CLASS OF ALGORITHMS FOR SYNTHESSIS OF NON-CONFLICT SCHEDULE IN COMMUNICATION NODES

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***Abstract**: In the paper are discussed six algorithms for non-conflict schedule obtaining in the switching nodes of type Crossbar. Comparative analysis of algorithms gives an overview of their potentiality related to the speed, required memory and performance as a function of the size N of the connection matrix T.*

***Keywords:** Network nodes, Message switching Node traffic, Crossbar switch, Conflict elimination, Packet messages, Sparse matrix.*

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

Introduction

Discusses six algorithms to obtain conflict-free schedule in the switching nodes of type Crossbar. Algorithms solve the problem of conflicts in the switching nodes.

The conflicts are available in the following two cases:

- When one source of massage requests communication to two or more massage receivers;
- When one massage receiver receives communication requests from two or more massage sources.

The evasion of the 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 member $T_{ij} = 1$ 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 [1].

The report is a comparative analysis of six algorithms in terms of speed, required memory and performance in different sizes of connection matrix through eight software models.

A software models performance **(P)** is defined as a ratio of the non- nil resolutions to the total number of the solutions. **R(v)** is the set of the nil solutions, **R(w)** is the set of the non-nil solutions, and **R** is a set of the all solutions[Kolchakov and Tashev, 2012].

An Approach for Conflict Issue Solving

One of the possible approaches for conflict issue solving is based on the research on the algorithms for non-conflict schedules obtaining:

1. Classic algorithm with masks matrices (**CMA**) [Kolchakov K., 2007].
2. Algorithm with joint mask matrices (**JMA**) [Kolchakov K., 2007].
3. Classic algorithm without masks matrices (**CWA**)[Kolchakov K., 2006].

4. Algorithm considering the massage direction (**DAA**) [Kolchakov K., 2004].
5. An algorithm by diagonal connectivity matrix activation (**ADA**)[Kolchakov K., 2011].
6. Algorithm with joint diagonals activations (**AJDA**)[Kolchakov and Tashev, 2012].

Software models are used for the algorithms investigation. Software models are written in Matlab programming language and tested on a Workstation Dell Precision 420.

The software models match completely the algorithms for non-conflict schedule obtaining.

1. A software model based on the classic algorithm with masks matrixes (**SMCMA**) is described and examined in [Kolchakov K., 2007].
2. A software model based on the algorithm with joint mask matrices (**SMJMA**) is described and examined in [Kolchakov K., 2007].
3. A software model based on a classic algorithm without mask matrices (**SMCWA**) is described and examined in [Kolchakov K., 2007].
4. A software model based on a algorithm considering the massage direction (**SMDAA**) is described and examined in [Kolchakov K., 2007].
5. A software model based on a classic algorithm with spare mask matrices (**SMCSM**) is described and examined in [Kolchakov K., 2007].
6. A software model based on the algorithm with joint spare mask matrices (**SMJSM**) is described and examined in [Kolchakov K., 2007].
7. A software model based on the algorithm by diagonal connectivity matrix activation (**SMADA**) is described and examined in [Kolchakov K., 2011].
8. A software model based on the algorithm with joint diagonals activations (**SMAJDA**) is described and examined in [Kolchakov and Tashev, 2012].

The results of the examination of the software models speed (**S**) is represented on Figure 1.

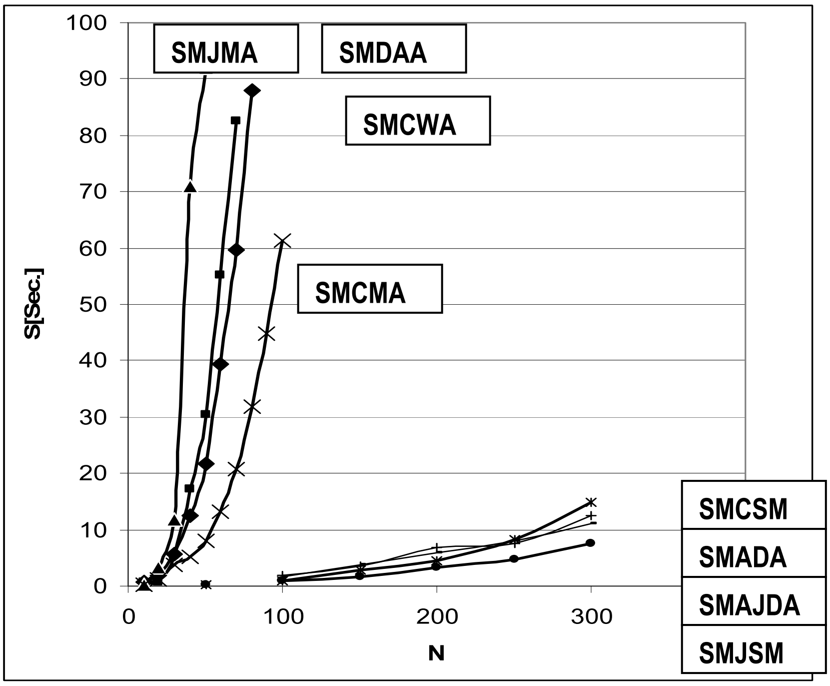


Figure1. Rapidity of software models

In Table 1 and Table 2 are represented the results of the software models investigation related to rapidity S[Sec.] and memory resources M[KB]. Figure 1 and Figure 2 illustrate the results from Table 1 and Table 2 graphically.

Table 1. Results of the software models investigation related to rapidity S[Sec.]

N	SMCWA S[Sec.]	SMDAA S[Sec.]	SMJMA S[Sec.]	SMCMA S[Sec.]	SMCSM S[Sec.]	SMADA S[Sec.]	SMAJDA S[Sec.]	SMJSM S[Sec.]
10	0,61	0,67	0,18	0,33	-	-	-	-
20	1,87	0,671	3,25	1,23	-	-	-	-
30	5,56	5,54	11,86	3,82	-	-	-	-
40	12,46	17,29	70,93	5,16	-	-	-	-
50	21,67	30,43	91,93	7,91	0,256	0,174	-	-
60	39,36	55,30	-	13,11	-	-	-	-
70	59,57	82,58	-	20,81	-	-	-	-
80	87,92	-	-	31,82	-	-	-	-
90	-	-	-	44,90	-	-	-	-
100	-	-	-	61,33	0,88	0,96	1,81	1,67
150	-	-	-	-	2,79	1,61	3,53	3,67
200	-	-	-	-	4,40	3,22	6,89	5,81
250	-	-	-	-	8,30	4,78	7,45	8,09
300	-	-	-	-	14,97	7,43	12,42	11,17

Table 2. Results of the software models investigation related to memory resources M[KB]

N	SMCWA M[KB]	SMDAA M[KB]	SMJMA M[KB]	SMCMA M[KB]	SMCSM M[KB]	SMADA M[KB]	SMAJDA M[KB]	SMJSM M[KB]
10	8,816	20,016	38,4	46,4	-	-	-	-
20	35,216	80,016	313,6	377,6	-	-	-	-
30	79,216	180,016	1065,6	1274,4	-	-	-	-
40	140,816	320,016	2534,4	3033,6	-	-	-	-
50	200,016	500,016	4960	5960	-	-	-	-
60	316,816	720,016	8582,4	10310,4	-	-	-	-
70	431,216	980,016	13641,6	16385,6	-	-	-	-
80	563,216	1280,016	20377,6	24473,6	-	-	-	-
90	712,816	1620,016	29030,4	34862,4	-	-	-	-
100	880,016	2200	39840	47840	4030	401	401	4010
150	-	-	-	-	32080	902	902	32030
200	-	-	-	-	108140	1630	1630	108140
250	-	-	-	-	256230	2540	2540	256060
300	-	-	-	-	500340	3604	3604	500080
350	-	-	-	-	-	4905	4905	-

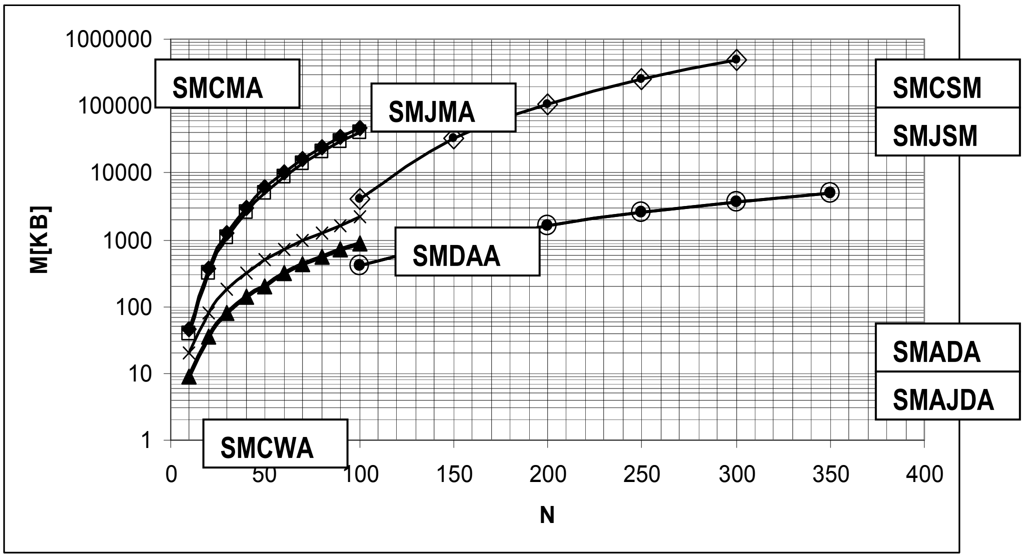


Figure 2. Memory resources of software models

Software Models Performance

A software models performance **(P)** is defined as a ratio of the non- nil resolutions to the total number of the solutions. **R(v)** is the set of the nil solutions, **R(w)** is the set of the non-nil solutions, and **R** is a set of the all solutions [Kolchakov and Tashev, 2012].

$$R = R(v) + R(w) \tag{1}$$

$$P = (R(w) / R).100[\%] \tag{2}$$

From formula 2 it is visible that when the nil solutions **R(v)** vanish to nil, than the performance **P** vanish to 100% [Kolchakov and Tashev, 2012].

To facilitate the performance examination, 5 kinds of matrices for simulation of the input connectivity matrix **T** are chosen. The special input matrices **2A, 2B, 2C, 2D** and **2E** [Kolchakov and Tashev, 2012] are represented on Figure 3.

In Table 3 are represented the investigation results related to the performance **P** of the software models. The results are represented on Figure 4 graphically.

2A

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

2B

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

2C

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

2D

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

2E

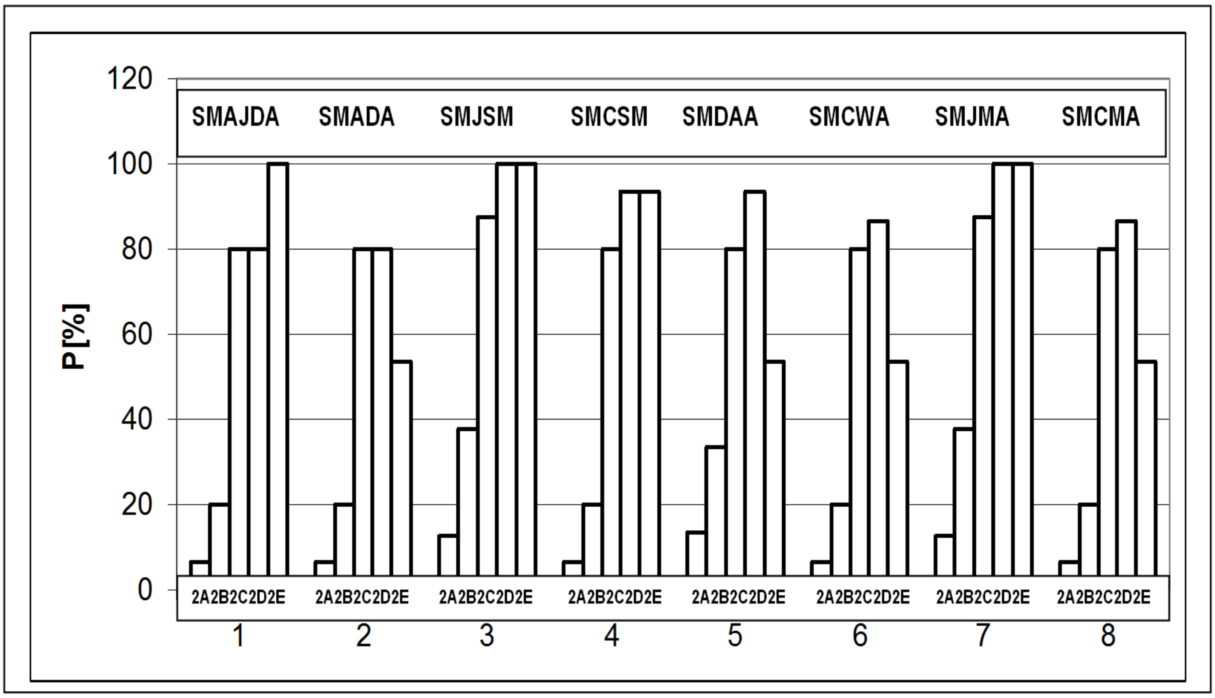
1	1	1	1	1
0	1	1	1	1
0	0	1	1	1
0	0	0	1	1

Figure 3. Special input matrices

Table 3: The investigation results related to P like a function of the input special matrices

P[%]	2A	2B	2C	2D	2E
SMCMA	6,66%	20%	80%	86,6%	53,3%
SMJMA	12,5%	37,5%	87,5%	100%	100%
SMCWA	6,66%	20%	80%	86,6%	53,3%
SMDAA	13,3%	33,3%	80%	93,3%	53,3%
SMCSM	6,66%	20%	80%	93,3%	53,3%
SMJSM	12,5%	37,5%	87,5%	100%	100%
SMADA	6,66%	20%	80%	80%	53,3%
SMAJDA	6,66%	20%	80%	80%	100%

Figure 4. Performance of software models



Conclusion

Software models **SMCMA, SMCWA, SMDAA** and **SMJMA** are times slower than software models **SMCSM, SMADA, SMAJDA** and **SMJSM**, making them unsuitable for connections matrix sizes greater than one hundred.

From software models **SMCSM, SMADA, SMAJDA** and **SMJSM** fastest is **SMJSM**. This software model corresponds to Algorithm with joint mask matrices (**JMA**), when using sparse matrices.

In terms of memory needed the software models **SMADA** and **SMAJDA** are most economical. The fastest **SMJSM** software model is the most wasteful in terms of memory as well as **SMCSM** software model.

The traffic is represented best with input matrix of **2D** type usually. The Performance of all software models for **2D** is equal to or greater than 80%, as the fastest algorithm **JMA**, represented by **SMJSM** software model is 100%.

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Bibliography

[D. Serpanos, P. and Antoniadis, 2000] D. Serpanos, P. Antoniadis:"FIRM: A Class of Distributed Scheduling Algorithms for High-Speed ATM Switches with Multiple Input Queues", IEEE Infocom 2000 Conference, Tel Aviv, Israel, March 2000.

[K. Kolchakov, 2006] K. Kolchakov, Algorithm for Synthesis of Non-conflict Schedule in a Communication Node, Workshop (DCCN – 2006), Sofia, Bulgaria, Oktober 30 - November 2, 2006, pp. 149 – 155.

[K.H.Kolchakov, 2008] K .H. Kolchakov, An approach for non-conflict schedule synthesis – modeling and optimization, Workshop MEPHI-2008, Moscow, 2008, pp.100-101.

[K.Kolchakov, 2005] K.H.Kolchakov, Synthesis approach of optimized non-conflict schedule in communication node, Workshop MEPHI-2005, Moscow 2005, pp.162-163.

[K.Kolchakov, 2007] К.Колчаков "Моделиране на подход с матрици-маски за получаване на безконфликтно разписание в комутационен възел".Работна статия в поредицата на ИИТ-БАН, IIT/WP-238B, Ноември 2007.

[K.Kolchakov, 2009] Kolchakov K., Software Models with Sparse Mask Matrixes for Non-Conflict Schedule obtaining in a Switching Node, Proceedings of the International Conference (DCCN – 2009), "Distributed Computer and communication networks DCCN 2009", Moscow: R&D Company "Information and Networking technologies" ISBN 978-5-9901871-1-5 Sofia, Bulgaria, 5-9. 10.2009, pp. 121-126.

[K.Kolchakov, 2010] K.Kolchakov, "An approach for performance improvement of class of algorithms for synthesis of non-conflict schedule in the switch nodes" , Proceedings of the 11th International Conference on Computer Systems and Technologies, Compsystech'10, 17-18 june 2010, Sofia, Bulgaria, pp.235-239, ISBN 978-1-4503-0243-2.

[Kolchakov and Tashev, 2012] Kolchakov K., Tashev T. "An Algorithm of Non-conflict Schedule with Joint Diagonals Activation of Connectivity Matrix", Proceedings of the International Conference on Computer Systems – CompSysTech'12, 22-23 June 2012, Ruse, Bulgaria, ACM PRESS, ICPS, VOL.630, pp. 245-250, ISBN 978-1-4503-1193-9.

[Kolchakov K, 2004] Kolchakov, K., Synthesis of an Optimized Non-conflict Schedule Accounting the Direction of Messages Transfer in a Communication Node. Cybernetics and Information Technologies, Bulgarian Academy of Scienses, Vol. 4, No 2, 2004, pp. 88-95, Sofia.

[Kolchakov K., 2007] Kolchakov K., A Modeling Approach for Obtaining of a Non – Conflict Schedule, Proceedings of the International Conference (DCCN – 2007), Moscow, 10-12.09., 2007, pp.168-173.

[Kolchakov K., 2011] Kolchakov K., "An Algorithm Synthesis of Non-Conflict Schedule by Diagonal Connectivity Matrix Activation" Proceedings of the International Conference AUTOMATICS AND INFORMATICS`11, John Atanasoff Society of Automatics and Informatics, Bulgaria, Sofia 03.10-07.10.2011., pp. B-247 – B251, Proceedings ISSN 1313-1850, CD ISSN 1313-1869

[Kolchakov K., 2012] Kolchakov K. Examination on Algorithms for Non Conflict Schedule with Diagonal Activation in Case of a Large Size Switching Matrix. International Conference Automatics and Informatics `12 03-05.10.2012 Sofia, Bulgaria. Proceedings CD: ISSN 1313 – 1869. pp.341-344.

[Kolchakov K.H., 2007] Kolchakov K.H., Non-conflict Schedule Synthesis Based on Communication Matrix Scanning, Workshop MEPHI-2007, Moscow 2007, pp.132-133.

[P. Gupta, and N. McKeown, 1999] P. Gupta, N. McKeown, “Designing and Implementing a Fast Crossbar Scheduler”, IEEE Micro, Jan.-Feb. 1999, pp.20-28.

[Tashev T. and Monov V. 2011] Tashev T., Monov V. Large-Scale Simulation of Uniform Load Traffic for Modeling of Throughput on a Crossbar Switch Node. 8-th Int.Conf. on “Large-Scale Scientific Computations” 6-10 June 2011, Sozopol, Bulgaria. Springer, Lecture Notes in Computer Science (LNCS) Volume 7116 (2012). pp. 630-637.

[Ташев Т.Д., Ташева Р.П.] Ташев Т.Д., Ташева Р.П. Модел за изследване елиминирането на конфликти в комуникационен възел с Обобщени мрежи. Годишник на Секция “Информатика” при Съюз на учените в България. Том 1, 2008. Издателство на Съюз на учените в България, София, 2008 г. с.105-111.

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