Modeling of the Process of Consumers with Several Extensions of Petri Nets

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ABSTRACT

It is discussed in the work, the specifics of modeling Consumers by Patel [2, p. 189]. It is researched the problems of limits of Classical Petri Nets as a modeling tool for solving such problems. It is observed several extensions of the traits of Petri Nets in the work. It is built the modeling process of Consumers the extensions of Restrictive Arc Petri Nets and Colored Petri Nets. It has been done the comparison of pointed extending nets complexities (number of arcs, positions and transitions) in terms of optimization.

Keywords

Petri Nets, Colored Petri Nets, Classical Petri Nets, token, arc

1. INTRODUCTION

Definition: Petri Net $M(C,\mu)$ pair, where $C=(P,T,I,O)$ is the network structure and μ is the network condition. In structure C of a P-positions, T-transitions are finite sets. $I:T\rightarrow P^{\infty}$, $O:T\rightarrow P^{\infty}$ are the input and output functions, respectively, where P^{∞} are all possible collections (repetitive elements) of P. $\mu:P\rightarrow N_0$ is the function of condition, where $N_0=\{0,1,...\}$ is the set of integers. We determine (in a known manner) the allowed transitions of Petri Nets and the transitions from one state to another, the set of reachable states as well [1,2].

Petri Nets can be used for different systems modeling such as accountable systems, hardware and programming software, chemical, social, military systems etc., as well as real times complex systems [2].

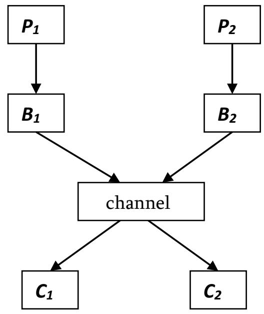
The varieties of the up mentioned examples show us that Petri Nets can model number of such systems, analyses their functional traits etc.

However, there can be systems existed, which can't be modeled with Petri Nets. Which means the power of Petri Nets modeling can be limited; therefore there is a need to propose Petri Nets traits, which can solve two limits of Petri Nets: the limit of modeling power of Petri Nets and the limit of allowed power.

The description of Consumers process.
Let us suppose that there are two processes of producers and consumers [2].

Process 1: P_1 producer creates data for the first process of consumer C_1, and P_2 producer for consumer C_2. Data, which are produced, but aren't used yet, are placed in the buffer. B_1 buffer is for (P_1,C_1) and B_2 is for (P_2,C_2) pair. Transmitting the data from buffers to consumers is done by the same channel. The channel during the one séance can deliver one element (from arbitrary buffer to arbitrary consumer). The producers should insert the data in to the buffer, the consumers should coordinate their actions by the usage of the channel. The following picture shows the before mentioned process (pic.1).

In the described system, there is the problem of distribution. (P_1,C_1) pair should have priority towards (P_2,C_2) in the meaning of channel usage. This means the following: the channel shouldn't report data from B_2 buffer to C_2 consumer as long as B_1 buffer is not empty. The idea of priority doesn't let model the mentioned system by Classical Petri Nets, as it is allowed in nature. The proof of the mentioned fact is described in [2, page 190-191].

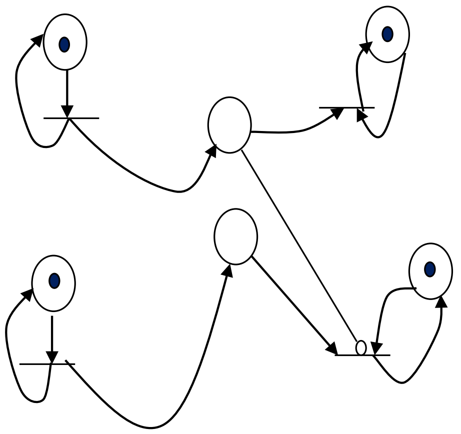


Pic. 1: The Consumers process with the common usage and bufferisation.

For solving that problem it's needed to extend Petri Net's several properties so the proposed properties are headed for the opportunity of checking the zero in Petri Nets.

The easiest extension, which allows zero checking, is the presence of restrictive arc. In the picture 2 it is shown extension of the Restrictive Arc Petri Net. In the picture 2 the restrictive arc is headed from P_i position to t_j transition. In the edge point instead of shunt there is an empty little round.

In that case it is permissible to transit performance, if there are tokens in the all transition's traditional access positions and they don't exist in the access positions of restrictive arcs. In the mentioned Petri extensive Nets the transition in done: with the position of traditional access by transmitting tokens. Therefore, in the Restrictive Arc Petri Nets (pic.2) the C_2 transition can be done, if the tokens exist in b_2 and P_4, but they don't exist in b_1. The mentioned net (pic.2) is the model of solved problem of priority usage.



Pic.2. The modeling of Consumer process with Restrictive Arc Petri Net.

Formal definition for Colored Petri Net.

Definition: A Colored Petri Net is a tuple $CPN = (\Sigma, P, T, A, N, C, G, E, I)$ satisfying the following requirements:

(i) Σ is a finite set of non-empty types, called **color sets**.

(ii) P is a finite set of **places**.

(iii) T is a finite set of **transitions**.

(iv) A is a finite set of **arcs** such that:

□ $P \cap T = P \cap A = T \cap A = \emptyset$

(v) N is a **node** function. It is defined from A into $P \times T \cup T \times P$.

(vi) C is a **color** function. It is defined from P into Σ.

(vii) G is a **guard** function. It is defined from T into expressions such that:

□ $\forall t \in T : [Type(G(t)) = Bool \wedge Type(Var(G(t))) \subseteq \Sigma]$.

(viii) E is an **arc expression** function. It is defined from A into
expressions such that:

□ $\forall a \in A : [Type(E(a)) = C(p(a))_{MS} \wedge Type(Var(E(a))) \subseteq \Sigma]$
where $p(a)$ is the place of $N(a)$.

(ix) I is an **initialization** function. It is defined from P into closed expressions such as:

□ $\forall p \in P : [Type(I(p)) = C(p)_{MS}]$.

Colored Petri Net is a graphical oriented language which is used for modeling, analysis, description and presentation systems [3], [4] [5], [6].

In the classical or traditional Petri Net tokens do not differ from each other, we can say that they are colorless. In difference of Classical Petri Nets, the position of Colored Petri Nets can contain tokens of arbitrary complexity -a note, lists, etc., that makes the reliable models more possible.

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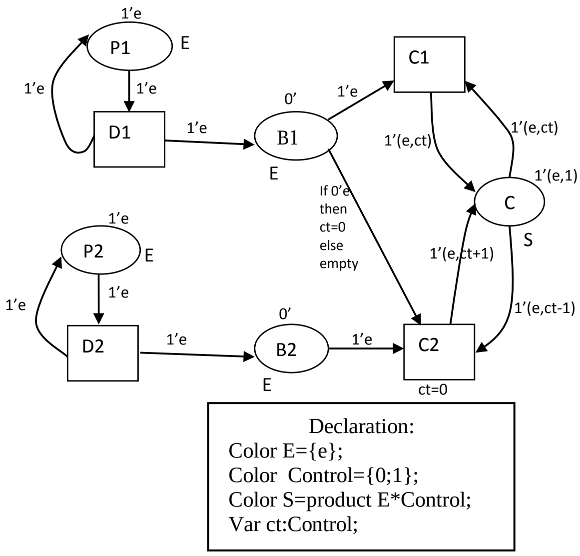
The Design/CPN system is used for modeling “NOKIA” phones, in order to find out the unwanted functional interactions [3]:



Pic. 3. The modeling of Consumer problem with Colored Petri Net.

In this pic. 3 declaration the E type is used for the positions, which include the produced elements. The Control type includes 0 or 1, through which the priority idea has been decided. The S type is the Cartesian product of E and Control types.

2. CONCLUSION

If we compare the 2 and 3 pictures' nets, in the complexity perspective the Colored Petri Net is more convenient for solving such problems, as it is optimal. The optimization of net means the positions, arcs and transitions.

So the optimization has a meaning in the case, when it is used in the mechanisms it will need less expenses. In the pic.3 net the number of positions is 5 and in pic.2 the number of positions is 6, the number of transitions and arcs are the same. The Colored Petri Net is more effective as the attached logical expressions of transitions and arcs regulate the order of implementing the actions of the system. In this case the net becomes simpler and clear.

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