UDC004.81:681.3

# 3D MULTISERVICE COMMUTATION STRUCTURE ON THE ELEMENTS BY BEREZOVSKY

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# 3D МУЛЬТИСЕРВИСНАЯ КОММУТАЦИОННАЯ СТРУКТУРА НА ЭЛЕМЕНТАХ БЕРЕЗОВСКОГО

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***Abstract.*** *The concept of a relatively modern multiservice switching structures, systems, networks implemented with regard to the new paradigm in the development of telecommunications is described. The concept of architecture formation of a multiservice structure is close to the basic ideas of SDN (Software-defined Networking), where the control level is separated from data transfer devices and implemented programmatically. The multiservice structure uses a single channel for transmitting data of different types, makes it possible to reduce the diversity of equipment types, apply common standards and technologies, and provide centralized management of the communication environment.*

*Particular attention has been paid to the task of ensuring intelligence, access invariance, comprehensiveness of services in a single transport environment of multiservice structures implemented on the basis of 3D technologies. 3D technology opens up a lot of opportunities for creating diverse topologies of the universal transport environment, which will ensure flexibility of the environment and accelerated data transfer along the least loaded routes.*

*The N-dimensional switching element by Berezovsky (SEB) has been proposed, which allows creating "switching patterns" for new 2D, 3D topologies of the transport environment, represented in the form of 2D, 3D commutation fabrics. 3D multiservice structure requires a complex and intelligent control system. The framework 3D models on the switching elements by Berezovsky allow visualizing route data, carrying out operational and retrospective analysis of these data in order to identify problems, simulate the effects of routing schemes on the operation of the structure, using database archives, etc.*

*The importance of developing the concept, procedures and algorithms for managing the state (traffic) of the 3D switching environment on the new "switching patterns" on the switching elements by Berezovsky has been emphasized.*

*The convergence of intelligent structures is becoming more and more noticeable, and 3D switching structures on the SEB can become the basis for solving this problem.*

***Keywords****: Berezovsky's switching element, 3D switching pattern by Berezovsky element, switching plant*

***Анотація.*** *Викладається концепція щодо сучасних мультисервісних комутаційних структур, систем, мереж, реалізованих з урахуванням нової парадигми в розробці телекомунікацій. Концепція формування архітектури мультисервісної структури близька до базових ідей SDN (Software-defined Networking), де рівень управління відділений від пристроїв передавання даних і реалізується програмно. Мультисервісна структура використовує єдиний канал для передавання даних різних типів, дає можливість зменшити різноманітність типів обладнання, застосувати єдині стандарти і технології, централізовано керувати комунікаційним середовищем.*

*Особливу увагу приділено завданню забезпечення інтелектуальності, інваріантності доступу, комплексності послуг в єдиному транспортному середовищі мультисервісних структур, що реалізуються на базі 3D технологій. 3D технології відкривають масу можливостей для побудови різноманітних топологій універсального транспортного середовища, що забезпечить гнучкість середовища і прискорене передавання даних по найменш завантажених маршрутах.*

*Пропонується N-мірний комутаційний елемент Березовського (КЕБ), який дозволяє формувати “комутаційні патерни” для нових 2D, 3D топологій транспортного середовища, що подається у вигляді 2D, 3D комутаційних фабрик. 3D мультисервісній структурі необхідна складна й інтелектуальна система управління. 3D моделі фреймворків на комутаційних елементах Березовського дозволяють візуалізувати маршрутні дані, здійснювати оперативний і ретроспективний аналіз цих даних з метою виявлення проблем, моделювати вплив схем маршрутизації на роботу структури, в тому числі з використанням архіву баз даних і т. д.*

*Підкреслюється важливість розробки концепції, процедур і алгоритмів управління станом (трафіком) 3D комутаційного середовища на нових “комутаційних патернах” на комутаційних елементах Березовського (КЕБ).*

*Дедалі помітнішою стає конвергенція інтелектуальних структур і 3D комутаційні структури на КЕБ можуть стати базою в процесі розв’язання цього завдання.*

***Ключові слова**: комутаційний елемент Березовського, 3D комутаційний патерн елемента Березовського, комутаційна фабрика*

**Аннотация.** *Излагается концепция относительно современных мультисервисных коммутационных структур, систем, сетей, реализуемых с учётом новой парадигмы в разработке телекоммуникаций. Концепция формирования архитектуры мультисервисной структуры близка к базовым идеям SDN (Software-defined Networking), где уровень управления отделён от устройств передачи данных и реализуется программно. Мультисервисная структура использует единый канал для передачи данных разных типов, даёт возможность уменьшить разнообразие типов оборудования, применить единые стандарты и технологии, централизованно управлять коммуникационной средой.*

*Особое внимание уделено задаче обеспечения интеллектуальности, инвариантности доступа, комплексности услуг в единой транспортной среде мультисервисных структур, реализуемых на базе 3D технологий. 3D технологии открывают массу возможностей для построения многообразных топологий универсальной транспортной среды, что обеспечит гибкость среды и ускоренную передачу данных по наименее загруженным маршрутам.*

*Предлагается N-мерный коммутационный элемент Березовского (КЭБ), который позволяет формировать "коммутационные паттерны" для новых 2D, 3D топологий транспортной среды, представляемой в виде 2D, 3D коммутационных фабрик. 3D мультисервисной структуре необходима сложная и интеллектуальная система управления. 3D модели фреймворков на коммутационных элементах Березовского позволяют визуализировать маршрутные данные, осуществлять оперативный и ретроспективный анализ этих данных с целью выявления проблем, моделировать влияние схем маршрутизации на работу структуры, в том числе с использованием архива баз данных и т. д.*

*Подчёркивается важность разработки концепции, процедур и алгоритмов управления состоянием (трафиком) 3D коммутационной среды на новых "коммутационных паттернах" на коммутационных элементах Березовского.*

*Все заметнее проявляется конвергенция интеллектуальных структур, и 3D коммутационные структуры на КЭБ могут стать базовыми в процессе решения этой задачи.*

***Ключевые слова:**коммутационный элемент Березовского, 3D коммутационный паттерн элемента Березовского, коммутационная фабрика.*

## INTRODUCTION

The concept of architecture formation of a multiservice structure is close to the basic ideas of SDN (Software-defined Networking), where the control level is separated from data transfer devices and implemented programmatically.

3D technology opens up a lot of opportunities for creating diverse topologies of the universal transport environment, which will ensure flexibility of the environment and accelerated data transfer along the least loaded routes.

## MULTISERVICE SWITCHING STRUCTURES

Multiservice switching structures (MSS), systems, networks can be built on the basis of various technologies, but today the paradigm prevails, according to which the structure management level (control plane) is separated from data transfer devices - data transport medium (data plane).

MSS is a hardware and software platform that can modify its state in real time, giving priority to the prior data stream or selecting optimal quality parameters for this stream, taking into account the topological features of the data transport medium and the server infrastructure.

In the MSS, it is possible to monitor not only the state of the channels of the data transmission medium, but also the services and the state of the client devices.

The transport data transmission medium is a universal high-speed and, if possible, homogeneous switching structure (SS), which ensures the transfer of all the provided data formats. This approach allows us to raise the question of the unification of the SS as to save money, as well as ease of operation and administration.

The modern topology of homogeneous SS is two-dimensional (2D) based on 2D switching elements. It is regular and easily scaled upwards.

A special problem of SS is the absence of modern conditional-graphic notation for switching elements for constructing spatial multidimensional SS.

The use of reprogrammable 2D, 3D switching structures on the element by Berezovsky [1]

## 3D MODELS OF THE FRAMEWORK OF THE SWITCHING ELEMENT BY BEREZOVSKY

To solve the problem, the framework forming switching element has been synthesized and patented [1]:

- N-dimensional switching element of Berezovsky (conventional symbol ($\underline{B_N^{\#}}$)).

The main advantages of the SEB are full accessibility and minimal delays.

The switching element by Berezovsky ($\underline{B_N^{\#}}$) with N = 1 is used as a switching framework.

The framework model of the Berezovsky switching element can be presented in black and white $\underline{B_{N2}^{\#}}\left({}^{B}/_{W}\right)$ or colored option without indicating the used color $\underline{B_{N2}^{\#}}(C)$ model or indicating, for example, $\underline{B_{N2}^{\#}}(RGB)$ or $\underline{B_{N2}^{\#}}(HEX)$ [2].

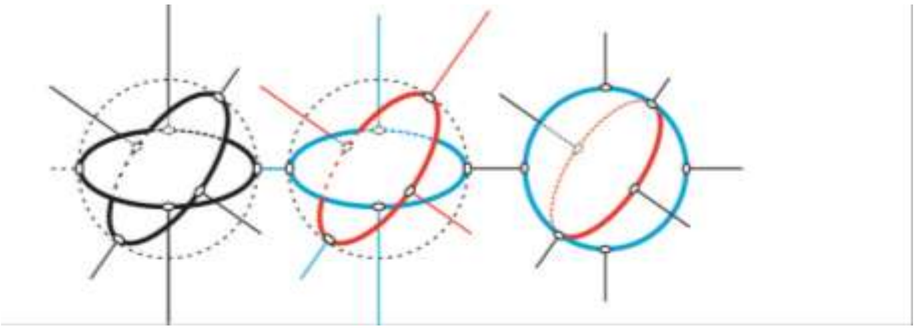

Figure 1 – Framework model of the Berezovsky switching element $B_{N2}^{\#}$

Application of SEB frame models opens up new possibilities for developers in the topology and architecture of the MSS.

## 3D SWITCHING FIELD ON THE ELEMENTS OF BEREZOVSKY

The switching element by Berezovsky (SEB) is used as a “switching pattern” to form the base element of the MSS field. The example of a planar field – a SS matrix is shown in Figure 2.

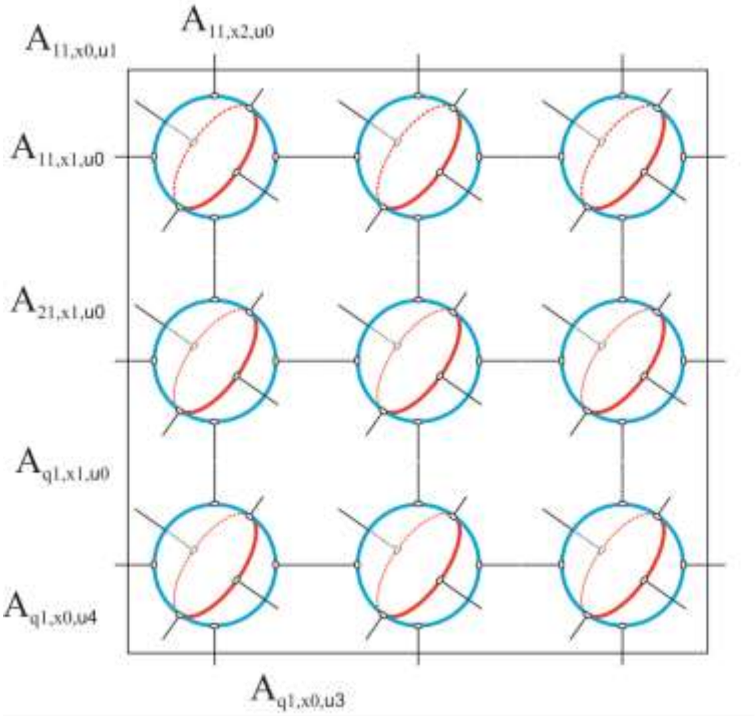

Figure 2 – Packaged planar frame model of the switching field – matrix on SEB $B_{N2}^{\#}$.

The use of switching patterns on the SEB allows synthesizing absolutely any physical topology (planes, surfaces, shapes) of the switching field.

These topologies have incorporated a lot of proven ideas, some of which are used in the technologies of switching patterns formation on the SEB for commutation fabrics:

$$F_P := \left\{\sum_{i=1}^{j} \left[\!\left[ \underline{B_{N2}^{\#}}(RGB)\left[n\ {}^{\Vee}VP_{1q} \Wedge m\ \right]\right]\!\right]\right\},$$

where $B_{N2}^{\#}$ is metric N=2.

An increase in the SEB pattern metrics provides an increase in the number of ”input-output“ contact terminals (ports) of a packaged switching field planar frame model – a matrix [2].

Switching fields are combined into commutational fabrics (Fig. 3).

The new commutational fabric on the SEB has a block/modular architecture, which allows users to avoid the necessity of a complete replacement of equipment when implementing next-generation technologies in their environments.

The commutational fabric is represented by 2 matrix modules $M_f$ and $H_u$ on planar packaged switching patterns of the SEB Fig.4

The flexible scalable structure of the commutational fabric allows users to start from the size and scale that meets their current needs, and at the same time creates the conditions to meet the growth of these needs in the future [2].

The ability to select hardware and software solutions for all levels of the network stack and payment by principle “pay-as-it-grows” allows starting on a small scale and expand the commutational fabric gradually, without tying yourself to a fully integrated proprietary solution, and this is the way to create a modern MSS.

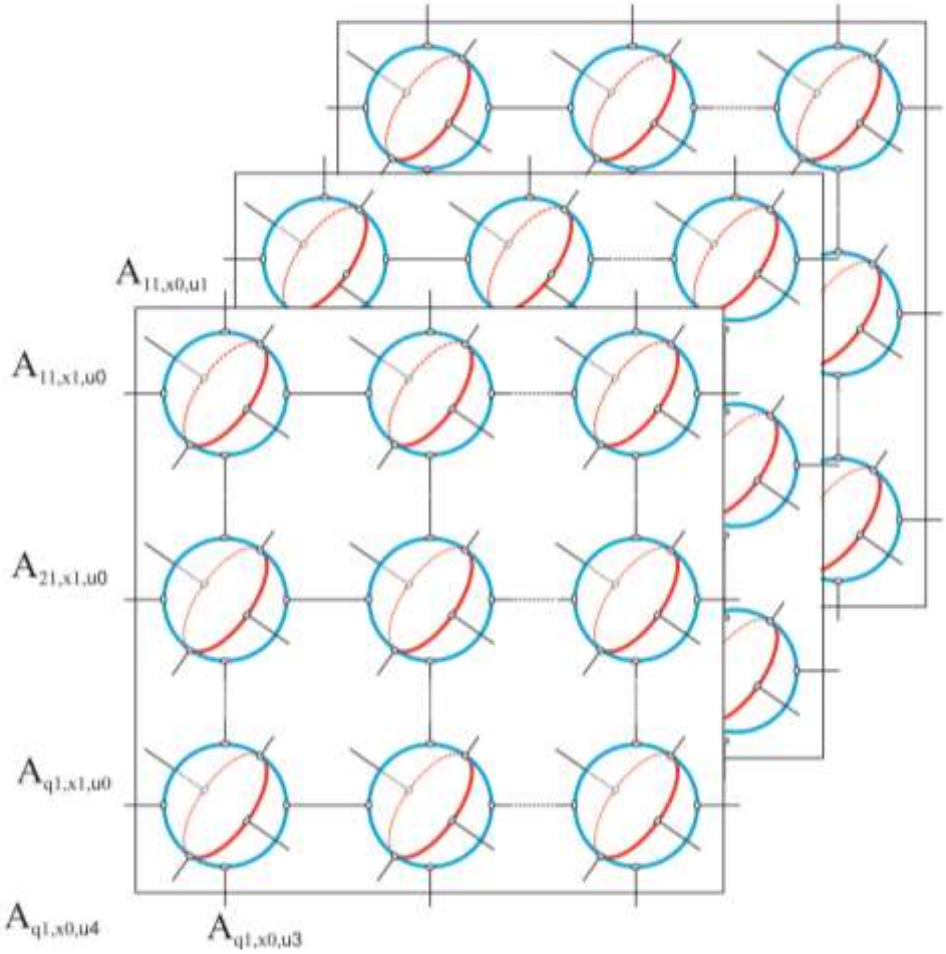

Figure 3 – 3D packaged frame monoblock k–planar painted on isometric patterns
with the metric N = 2 model of the switching field – the matrix on SEB

## GENERALIZED MSS STRUCTURE

The main functions of multi-stream routing of data fall on the commutation fabric of $P_r\ ,r=\ \overline{1,w}$ controllers and are to determine the information transfer routes, as well as to control devices that process $Q_e\ ,e=\ \overline{1,a}$ and balance data flows (Figure 4).

In the MSS, in some cases, there may be formed communication channels,. limiting the transfer of information from one part of the structure to another, or even isolating one part from another.

The use of SEB-1, SEB-2 in the synthesis of new MSS allows more efficient and full use of the structure.

A generalized block diagram of MSS switching field is shown in Figure 4.

The MSS is characterized by the fact that its switching field on the SEB commutes channels through which information can be transmitted in both digital and analog form.

The algorithms and protocols of the control plane that ensure the interaction of intelligent planar, block-matrix MSS on the SEB are not included into the topic of work and are not considered.

The quality of the MSS is in large part determined by the effectiveness of routing algorithms. It’s a difficult task, since it is necessary to take into account the topology of the switching structure of the field, fabric. During the process of work, the state of the individual switching elements change dynamically over time; in addition, failure of equipment and many other factors are possible.

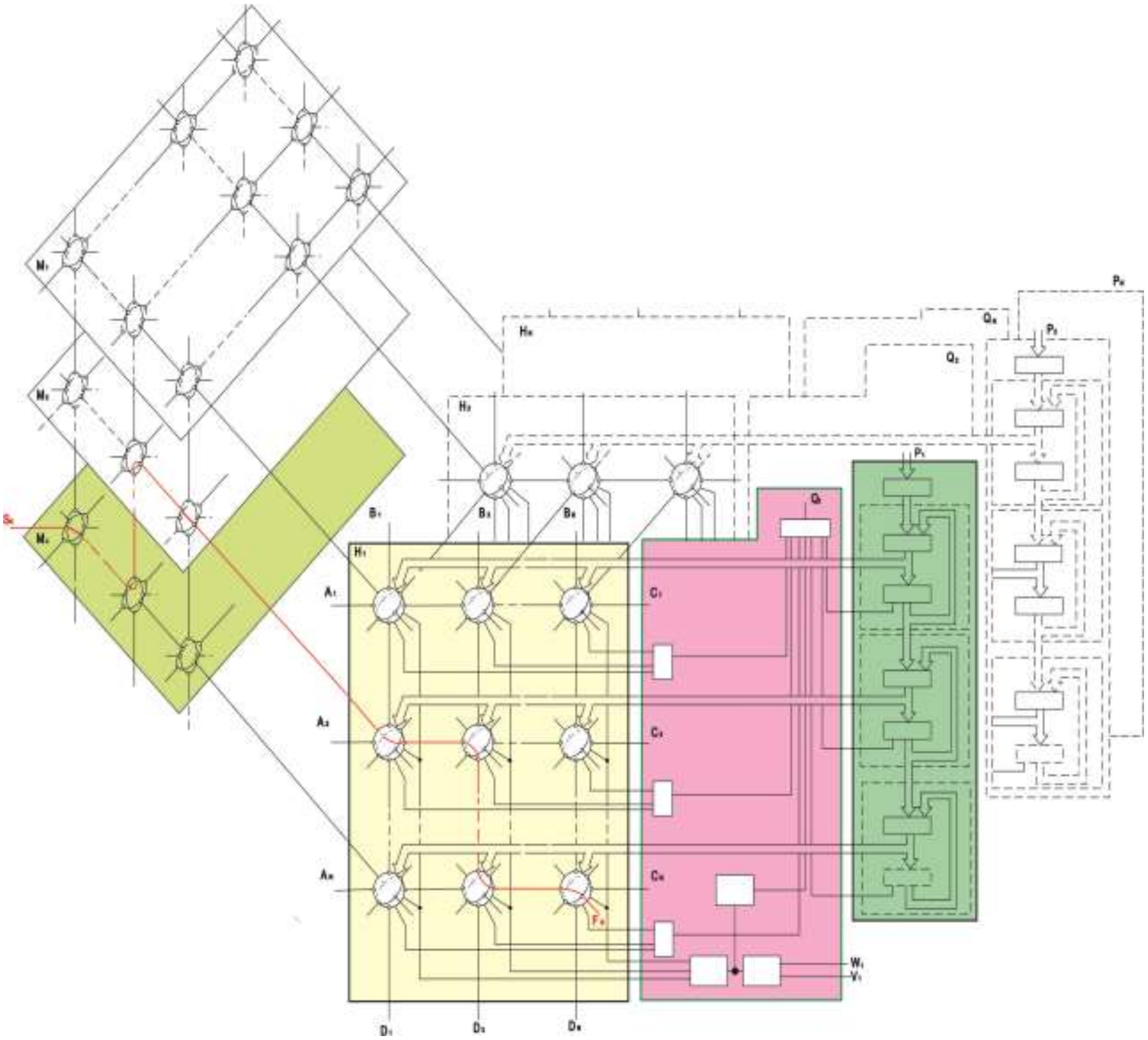

Figure 4 – Structural diagram of the MSS generalized switching field

## FORMATION OF THE STATE OF SWITCHING STRUCTURE

For a given topology of the MSS switching structure containing *M* channels $y_k$ $(k=\overline{1,M})$, it is necessary to ensure the switching of the basic "switching patterns" to N states $S_i$ $(i=\overline{1,N})$ on the basis of the switching module (SM) – Berezovsky's switching element. In its turn, the SM is characterized by *n* commuting variables $x_r$ $(r=\overline{1,n})$ and *m* commuted poles (variables) $z_l$ $(l=\overline{1,m})$. At the same time, for SM there also exists a certain number Q of switching states (SS) $V_j$ $(j=\overline{1,Q})$ in the set of variables *z.*

Then the solution of the task of switching the considered MSS can be reduced to determining a certain number of SMs, which, based on a number of *V* states under the control of *n* commuting variables *x*, by variables *z* provide the switching of *y* channels for given states S.

## METHOD OF REVERSE SUBSTITUTION

As a second procedure, supplementing the basic approach outlined in [3], and allowing to solve the considered task of forming a SS for the MSS based on SM, a reverse substitution method (RSM) has been proposed, the essence of which is as follows.

The stage of constructing descriptions (12) and (13) in [3] is retained in RSM, as in the MDS [3], and the step of specifying connections (14) in [3] is excluded. In the next step, in each set (16) in [3] ($V_j - S_1,\ ...,V_j - S_N,\ \ j = \overline{1,Q}$) one expression is selected with mismatching values *j:*

$$V_\alpha - S_1 = b_\alpha - a_1;\ \ V_\beta - S_2 = b_\beta - a_2\ \ ,...,\ \ V_\varpi - S_N = b_\varpi - a_N\,. \tag{1}$$

From the se expressions (1), based on the fulfillment of requirements (16) in [3], the SSM SS $S_i^*\ \ (i = \overline{1,N})$ are formed in the form (15) in [3]:

$$S_i^* = \sum_{k=\alpha_i}^{a_i^*} w_r^*(i) = a_i,\ \ i = \overline{1,N},\quad (a_i^* = \alpha_i + a_i)\,, \tag{2}$$

which are further equated to the original representations $S_i\ \ (i = \overline{1,N})$ (12) in [4]

$$S_i^* = S_i = \sum_{k=i}^{a_i} w_k^*(i) = \sum_{k=1}^{a_i} g_k(i),\quad i = \overline{1,N}. \tag{3}$$

From equalities (3) it is easy to obtain the following relations

$$w_k^*(i) = g_k(i),\ \ k = \overline{1,a_i},\quad i = \overline{1,N}, \tag{4}$$

which, in turn, make it possible to determine the desired compounds in the form

$$z_\alpha z_\beta = y_\gamma y_\delta,\qquad z_\varepsilon z_\mu = y_\nu y_\rho\quad ,...,\quad z_\tau z_\eta = y_\xi y_\psi \tag{5}$$

or

$$y_\gamma = z_\alpha,\quad y_\delta = z_\beta,\qquad y_\nu = z_\varepsilon,\qquad y_\rho = z_\mu\ \ ,...,\ \ y_\xi = z_\tau,\qquad y_\psi = z_\eta. \tag{6}$$

The received connections should be coordinated for all $S_i\ \ (i = \overline{1,N})$, which in most cases requires the use of complex switching. As in the previous method, the use of index tables (Table 7 and Table 8) in [3] in the reverse order can be quite effective here.

Let us take the following example as an illustration of the application of the proposed RSM. Then, using the conditions of the task and the data of the representation (17), ..., (20) in [3], we consider the following conditions of the type (1):

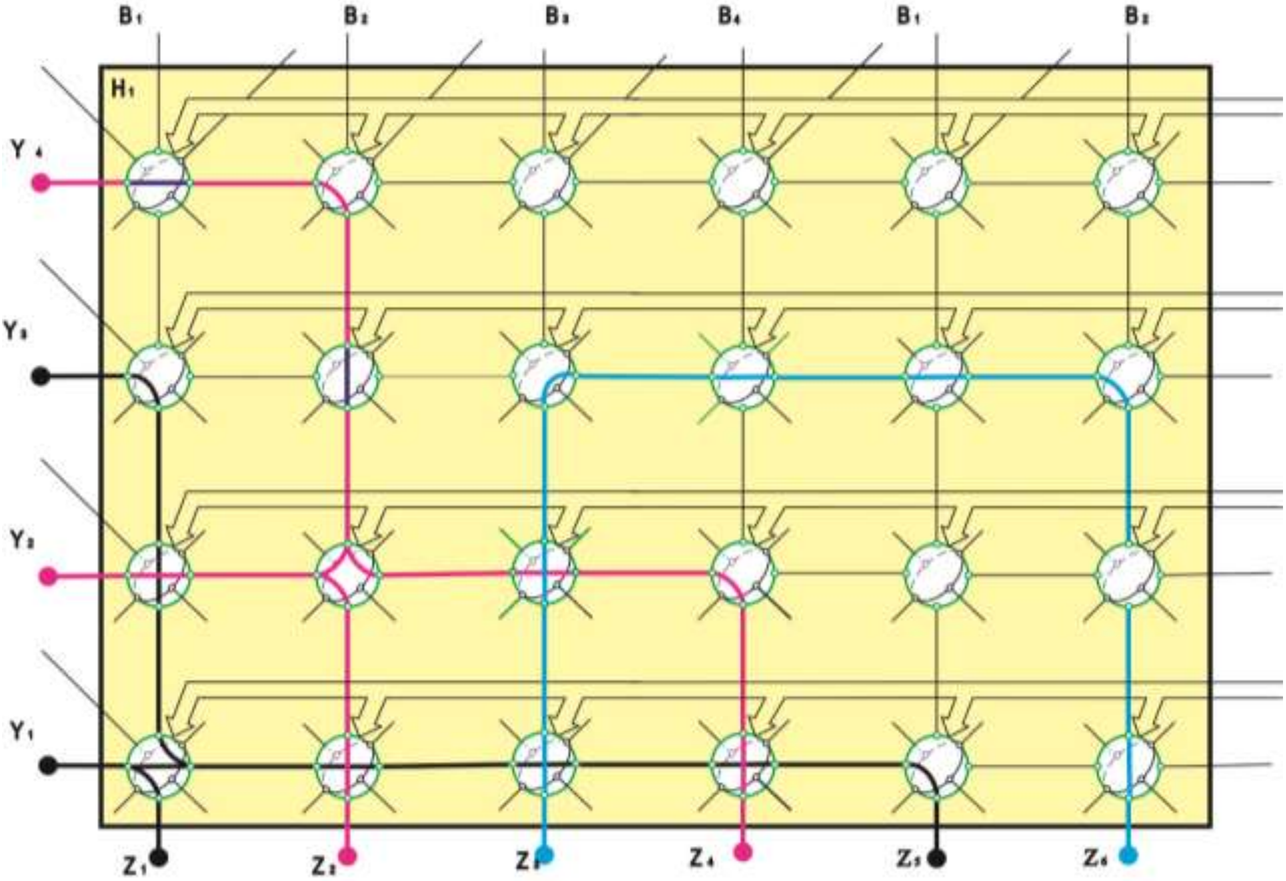

Figure 5, a – Implementation of SS

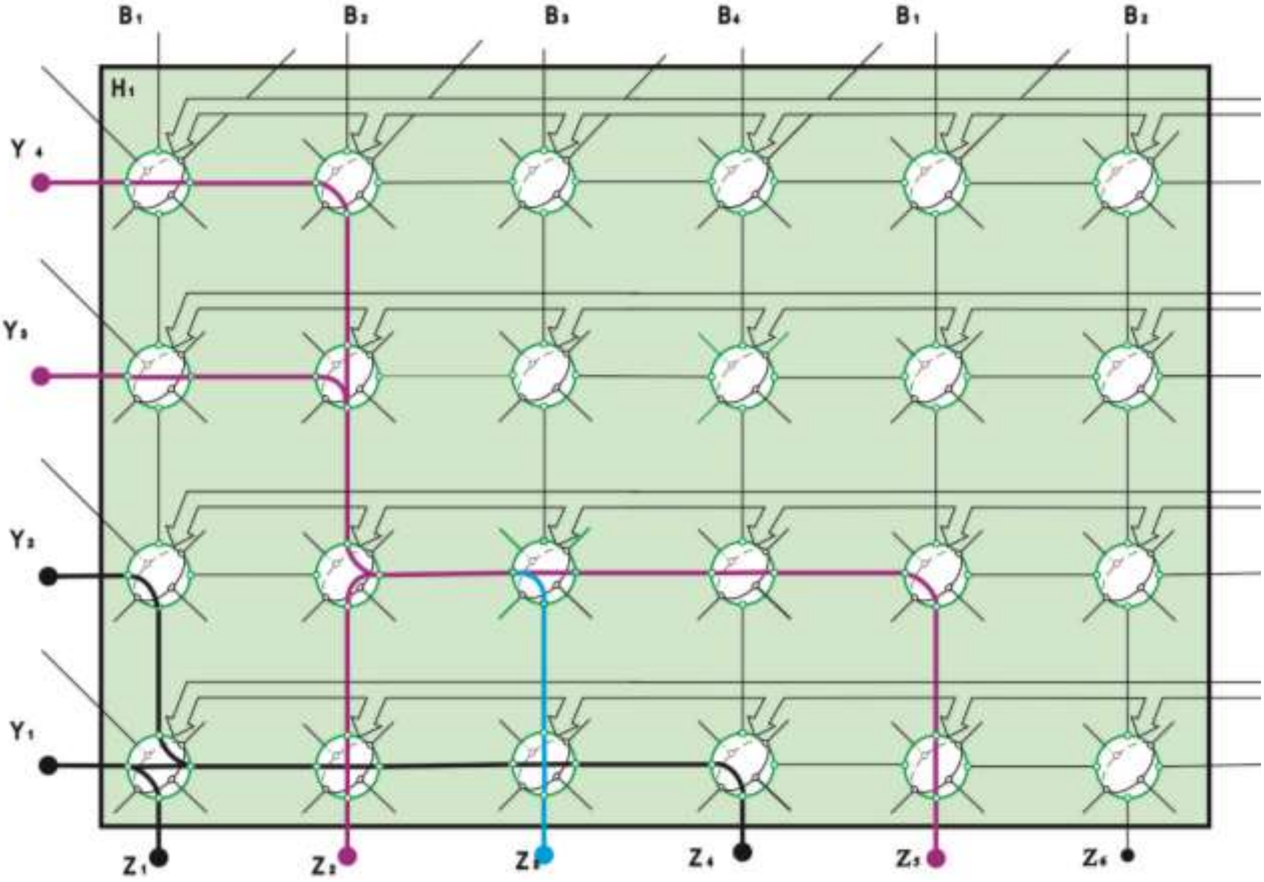

Figure 5, b – Implementation of SS

$$\begin{aligned} &V_1 - S_1 = w_3(1) + w_6(1) + w_8(1) - w_3^*(1) - w_8^*(1) = 1; \\ &V_3 - S_2 = w_2(3) + w_7(3) + w_{15}(3) - w_2^*(2) - w_7^*(2) = 1, \end{aligned} \qquad (7)$$

from which we obtain equalities of the form (3)

$$g_2(1) + g_7(1) = w_3^*(1) + w_8^*(1); \qquad g_1(2) + g_{10}(2) = w_2^*(2) + w_7^*(2). \qquad (8)$$

Equation (8) can be represented in the form (4)

$$w_3^*(1) = g_2(1); \quad w_8^*(1) = g_7(1); \quad w_2^*(2) = g_1(2); \quad w_7^*(2) = g_{10}(2). \qquad (9)$$

The relation (9) in view of the notation (13) in [3] takes the form(5):

$$z_1 z_4 = y_1 y_3; \quad z_2 z_5 = y_2 y_4; \quad z_1 z_3 = y_1 y_2; \quad z_2 z_4 = y_3 y_4. \qquad (10)$$

Finally, the desired compounds (6) are determined on the basis of equality (10)

$$y_1 = z_1; \quad y_2 = z_3 \ (y_2 = z_5); \quad y_3 = z_4; \quad y_4 = z_2. \qquad (11)$$

Figure 5,a) shows the realization of SS$S_1$ by means of SSSM$V_1$, and in Figure 5,b) presents the implementation of $S_2$ based on $V_3$. In this case, $X_1$ and $X_3$ (20) [3] are fed to the CCSM.

Both in the first and second cases (Figure 5) the reoccurs a complicated commutation ($y_2 z_3$, $y_2 z_5$, $z_2 z_3$, $z_2 z_5$) and ($y_2 z_3$, $y_2 z_5$). For clarity of the solution it is possible to use tables of indexes (table 7 and table 8) in [3].

## METHOD OF HYBRID SUBSTITUTIONS

The third procedure, which has been proposed for solving the problem of the specified SS formation for complex switching structures-fabrics of the MSS, includes both direct and reverse substitution. It is a combined procedure called the hybrid substitution method (HSM).

In this method, at the first stage, descriptions (12), (13) in [3] are formed in accordance with the conditions of the task. Further, they are set by separate compounds (14) in [3], and some of the variable s*y* remain unknown:

$$y_1 = z_\alpha, \quad y_2 = z_\beta, \ldots, \quad y_d = z_\lambda, \quad y_{d+1} = \chi_1, \quad y_{d+2} = \chi_2, \ldots, \quad y_M = \chi_{M-d-1}. \qquad (12)$$

Then for the SSM SS $S_i \ (i = \overline{1, N})$ can be written as

$$S_i = S_{i1} + S_{i2}, \quad S_{i1} = \sum_{k=\alpha_i}^{a_{i\alpha}} w_k(i); \quad S_{i2} = \sum_{k=\beta_i}^{a_{i\beta}} w_k^*(i), \quad i = \overline{1, N}, \qquad (13)$$

where $w_k^*(i)$ - contains unknown connections based on $\chi_\nu \ (\nu = \overline{1, M-d-1})$

In the next step, non-recurring requirements of the form (1), (16) in [3] are chosen for each $S_i \ (i = \overline{1, N})$ of the set (16) in [3]:

$$V_\alpha - S_{11} - S_{12} = b_\alpha - a_1; \ V_\beta - S_{21} - S_{22} = b_\beta - a_{21}, \ldots, \ V_\omega - S_{N1} - S_{N2} = b_\omega - a_N, \qquad (14)$$

on the basis of which

$$S_{i2} = \sum_{k=\beta i}^{a_{i\beta}} w_k^*(i), \quad (a_{i\beta} = \alpha_i + a_i), \quad i = \overline{1, N} \qquad (15)$$

are defined.

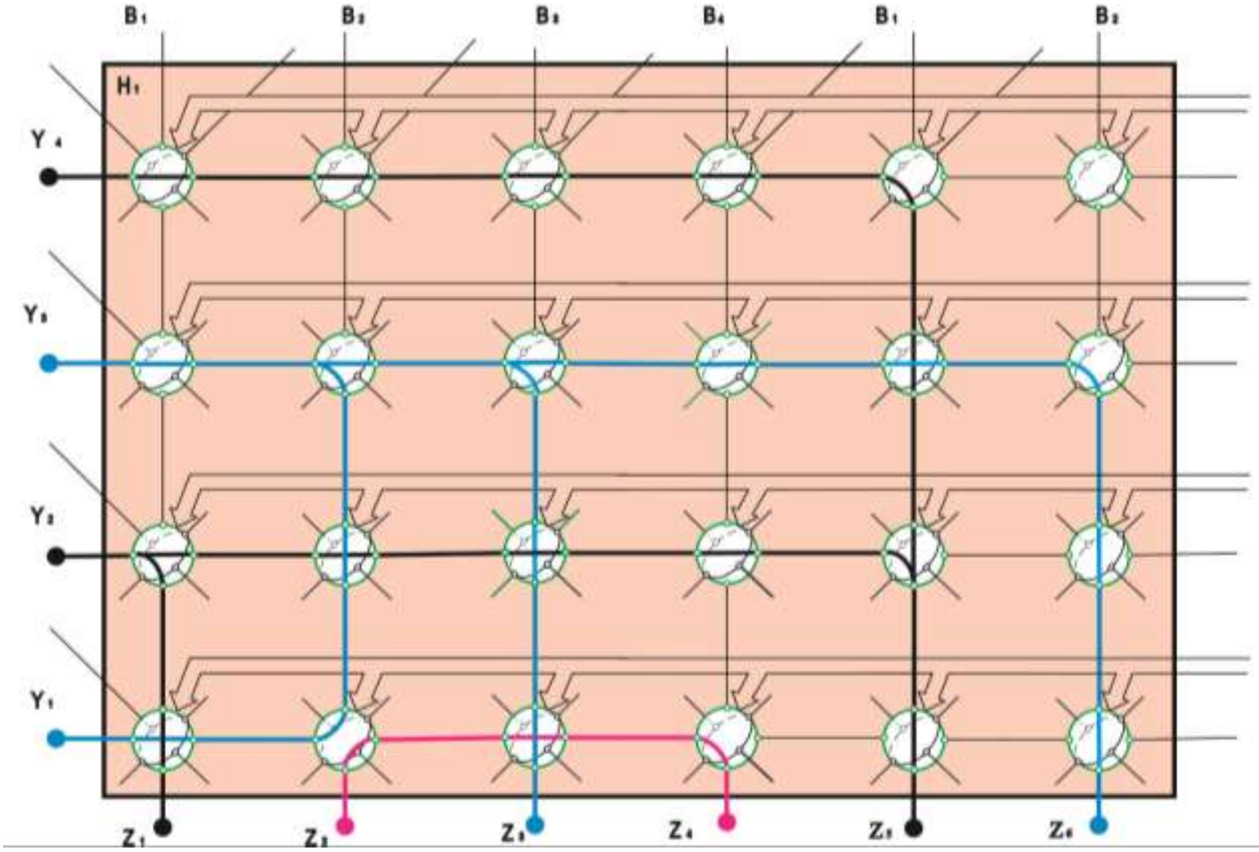

Figure 6, a –Implementation of SS $S_1$

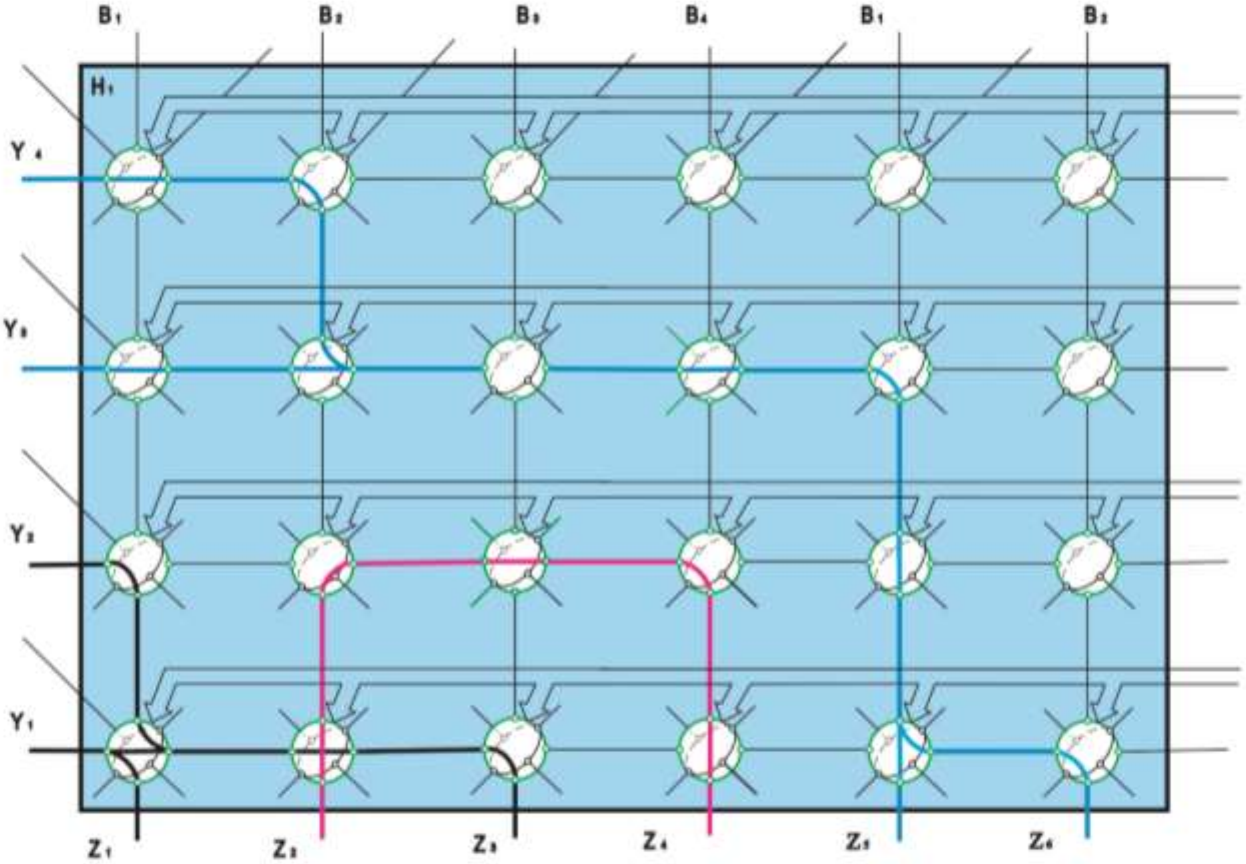

Figure 6, b– Implementation of SS $S_2$

Then we apply expressions (4), leading to relations of the form

$$z_{\varphi} z_{\omega} = \chi_{\gamma} \chi_{\delta}, \quad z_{\varepsilon} z_{\mu} = \chi_{\nu} \chi_{\rho} \ ,..., \quad z_{\tau} z_{\eta} = \chi_{\xi} \chi_{\psi}, \tag{16}$$

by means of which we can determine the correlated between $S_i \ (i = \overline{1, N})$ compounds (6):

$$\chi_{\gamma} = z_{\varphi}, \quad \chi_{\delta} = z_{\omega}, \quad \chi_{\nu} = z_{\varepsilon}, \quad \chi_{\rho} = z_{\mu} \ ,..., \quad \chi_{\xi} = z_{\tau}, \quad \chi_{\psi} = z_{\eta}. \tag{17}$$

The final solution (the desired connections) is formed on the basis of the expressions (12) and (17) in the form of the following equations:

$$y_1 = z_{\alpha 1}, \quad y_2 = z_{\beta} \ ,..., \quad y_d = z_{\lambda}, \quad y_{d+1} = z_{\omega} \ ,..., \quad y_M = z_{\eta}. \tag{18}$$

Here, as well as in the previous methods, in a number of cases it is useful to consider the use of index tables (Table 7 and Table 8) in [3].

As an example illustrating the essence of the proposed MHS, MKS and the task of forming its SS under conditions (17), ..., (20) in [3] can also be used.

Thus, we adopt the following notation (12):

$$y_1 = z_3, \quad y_3 = \chi_1, \quad y_3 = z_6, \quad y_4 = \chi_2. \tag{19}$$

Further, by virtue of formulas (13), we have

$$\begin{aligned} S_1 &= S_{11} + S_{12}, \quad S_{11} = w_{12}(1), \quad S_{12} = w_1^*(1); \\ S_2 &= S_{21} + S_{22}, \quad S_{21} = w_1^*(2), \quad S_{22} = w_2^*(2), \end{aligned} \tag{20}$$

where $w_k(1) = z_3 z_6, \quad w_1^*(1) = \chi_1 \chi_2, \quad w_1^*(2) = z_3 \chi_1, \quad w_2^*(2) = z_6 \chi_6.$

We formulate a record of requirements of the type (14):

$$\begin{aligned} V_2 - S_1 &= w_4(2) + w_7(2) + w_{12}(2) - w_{12}(1) - w_1^*(1) = 1; \\ V_3 - S_2 &= w_2(3) + w_7(3) + w_{15}(3) - w_1^*(2) - w_2^*(2) = 1, \end{aligned} \tag{21}$$

From which we obtain a relation of the form (15):

$$w_4(2) = w_1^*(1); \quad w_2(3) = w_1^*(2); \quad w_{15}(3) = w_2^*(2). \tag{22}$$

These relations (20),(22) are the basis for obtaining descriptions of the type (16)

$$z_1 z_5 = \chi_1 \chi_2, \quad z_1 z_3 = z_3 \chi_1, \quad z_5 z_6 = z_6 \chi_6, \tag{23}$$

which allow us to define expressions of the form (17)

$$\chi_1 = z_1, \quad \chi_2 = z_5. \tag{24}$$

The desired compounds are definitely determined on the basis of formulas (18), (19), (24)

$$y_1 = z_3, \quad y_2 = z_1, \quad y_3 = z_6, \quad y_4 = z_5. \tag{25}$$

These compounds (25) provide the implementation of SS$S_1$ *and* $S_2$ MSS, as illustrated in Figure 6, a and Figure 6, b, respectively. In this case, the CCSM is controlled for $S_1$ by the signal $X_2$ (20) in [3], and the *SSS*$_2$ by the signal $X_3$ (20) in [3].

In the example (Figure 6) there is no complicated commutation. Here, as in the previous cases (Figure 5), tables of indices (Table 7–Table 12) in [3] can be used for greater clarity of the solution obtained.

## CONCLUSION

In conclusion, we note that each of the proposed methods has its advantages and disadvantages. Thus MDS (12),...,(26) in [3] allows to get all possible solutions, it is simply algorithmized and easily allows to take into account additional requirements when selecting connections. These requirements include restrictions on currents, voltages, power, speed, etc. MSS channels and their coordination with the SM capabilities. The short coming of this method is its chunkiness.

The second method of RSM allows to find quickly a solution, but it requires intelligent support, it hardly describes all the variety of solutions and has a number of difficulties in taking into account the additional conditions imposed on the SS and the properties of the switched channels.

The third method of HSM, being a combined procedure, in case of its experimental application can combine the advantages of the first two methods described above, and minimize the short comings of MDS and RSM.

In the process of solving the problem, several CMs of one or various types can be used. In this case, the description of the methods will become somewhat more complicated. It is important at the same time to strive to comply with the requirements of $Q_\Sigma \geq N$ and $m_\Sigma \geq M$, where $Q_\Sigma$, $m_\Sigma$ denotes the total number of SSSM and their commutated poles. Equalities $Q_\Sigma = N$ and $m_\Sigma = M$ testifies to the existence of the risk of failing in the solution of the task.

In addition, we should note that the control variables $x_l\,(l = \overline{1,n})$ can be considered as a switching object, connecting the SM of the first level to the SM of the following levels. At the same time successful application will find the proposed methods of forming a SS for solving switching problems of all levels.

The third proposed procedure allows the condition that part of the variables $y$ remains unknown.

In this procedure, you can use algorithms of ternary associative memory (Ternary Content Addressable Memory, TCAM). The use of ternary associative memory (AM) for the routing table makes the search process very efficient and simplifies the design of the hardware for the implementation of the procedure. When selecting the index feature, a third value is added for comparison – “not important”, for one or more bits in the saved word – the index.

Thus, when searching for a sign – the destination address in the AM, the correct index is immediately retrieved – the input of the next switching element in the routing table; Both operations – mask and comparison applications – are performed by hardware using the AM control plane.

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