Fifth Int. Workshop on GNs, Sofia, 10 Nov. 2004, 19-24

GENERALIZED NET MODEL OF ALGORITHM FOR NON-CONFLICT SWITCH IN PACKET COMMUNICATION NODE *

Tasho D. Tashev

Institute of information technology - B.A.S
Akad.G.Bonchev Str. Bl. 2, 1113 Sofia, Bulgaria
E-mail : ttashev@iit.bas.bg

1. Introduction

In time-multiplex communication systems, crossbar packet switches route traffic from the input to output where a message packet is transmitted from the source to the destination. The randomly incoming traffic must be controlled and scheduled to eliminate conflict at the crossbar switch where the conflikt is that two of more users may simultataneously access to a single output.The goal of the traffic-scheduling for the time-multiplex crossbar switches is not only to maximize the throughput of packet through a crossbar switch but also to minimize packet blocking probability and packet waiting time [1].

The researchers presented the technique utilized in the algorithm is a systematic method of finding distinct representatives from the row sets of a traffic matrix, algorithm based on a cellular automation and neural network [1,2].We consider that the Generalized nets (GN) [3,4] may be used for modelling of such tasks because of us possibilities to model as the structure of the investigated object, as the dynamics of the flowing in it processes. The GN are contemporary development, suggesting detail reflection of the structure and time relation in parallel processes.

In this paper we shall use GN apparatus for construction of model of algorithm for non-conflict switched , allowing zero blocking probability.

---

* This work is partially supported by IIT-B.A.S. Theme “Net models for research and computer modelling of information processes and systems” -010058

2. Algorithm for non-conflict switched

A request for packet transmission through an *n x n* crossbar is described by an *n x n* traffic matrix T. In the traffic matrix T, each element t_{ij} ($t_{ij} \in [0,1]$)represents a request of packets from input *i* to otput *j*. For example, $t_{ij}=0$ means that there is no packet to be transmitted on the *j*th output line from the *i*th input line. $t_{ij}=1$ means that at least one packet on the *i*th input line should be transmitted on the *j*th output line of the crossbar [2].

Conflict situation is created when at any row of the traffic matrix the number of ones is bigger then one. This is corresponding to case when one source announces connection with more then one receiver. Existance of more then one (1) at any column of matrix T is also showing that conflict situatiion is available and means, that more then one source is announced connection to the same receiver [5]. Avoiding of the conflicts is directly relatives to the efficiency of the communication node.

The sence of the suggested algorithm is the following : we copy matrix T in intermediate matrix M. That matrix M is checked sequently along the rows if one (1) is available. By the first middle one (1) we write in this cell of the matrix T zero (0), and in matrix M under this cell – in this column – zero (0). Value of this cell (1) is writen in the same cell of new matrix R, which we call matrix of aloowed non-conflict switches.

After that we go to the next row of the matrix M until we check all rows. After checking the last row of the matrix M is formed matrix R, which contains no conflicts and R is delivered for control of the contains transmition. The matrix T already no sended for transmition requests.

The process is iterative. After the first formed non-conflict matrix R we copy already changed matrix Tin intermediate matrix M and repeat the searching. The algorithm ends its action when in matrix T no one (1)is available i.e. all the requests are satisfacted.

3. GN-model of the algorithm

Our task is to construct a model of the algorithm in type of GN, and the the purpose is the so obtained GN to be easy to scale (to allow parallelism).

The offered decision in GN type is showed on the fig.1.

The tokens in the GN-model presented the matrix and variables. They have nine paramerers : <n>, <T>, <k>, <M>, <R^k>, <i>, <j>, <l>, <r>..

The token α come into position l_1 with initial characteristic “<n>, <T>, <k>=1”

The characteristic <n> has size $n \in N$ $(n \ x \ n)$ of matrix T, M and R. The characteristic <T> showed the traffic matrix T. The characteristic <M> showed the intermediate matrix M. The characteristic <R> showed the switched matrix R. The characteristic <i> showed the number of row of matrix : $i \in [1,n]$. . The characteristic <j> showed the number of column of matrix : $j \in [1,n]$. The characteristic <k> showed the number of iterations. The characteristic <l> showed the intermediate cell under the $t_{ij}=1$. The characteristic <r> showed the number ot elements $t_{ij}=1$ in current iteration.

The concrete descriptions of positions is :

l_1 - start;

l_2 – initial parameters;

l_3 - no request ($M_{ij}=0$);

l_4 – request for transmission ($M_{ij}=1$);

l_5 - the row is not eluded;

l_6 – the row is eluded ($j>n$)

l_7 - to new row;

l_8 – the M is not eluded;

l_9 - the M is eluded;

l_{10} – to new iteration;

l_{11}- the R^k is ready;

l_{12} – stop;

l_{13}- the column is eluded ($l>n$);

l_{14} – the column is not eluded;

l_{15}- to new cell.

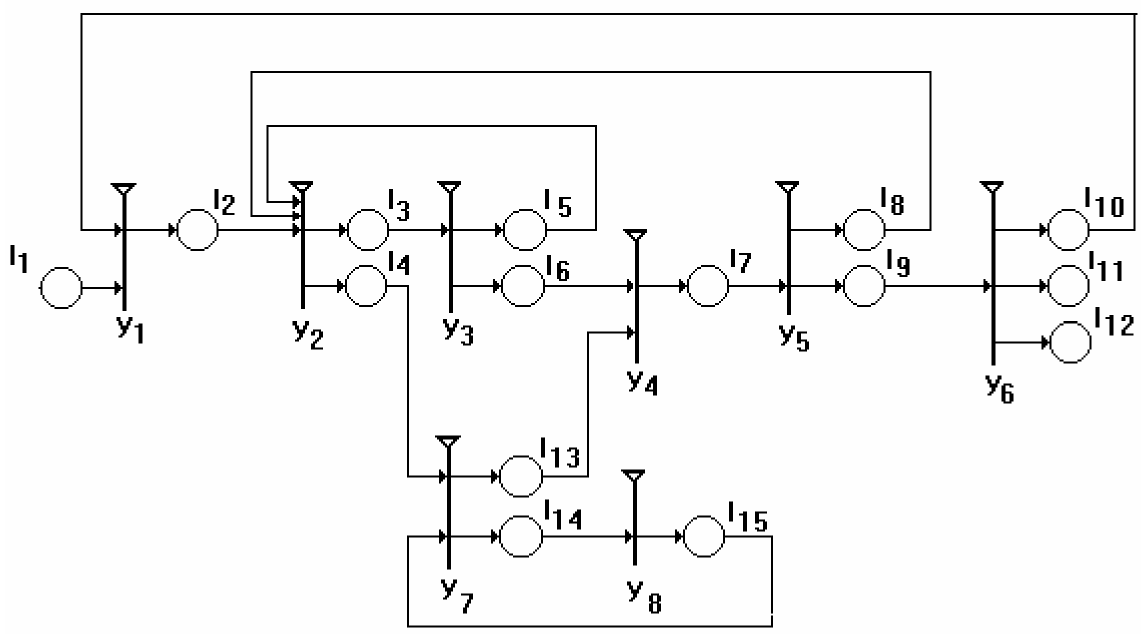

Fig.1. GN-model of algorithm

The formal description is:

$y_1 = < \{l_1, l_{10}\}, \{l_2\}, r_1, v(l_1, l_{10}) >$, where

$r_1 =$

	l_2
l_1	true
l_{10}	true

The characteristic functions are : Φ_2="$<M>:=T, <R^k>:=0, <i>:=1, <j>:=1, <r>:=0$ "

$y_2 = < \{l_2, l_5, l_8\}, \{l_3, l_4\}, r_2, v(l_2, l_5, l_8) >$, where

$r_2 =$

	l_3	l_4
l_2	$\neg W_1$	W_1
l_5	$\neg W_1$	W_1
l_8	$\neg W_1$	W_1

The predicate W_1 have the following forms: W_1 ="$M_{ij}=1$" ;

The characteristic functions are : Φ_3="$<j>:= j+1$" ; Φ_4="$<T_{ij}>:=0, <R^k_{ij}>:=1,:<l>:= i+1, <r>:= r+1$".

$y_3 = < \{l_3\}, \{l_5, l_6\}, r_3, v(l_3) >$, where

$r_3 =$

	l_5	l_6
l_3	$\neg W_2$	W_2

The predicate W_2 have the following forms: W_2 =" $j>n$ " .

The characteristic functions are "*":

$y_4 = < \{l_6, l_{13}\}, \{l_7\}, r_4, v(l_6, l_3\} >$, where

$r_4 =$

	l_7
l_6	true
l_{13}	true

The characteristic functions are :Φ_7="$<i>:= i+1$" .

$y_5 = < \{l_7\}, \{l_8, l_9\}, r_5, v(l_7) >$, where

$r_5 =$

	l_8	l_9
l_7	$\neg W_3$	W_3

The predicate W_3 have the following forms: W_3 =" $i>n$ " .

The characteristic functions are :Φ_8="<j>:= 1" , Φ_9= "*".

y_6=< { l_9}, { l_{10}, l_{11}, l_{12}},r_6, v (l_9) > , where

r_6 =

	l_{10}	l_{11}	l_{12}
l_9	$\neg W_4$	true	W_4

The predicate W_4 have the following forms: W_4 =" r= 0 " .

The characteristic functions are : Φ_{10}="<k>:= k+1" , Φ_{11}= "<R^k> to swich", . Φ_{12}= "*".

y_7=< { l_4, l_{15} }, { l_{13}, l_{14} },r_7, v (l_4, l_{15}) > , where

r_7=

	l_{13}	l_{14}
l_4	W_5	$\neg W_5$
l_{15}	W_5	$\neg W_5$

The predicate W_5 have the following forms: W_5 =" l > n " .

The characteristic functions are : Φ_{13}="*" , Φ_{14}= "<M_{lj}>:=0".

y_8=< { l_{14} }, { l_{15} },r_8, v (l_{14}) > , where

r_8 =

	l_{15}
l_{14}	true

The characteristic functions are : Φ_{15}="<l>:= l + 1".

4. Properties of the constructed GN-model

Capacity of all arcs are equal to one. Capacity of all places is also one, except of place l_{11}.which has capacity n. Priorities of places are equivalent, priorities of transitions are equivalent – i.e. priorities are not necessarily.The GN has no local and global temporal components. Therefore, the constructed GN is a reduced GN form concerning common class Σ of all GN.

The chosen way if searching of the matrix M introduces priorities in the service of requestes. The requests, corresponding to the element t_{11} will serviced first, and t_{nn} – last. The priorities of service may be change through transposition of row and columns of the matrix T.

5. Conclusion

The specified algorithm is with sequent action – in a single time interval fires only one transition, but the task allows parallelism.By division of the matrix T into 4 submatrix (2x2) two computing devices can work following the such described algorithm parallely. If we have 9 submatrix (3x3), 3 parallel devices can be used i.e. to n parallel devices.

A task for investigation is to determine the best and worst time for satisfaction of the request. This is the object of our current investigations therefore the so constructed GN model has a potential for investigation.

References

[1] Inukai, T. An Efficient SS/TDMA Time Slot Assignment Algorithm. Communications, IEEE Transactions on , Oct 1979, Volume: 27, Issue: 10. pp. 1449- 1455. ISSN: 0096-2244

[2] Takefuji Y. and K.C.Lee. An artifical hysteresis binary neuron : a model suppressing the oscillatory behaviors of neural dynamics. Biol.Sybernetics, 1991, Vol.64, pp.353-356.

[3] Atanassov, K. Generalized Nets. World Scientific, Singapore, 1991.

[4] Atanassov K. Generalized Nets and System Theory. . Akad. Press "Prof.M.Drinov", Sofia, Bulgaria, 1997.

[5] Kolchakov K., H. Daskalova, Comparative analyses of approaches for non-conflict sheduling in TDMA radio networks, Proc. of Int. Scientific Conf. "Communication, Electronic and Computer Systems 2000", May 2000, Sofia, Bulgaria. Vol.1, pp.200-205.