ADAPTIVE ALGORITHM FOR MANAGEMENT BY WEIGHT COEFFICIENTS OF THE TRAFFIC IN CROSSBAR COMMUTATOR

Kiril Kolchakov, Vladimir Monov

Abstract: *An adaptive algorithm for management by weight coefficients of the traffic in Crossbar commutator is synthesised. The algorithm is adaptive because the matrix of weights corresponds to the matrix of the requests, each request receives a weight. The algorithm is modified in order to reduce the number of the weights by the diagonal location.*

Keywords*: Network nodes, Crossbar switch, Conflict elimination, Packet messages.*

ACM Classification Keywords*: C.2.1 Network Architecture and Design, C.4 Performance of Systems.*

Introduction

The purpose of this study is to find an approach for the conflicts problem solution in switching nodes of type Crossbar by management of weight coefficients of the traffic. For this purpose, an adaptive algorithm is synthesized for management by weight coefficients of the traffic in Crossbar commutator. The algorithm is adaptive because the matrix of the weights corresponds to the requests matrix. To each request a weight coefficient is assigned. The high weight corresponds to a high priority in the implementation of service requests.

The traffic via Crossbar switching nodes is casual and depends on the users. The formulation of a conflict issue during operation of the switching nodes is as follows. The dimensions of switches in the switching nodes are N x N, where N sources of packet massages are connected to N receivers via the switch of the switching node. The traffic is random by nature and conflicts are available in the following two cases:

1. When one source of message requests communication to two or more message receivers.
2. When one message receiver receives communication requests from two or more message sources.

The evasion of conflicts is directly related to the switching node performance. The status of the switch of the switching node is represented with the so called connection matrix. For N x N dimensional switch the dimension of the connection matrix T is N x N also, where every element $T_{ij} = 1$ if the connection request from i- source to j- receiver exists. In the opposite case $T_{ij} = 0$.

A conflict situation arises if any row of the connection matrix has more than a single 1, which corresponds to the case when one source requests a connection with more than one receiver. The presence of more than a single 1 in any column of the matrix T also indicates a conflict situation it means that two or more sources have requested a connection with the same receiver [Kolchakov and Monov, 2014a].

Approach for Traffic Control Description

The essence of the approach is to give the weight factors of the keys of the switch in order to avoid conflict situations to some extent.

The high weight corresponds to the high priority. It is applied a conflict indicator of requests (C), which is the ratio of the number of conflicts (K) in the matrix of connections (T) and the total number of requests (R).

$$C = K/R.100[\%] \tag{1}$$

Conflict can be caused by two or more service requests. The total number of requests is occasional by nature and depends on the traffic at the moment. Weight factors of the keys in the switch are changed periodically in a random law. The number of weights may vary. The matrix of the weights W is N x N size, like the connections matrix T.

Figure 1 shows an exemplary placement of the weight coefficients in W matrix with dimension 4 x 4 and five of the weight factors. Matrix T has 4 x 4 dimension also [Kolchakov and Monov, 2014a].

W

1	5	2	3
3	2	4	5
4	3	1	4
5	1	3	1

T

1	0	0	1
0	1	0	1
1	0	1	1
1	0	1	1

W.*T

1	0	0	3
0	2	0	5
4	0	1	4
5	0	3	1

Figure 1. *Exemplary placement of the weight coefficients*

Figure 1 shows that the indicator C of the matrix T is 7/10 (K = 7, R = 10), while the use of weight coefficients C decreases to 1/10 (K = 1, R = 10). The number of the weight coefficients from Figure 1 is w = 5, located randomly in weight matrix W. It is obvious that the non-conflict request commutation improves at times (C decreases at times). The price of this is a decrease of the performance at times. The aim is a reasonable compromise, in which C is minimal at a relatively small number of weight factors [Kolchakov and Monov, 2014a].

From the graphics of Figure 2 it is visible that for N = 4, the use of two weights leads to a seven-fold decrease of C. When N = 32 even in ten weights C is not changed and is in non-sensitive zone. In case of N = 2, C is permanently zero for six of weights [Kolchakov and Monov, 2014a]. In order to avoid the non-sensitive zone it is created an algorithm based on the approach for traffic management with weight factors in Crossbar commutator.

For a matrix of T requests, it is applied a family of weight matrices W. In each weight matrix it is determined value of C. If C = 0 iterations stop, because it is found a weight matrix that guarantees non-conflict schedule [Kolchakov and Monov, 2014b].

A software model of the algorithm is synthesized written in Matlab 6.5 language. Computer configuration Dell OPTIPLEX 745 (Core 2 Duo E6400 2,13GHz, RAM 2048) is used [Kolchakov and Monov, 2014b]. The study is done for N = const., T = const. and a family of weight matrices (W) with a different number of weights (w), selected in random law. The results are presented graphically on Figure 3 [Kolchakov and Monov, 2014b].

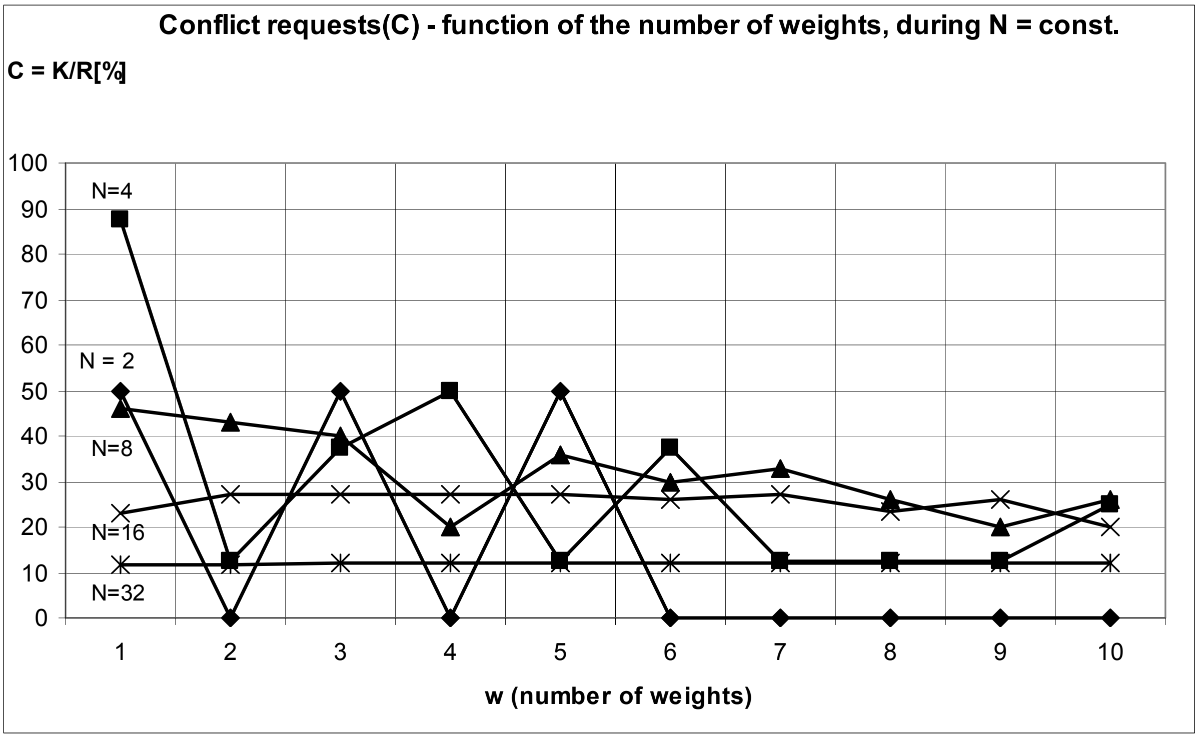

Figure 2. Conflict requests (C) – function of the number of weights, during N = const

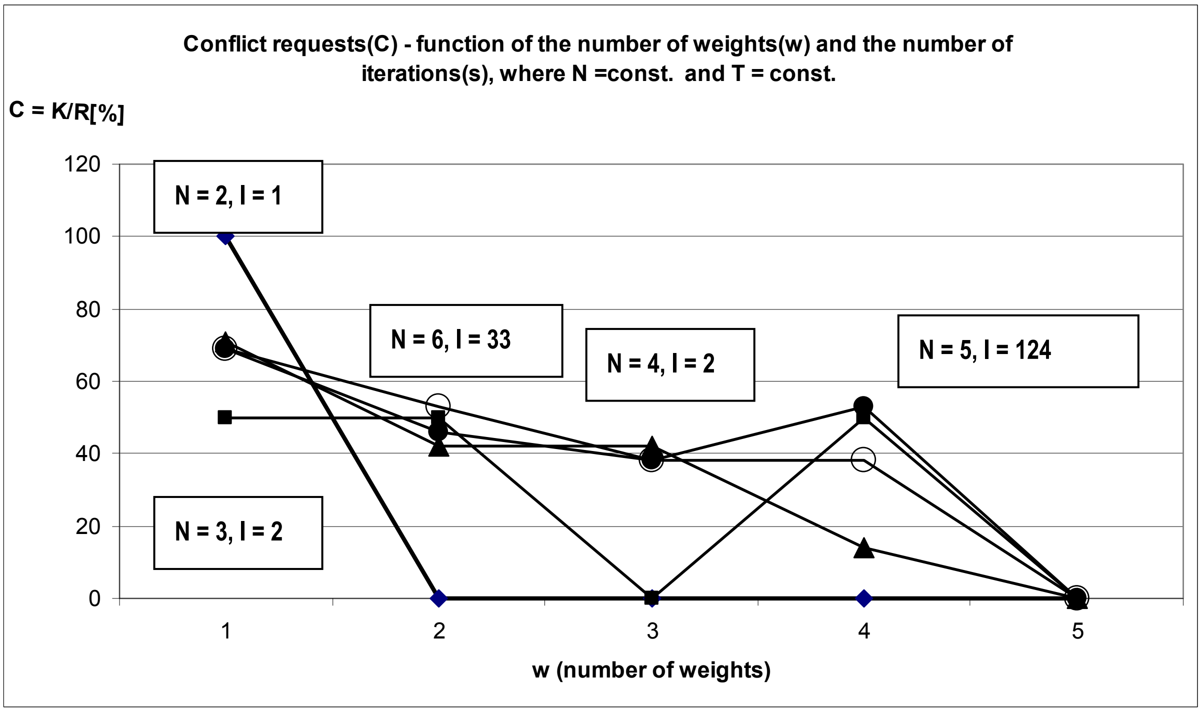

Figure 3. Conflict requests (C) – function of the number of weights and the number of iterations (I), where N = const. and T = const

From the results on Figure 3 it is visible that when N = 2 it is sufficient one iteration to achieve C = 0 when w = 2, while for N = 3, C is set to zero at w = 3 for two iterations [Kolchakov and Monov, 2014b].

When N = 5 only for w = 5 and 124 iterations C becomes zero.

It is important to note, that the algorithm ensures always a final solution and the non-sensitive zone is avoided. For a given number of iterations, or increase of the number of weights a non-conflict schedule (C = 0) is achieved [Kolchakov and Monov, 2014b].

Adaptive Algorithm for Traffic Management in Crossbar Commutator Description

An essential element in the adaptive algorithm is the requests detector in the matrix of connections. The detector finds requests by scanning the matrix of connections and assigns different weight factor of each request. The weights manage commutator switches so that the high weight corresponds to a high priority. The strategy is to increase the weights from left to right and from top to bottom in the weight matrix.

It is important to note that the selected approach leads to a non-conflict schedule (C = 0). Figure 4 shows the result of the operation of the adaptive algorithm for management (AAM).

T	1	0	1	0
	0	1	0	1
	1	0	1	0
	1	0	1	1
W	1	0	5	0
	0	4	0	8
	2	0	6	0
	3	0	7	9

Figure 4. *The result of the operation of the adaptive algorithm*

From Figure 4 it is seen that the number of weights is equal to the number of requests which is quite wasteful and leads to delay in the implementation. Obviously it is needed to optimize the process in terms of the number of weights.

Using the knowledge that diagonally located requests are non-conflict to one another could reduce the number of weights. It is enough the requests detector to group the requests by diagonals and to assign one and the same weight within the diagonal.

Figure 5 shows the result of an optimized version of the adaptive algorithm (AAMO).

From Figure 5 it is clear that in the optimized variant of the adaptive algorithm for one and the same number of requests with one and the same location in the connections matrix T, the number of the weights decreases from 9 to 5.

In the adaptive algorithm (AAM) in the limiting case where the maximum number of requests is equal to NxN the number of weights is equal to the NxN also, while in the optimized version of the adaptive algorithm (AAMO) the number of weights is 2N-1 only.

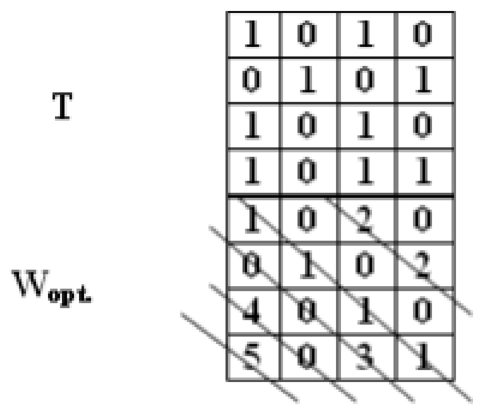

Figure 5. *The result of an optimized version of the adaptive algorithm*

We have synthesized software models of the adaptive algorithm (SMAAM) and its optimized version (SMAAMO) which is written in the language of Matlab 6.5. Computer configuration Dell OPTIPLEX 745 (Core 2 Duo E6400 2,13GHz, RAM 2048) is used for simulations.

SMAAM and SMAAMO are tested at T = const in terms of the required number of weights to achieve a non-conflict schedule (C = 0). The results of this test are shown in Table 1 and Figure 6.

Table 1. *Required number of weights (w) for C = 0 at T = const*

N	**w** by **SMAAM**	**w** by **SMAAMO**
4	9	6
8	26	12
16	133	28
32	502	63

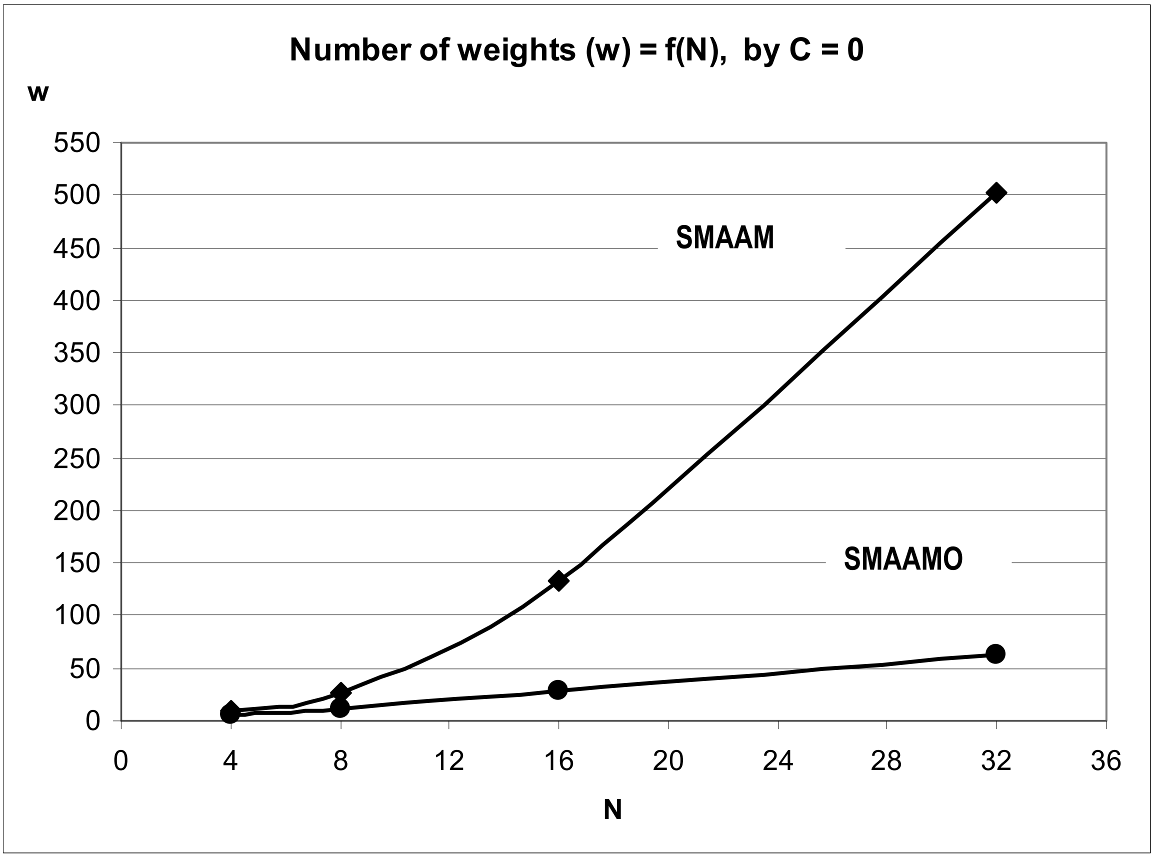

Figure 6. *The required number of weights to achieve non-conflict schedule*

Conclusion

From the performed tests it is seen that the adaptive algorithm (AAM) for the traffic management in Crossbar commutator with weight factors can be used for large size of the matrix of connections. The disadvantage is the relatively large number of weight factors.

In the optimized version of the adaptive algorithm (AAMO) that disadvantage is avoided. When N = 32, the number of weights in the optimized version is less than seven times, compared to the baseline adaptive algorithm.

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