processing of the exiting vehicles of the terminal. At the exit they must do the final check-up before they leave the terminal.

2 The GN-model

The places in the generalized net [2], as illustrated on Fig. 2, fall into two categories: *T*-places standing for the separate vehicles; and *L*-places describing the information.

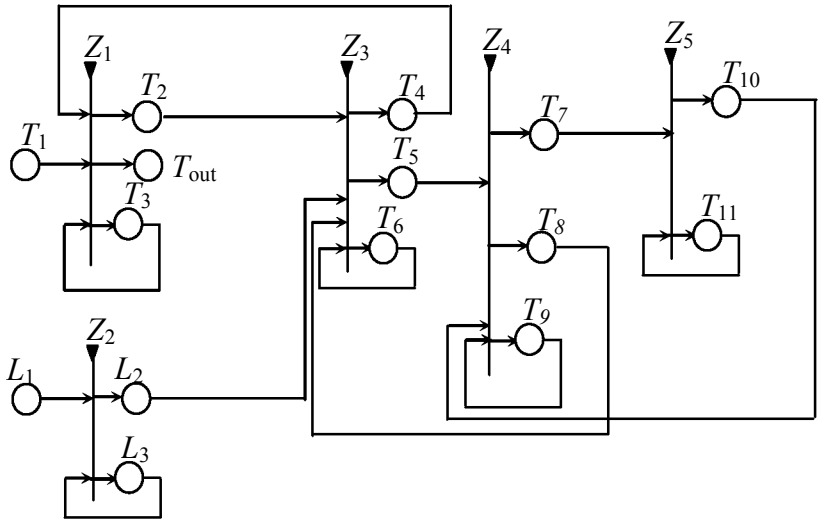

Figure 2: Generalized net model of the workflow in container terminal

On the other hand, the vehicles are interpreted in container terminal by means of the α-tokens in the *T*-places. The information are described by *β*-tokens at *L*-places.

Sequentially, α-tokens enter the net through place T_1 in some moments of time. 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 "Vehicles with container *i*", $i = 1, 2, \ldots, n$.

Initially, there might be *β*-tokens located at places L_3 with the characteristics "Information office".

The vehicle can enter in the container terminal after the information about the container has already been accepted.

The Generalized Net contains of the following set of transitions:

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

where the following transitions represent:

- Z_1 – Coming the vehicles on parking;
- Z_2 – Work on the information office;
- Z_3 – Processing of the vehicles in the yard;
- Z_4 – The processes of the freighting on the containers;
- Z_5 – Process of the stabilizing.

The transitions have the following forms.

$$Z_1 = \langle \{T_1, T_3, T_4\}, \{T_2, T_{out}, T_3\}, R_1, \vee(T_1, T_3, T_4)\rangle$$

The index matrix [1] of the transition conditions is:

$$R_1 = \begin{array}{c|ccc} & T_2 & T_{out} & T_3 \\ \hline T_1 & false & false & true \\ T_3 & W_{3,2} & W_{4,out} & true \\ T_4 & false & false & true \end{array},$$

where:

- $W_{3,2}$ = "There is a vacant place in the parking lot";
- $W_{4,out}$ = "The container is ready to go out from the port".

The α-tokens, entering places T_2 and T_{out} do not obtain new characteristics.

$$Z_2 = \langle \{L_1, L_3\}, \{L_2, L_3\}, R_2, \vee(L_1, L_3) \rangle$$

The index matrix of the transition conditions is:

$$R_2 = \begin{array}{c|cc} & L_2 & L_3 \\ \hline L_1 & false & true \\ L_3 & W_{3,2} & true \end{array},$$

where $W_{4,2}$ = "There is enough information for the cargoplan". The token, entering places L_2 obtain characteristic: "Cargoplan".

$$Z_3 = \langle \{T_2, L_2, T_6, T_8\}, \{T_4, T_5, T_6\}, R_3, \vee(T_2, L_2, T_6, T_8) \rangle$$

The index matrix of the transition conditions is:

$$R_3 = \begin{array}{c|ccc} & T_4 & T_5 & T_6 \\ \hline T_2 & false & false & true \\ L_2 & false & false & true \\ T_6 & W_{6,4} & W_{6,5} & true \\ T_8 & false & false & true \end{array},$$

where:

- $W_{6,4}$ = "There is a vehicles for unloading";
- $W_{6,5}$ = "There is a vehicles for loading".

The α-token, entering place T_4 and T_5 obtain characteristic: "Vehicle for loading/unloading", respectively.

$$Z_4 = \langle \{T_5, T_9, T_{10}\}, \{T_7, T_8, T_9\}, R_4, \vee(T_5, T_9, T_{10}) \rangle$$

The index matrix of the transition conditions is:

$$R_4 = \begin{array}{c|ccc} & T_7 & T_8 & T_9 \\ \hline T_5 & false & false & true \\ T_9 & W_{9,7} & W_{9,8} & true \\ T_{10} & false & false & true \end{array},$$

where: $W_{9,7}$ = "All vehicles are freighting". The α_1–token, entering place T_6 obtain characteristics: "Full ship".

$$Z_5 = \langle \{T_7, T_{11}\}, \{T_{10}, T_{11}\}, R_5, \vee(T_7, T_{11}) \rangle$$

The index matrix of the transition conditions is:

$$R_5 = \begin{array}{c|cc} & T_{10} & T_{11} \\ \hline T_7 & false & true \\ T_{11} & W_{8,7} & true \end{array},$$

where $W_{8,7}$ = "All vehicles in the ship stabilized". The tokens, entering place T_9 obtain characteristics: "Vehicle i", i = 1, 2, …, n.

3 Conclusion

The Generalized Net model described here is a possible model for the process of servicing flow of vehicles in the container terminal.

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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The papers presented in this Volume 2 constitute a collection of contributions, both of a foundational and applied type, by both well-known experts and young researchers in various fields of broadly perceived intelligent systems.
It may be viewed as a result of fruitful discussions held during the Tenth International Workshop on Intuitionistic Fuzzy Sets and Generalized Nets (IWIFSGN-2011) organized in Warsaw on September 30, 2011 by the Systems Research Institute, Polish Academy of Sciences, in Warsaw, Poland, Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences in Sofia, Bulgaria, and WIT - Warsaw School of Information Technology in Warsaw, Poland, and co-organized by: the Matej Bel University, Banska Bystrica, Slovakia, Universidad Publica de Navarra, Pamplona, Spain, Universidade de Tras-Os-Montes e Alto Douro, Vila Real, Portugal, and the University of Westminster, Harrow, UK:

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The consecutive International Workshops on Intuitionistic Fuzzy Sets and Generalized Nets (IWIFSGNs) have been meant to provide a forum for the presentation of new results and for scientific discussion on new developments in foundations and applications of intuitionistic fuzzy sets and generalized nets pioneered by Professor Krassimir T. Atanassov. Other topics related to broadly perceived representation and processing of uncertain and imprecise information and intelligent systems have also been included. The Tenth International Workshop on Intuitionistic Fuzzy Sets and Generalized Nets (IWIFSGN-2011) is a continuation of this undertaking, and provides many new ideas and results in the areas concerned.

We hope that a collection of main contributions presented at the Workshop, completed with many papers by leading experts who have not been able to participate, will provide a source of much needed information on recent trends in the topics considered.

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