

A Generalized Net Model of the Separate Information Flow Connections within the Technical University, Sofia

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Introduction

The information exchange of a university is very important process. The coordination of the departments and the level of the education depend on this. So it is very important to reduce the needed times for processing, allocating and delivering the information packets. Poorly organized processes of information exchange could reduce the level of the university. The aim of this paper is to simulate the current state of *Technical University – Sofia* – its structure, hierarchy and inside relationships. As a simulation tool is chosen *Generalized Nets (GN)*. The present paper is designed as a concretization of the GN-model of an abstract university, presented in [1]. This model can be used as a basis for description and comparison of different universities.

The concepts of generalized nets

Generalized Nets (GNs, see [2]) are extensions of the Petri nets and other modifications of them. They are tools intended for detailed modelling of parallel processes.

A GN is a collection of *transitions*, defined in turn as a set of *places* (see Fig.1). Every transition has at least one input and one output place, denoted by a specific sign. The transitions with their places form the static part of the generalized nets. With every transition is related an index matrix with elements – predicates. Some GN-places contain *tokens* – dynamic elements that enter the net with initial characteristics and obtain next ones during their movement in the net. Tokens proceed from the input to the output places of the transitions if the predicate corresponding to these places is evaluated as “*true*”. Every token has its own identifier and collects its own history that could influence the development of the whole process modelled by the GN.

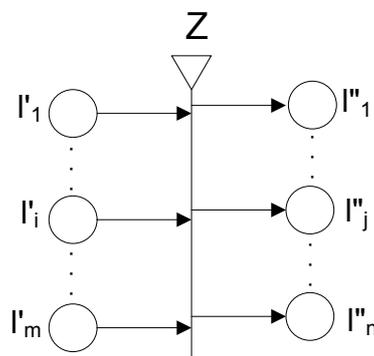


Fig. 1. GN-transition

A GN can have only a part of its components. In this case it is called a reduced GN. Here we shall give the formal definition of a reduced GN without temporal components, places' and arcs' capacities, and tokens', places' and transitions' priorities.

Formally, every transition in the used below reduced GN is described by a three-tuple:

$$Z = \langle L', L'', r \rangle,$$

where:

- (a) L' and L'' are finite, non-empty sets of places (the transition's input and output places, respectively); for the transition these are

$$L' = \{l'_1, l'_2, \dots, l'_m\} \text{ and } L'' = \{l''_1, l''_2, \dots, l''_n\};$$

- (b) r is the transition's *condition* determining which tokens will pass (or *transfer*) from the transition's inputs to its outputs; it has the form of an Index Matrix (IM):

$$r = \begin{array}{c|cccc} & l''_1 & \dots & l''_j & \dots & l''_n \\ \hline l'_1 & & & & & \\ \dots & & & r_{i,j} & & \\ l'_i & & & (r_{i,j} - \text{predicate}) & & \\ \dots & & & (1 \leq i \leq m, 1 \leq j \leq n) & & \\ l'_m & & & & & \end{array}$$

$r_{i,j}$ is the predicate that corresponds to the i -th input and j -th output place. When its truth value is "true", a token from the i -th input place transfers to the j -th output place; otherwise, this is not possible;

The ordered four-tuple

$$E = \langle A, K, X, \Phi \rangle$$

is called a *reduced Generalized Net* if:

- (a) A is the set of transitions;
- (b) K is the set of the GN's tokens;
- (c) X is the set of all initial characteristics which the tokens can obtain on entering the net;
- (d) Φ is the characteristic function that assigns new characteristics to every token when it makes the transfer from an input to an output place of a given transition.

A lot of operations (e.g., union, intersection and others), relations (e.g., inclusion, coincidence and others) and operators are defined over the GNs. Operators change the GN-forms, the strategies of token transfer and other. They are six types: global, local, hierarchical, reducing, extending and dynamic operators.

The GN-model

Technical University-Sofia, like any other university, is an open system. Everyone could receive information about its structure. It is managed by rector who has three vice-rectors. Every one of the vice-rectors is responsible for the management of a given part of the processes in the university. Separated, differentiated sections are the faculties, managed by deans. Every dean has two vices. The one of the vice-deans is responsible for the educational activity and the other for all the rest problems that need opportunely taken decision. Separated sections are the different departments of the faculties too. Every department is managed by a head of a department. Important place in the hierarchical structure of the university management take the departments' and faculties' chancelleries. They are of a very big importance for the students. These chancelleries are the basic places where the students can

have information about the questions that affects them personally or can give an opinion about the processes in the university.

The information processes in the university run together in parallel and in consecutive. A part of the information is delivered through the hierarchical structure consecutively- from the rector to the vice-rectors, the deans, the vice-deans, the heads of the departments, the departments' and faculties' chancelleries and finally the students. Together with this consecutively running process the separate sections can exchange information independently. The structure of the university is together strong and very free. The information can be generated and delivered not only in the university. It can intrude from the outside. It can also be addressed to persons or organizations outside the university.

The GN-model of TU-Sofia is represented on Fig. 2. It is based on the model from [1]. But it contains some specific additions.

Transition Z_1 represents the university server and Intranet and it corresponds to the GN-models from papers [3, 4, 5, 6]. The administrative, financial and servicing processes of the university are represented by transition Z_2 and it corresponds to the GN-models from papers [3, 7, 8]. Transition Z_3 represents the university library and it corresponds to the GN-model from paper [9], Z_4 – the process of preparing of the university timetables and it corresponds to the GN-model from paper [10] and Z_5 – the electronic archive functioning and it corresponds to the GN-model from paper [11]. The abstract university described in [1] on the basis of [12], contains transitions for e-learning: education and examination. Technical university does not have built system for e-learning, so the model on Fig. 2 contains three transitions less. The current state of every one of the considered sections is represented by tokens (α , β , γ , δ and ε), which are initially in places l_3 , l_7 , l_9 , l_{11} and l_{13} . These tokens accumulate history about the running processes. While they may split into two or more tokens, one of them - the original token, will remain in its own place the whole time.

The original tokens have the following initial and current characteristics:

- token α : “initial or current status of the university server” (in place l_3),
- token β : “initial or current status of the university administrative, financial and servicing university units” (in place l_7),
- token γ : “initial or current status of the university library” (in place l_{10}),
- token δ : “initial or current status of the university timetabling” (in place l_{12}),
- token ε : “initial or current status of the university electronic archive” (in place l_{14}).

With l_i ($i = 1, \dots, 13$) are denoted the places that are general for the both GN-models (from the present paper and from [1]). With e_j ($j = 1, \dots, 5$) are denoted places that are complement to the model from [1].

The first transition Z_1 has the form:

$$Z_1 = \langle \{ l_3, l_4, l_8, e_1 \}, \{ l_1, l_2, l_3, e_2 \}, r_1 \rangle$$

	l_1	l_2	l_3	e_2
l_3	$W_{3,1}$	$W_{3,2}$	true	$W_{3,e2}$
$r_1 = l_4$	false	$W_{4,2}$	$W_{4,3}$	false
l_8	false	false	$W_{8,3}$	false
e_1	false	false	true	false

where:

$W_{3,1}$ = “There is an information for administrative, financial or servicing offices”;

$W_{3,2}$ = “There is an information (request) for library”;

$W_{3,e2}$ = “There is an information (instruction) related to external instances or persons”;
 $W_{4,2}$ = “There is an information (order) for library”;
 $W_{4,3} = W_{8,3}$ = “There is an information for the server”.

Token α can split into two, three or four tokens. As we mentioned above, the original token continue to stay in place l_3 , while the other tokens enter other places, as follows. Token α' enters place l_1 with a characteristic: “*information for administrative, financial or servicing offices*”, and token α'' enters place l_2 with a characteristic: “*information (request) for the library*”. The tokens obtain as a characteristic in place e_2 : “*information for external instances or persons*”.

Transition Z_2 has the form:

$$Z_2 = \langle \{ l_1, l_7, l_{10}, l_{12}, e_3 \}, \{ l_4, l_5, l_6, l_7, e_4 \}, r_2 \rangle$$

	l_4	l_5	l_6	l_7	e_4	
$r_2 =$	l_1	false	false	false	true	false
	l_7	$W_{7,4}$	$W_{7,5}$	$W_{7,6}$	true	$W_{7,e4}$
	l_{10}	false	false	false	true	$W_{10,e4}$
	l_{12}	false	false	false	true	$W_{12,e4}$
	e_3	false	false	false	true	false

where:

$W_{7,4}$ = “There is an information (order, instruction) for other university units”;
 $W_{7,5}$ = “There is an information (order, instruction) for the Educational Department with respect of preparing timetabling”;
 $W_{7,6}$ = “There is information (order, instruction) for the Electronic Archive”;
 $W_{7,e4} = W_{10,e4} = W_{12,e4}$ = “There is an information (instruction) related to external instances or persons”.

Like α , token β can split into two, three or four tokens, but the original remains in place l_7 , while the other tokens enter places l_4 , l_5 , and/or l_6 . Tokens (β') obtain as a characteristic in place l_4 : “*information (order, instruction) for determined (concrete) university units*”. Token β'' enters place l_5 with a characteristic: “*information (order, instruction) for the Educational Department with respect of preparing timetabling*”, and token β''' enters place l_6 with a characteristic: “*information (order, instruction) for the Electronic Archive*”. The tokens obtain as a characteristic in place e_4 : “*information for external instances or persons*”.

Transition Z_3 has the form:

$$Z_3 = \langle \{ l_2, l_9, e_5 \}, \{ l_8, l_9, e_6 \}, r_3 \rangle$$

	l_8	l_9	e_6	
$r_3 =$	l_2	false	true	false
	l_9	$W_{9,8}$	true	$W_{9,e6}$
	e_5	false	true	false

where:

$W_{9,8}$ = “There is information, requested for the needs of education processes”;
 $W_{9,e6}$ = “There is an information (instruction) related to external instances or persons”.

Token γ can split into two or three tokens, but again the original stays in place l_{10} , while the other tokens enter places l_8 and/or l_9 . Token γ' enters place l_8 with a characteristic “*information, requested for the needs of education processes*” and token γ'' enters place l_9

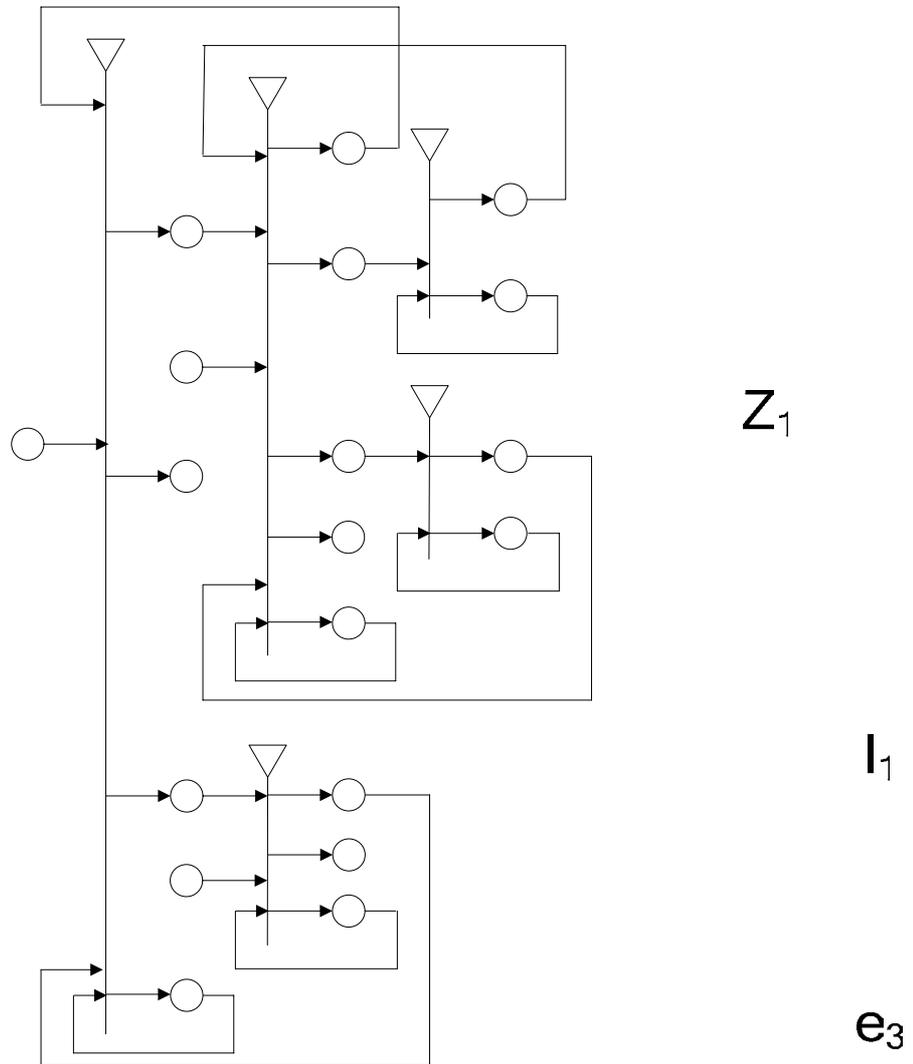


Fig. 2. The GN-model.

with a characteristic “*information (report) to other university units*”. The tokens obtain as a characteristic in place e_6 : “*information for external instances or persons*”.
 Transition Z_4 has the form:

$$Z_4 = \langle \{l_5, l_{11}\}, \{l_{10}, l_{11}\}, r_4 \rangle$$

	l_{10}	l_{11}
r_4	false	true
l_{11}	$W_{11,10}$	true

where:

$W_{11,10}$ = “There is an information (report) to the university administration”.

Token δ can split into two tokens, and the original remains in place l_{12} , while the other token enters place l_{11} . The tokens obtain as a characteristic in place l_{11} : “*information (report) to the university administration*”.

Transition Z_5 has the form:

$$Z_5 = \langle \{l_6, l_{13}\}, \{l_{12}, l_{13}\}, r_5 \rangle$$

	l_{12}	l_{13}
$r_5 = l_6$	false	true
l_{13}	$W_{13,12}$	true

$W_{13,12}$ = “There is an information (report) to the university administration”.

Token ε can split into two tokens, with the original staying in place l_{14} , while the other token enters place l_{13} . Token ε' enters place l_{13} with a characteristic “*information (report) to university administration*”.

Conclusions

This generalized net of Technical University - Sofia presents the sophisticated process of exchange of the information between the separated sections. It can be used for a simulation, which will require real intervals of time for transitions’ activations. The obtained results could help for the optimization of the relationships between the different departments in order to reduce the spent of financial resources.

The present paper is an outline exposition of the information flow connections between and within the separate processes commonly associated with the procedures required for effective information flow in any modern university.

This GN-model could assist in creating common e-learning system for all departments.

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