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Рассмотрена задача выбора программно-технических решений, принципов создания и применения сервисов научно-образовательного пространства академического учреждения в условиях развития базовых и перспективных коммуникационных и информационных технологий и общей глобализации. На основе анализа технологических стандартов, применяемых в телекоммуникационных структурах и центрах управления сетями, описано формирование рекомендаций по созданию центра управления сетями, в частности, базового компьютерного телекоммуникационного узла.

Ключевые слова: информационные технологии, интеллектуальные информационные технологии, облачные вычисления, распределенные вычислительные ресурсы, адаптивная эластичность, сервис по требованию, сервисная модель, частное облако.

The problem of the software choice and the hardware solutions, the creation principles and application services of the scientific and educational academic institutions environment in condition of the basic developing, the information communication technology innovation and general globalization is scrutinized. Based on the technological standards analysis that apply to the telecommunications infrastructure and network management centers, the recommendations for the network control center creation, in particular, the basic computer telecommunication center are described.

Keywords: information technologies, intellectual information technologies, cloud computing, distributed computing resource, rapid elasticity, on-demand self-service, service model, private cloud.

Розглянуто задачу вибору програмно-технічних рішень, принципів створення і застосування сервісів науково-освітнього простору академічної установи в умовах розвитку базових і перспективних комунікаційних та інформаційних технологій і загальної глобалізації. На основі аналізу технологічних стандартів, які застосовуються в телекомунікаційних структурах і центрах управління мережами описано формування рекомендацій щодо створення центру управління мережами, зокрема, базового комп'ютерного телекомунікаційного вузла.

Ключові слова: Інформаційні технології, інтелектуальні інформаційні технології, хмарні обчислення, розподілені обчислювальні ресурси, адаптивна еластичність, сервіс за вимогою, сервісна модель, випадкова (частное) хмара.

Problem statement. Now days we can observe the number of questions which are associated with the global development hard/software and technologies: the campus and corporate telecommunication computer network infrastructure (TCI), the research and training centers, the scientific and educational environment; shared the computing systems [1]. This different directions are combined around the problem of choosing the equipment and technologies of the education and science environment. In the article we describe the methods and recommendations for networks coordination center forming and particularly BCTN.

Introduction

The solution of the problem, which is describes, is based on the analogies of clouds services grouping technologies with perspective BCTN service clouds creation. It is necessary to consider: the global modeling TCI problems, the theoretical approaches and the practical rules of simulation models TCI segments, the parameters and criteria for creation the models in TCI science and educational environment (SEE) [5], the organization principles of gateways structures, the leased servers and the global BCTN model. It is also necessary to pay attention to the system control methods and monitor the status of TCI BCTN SEE with QoS criteria [2, 3].

SEE operation is necessary for the work of the traditional universities, science institutions and other components of education and science structure [5, 6]. Problem of TCI assembly as a component of SEE is viewed as analogy task of assembly TCI cooperatives campus network.

When we talk about campus [7], we consider it as the group of compact located buildings, for example: the industrial enterprises, educational institutes, university campus. Consequently, corporate campus is the Internet – distributed structure, which integrates the mentioned components.

For creation united SEE in enterprise with distributed corporate-campus TCI it is necessary to integrate the bone TCI. The modern computing technologies brings the following possibilities for SEE users:

- multimedia attachments supporting;
- wideband attachments supporting (multipoint videoconference, video monitoring systems, etc.);
- dynamic management of band width for traditional established networks;
- supporting the actual program versions for any provided protocols in traditional local networks;
- users and departments unification\division to local subnetworks by territorial basis;
- users and departments unification\division which are involved in the common business problems to virtual networks with control and access permissions to common resources;
- creation of specialized information centers (IC), which operate with users and groups data and storage this date. Such IC provides all types LAN\WAN access to own resources;
- easy connection and authorization procedure for new segments TCI without necessaries to rebuilding or reconstruction present TCI;
- hi-level performance and replication ability TCI, which provide growing users requirements with considering personal bandwidth for each user;
- urgently resumption TCI after collisions or crash;
- low labor costs for TCI installation and service;
- hi reliability level of TCI functioning.

There are three hierarchy levels in classical SEE TCI [7]:

- core;
- distribution;
- access.

Such approaches to TCI scalability allow the possibilities to:

– standard equipment choosing;

– network segment determination;

– the most exactly formulation function requirements for specific TCI.

The main aim in the article is to determine the main BCTN characteristics, tasks and components, which correspondence to the main interconnection level in SEE TCI.

1. Core level (CL) – backbone level. CL – network core is the central part of a TCI that provides the main trunks to customers who are connected by the access network and distributed networks. For supporting functioning of network core the one must have the next properties:

- hi-level reliability, which is obtained, in particularly, via equipment and software redundancy, which provide TCI operability after collisions;
- ability to adapt to changes in TCI environment;
- short delay data transfer;
- a good manageability and predictable performance.

2. Distribution level (DL). The level solves the problem access to different network part and various services. For DL the next functions are typical:

- safety politics
- information resources access politics;
- QoS management;
- quality of data transfer environment;
- logical routing;
- multimedia domain determination e.t.c.

3. Access level (AL). AL provids access to corporate resources for workgroups and network segments. In local networks AL is characterized by commutation or distribution users access to data transfer environment.

Obviously, that LAN future depends on the developing of Ethernet technologies versions (1G Ethernet, 10G Ethernet) [7]. These technologies are the most used standards in campus network structures. These technologies provide:

- effective hi speed data exchanging;
- low cost of network design;
- simple and convenient practice realization;
- compatibility with all known types software application including multimedia.

Modern soft and hardware means solving the following main problems of TCI SEE management:

- crash and collisions control in manageable pc and manageable devices, detecting the collisions and automatic addressing the causes, correcting their consequences, prevent crashes, for example by diagnostic operation;
- pc and network devices configuration management, in particularly, the initialization, reconfiguration and hotswitching manageable computing devices;

• network resources management by users or workgroups, for example, adjustment disk quotas, etc.;

• network performance devices management and services management by collecting and analysis of statistic of intensity appearing errors, artificial determine performance level by ones data analyse;

• data protection management by access control to prevent the network resources safety politics and by administrator's alert system warning.

Software and hardware complex BCTN is an example of the management tools and the campus and corporate SEE TCI adaptation. BCTN logic model consists of the common service module sets which correspond to the list of hi level TCP/IP stack (VoIP, NAS, DNS, SMTP, HTTP, etc.). One set provides two service lines – internal and external. Access to these services lines is provided through the secure connection from the campus, terminal, tunnels, terminals or virtual AL channels (Fig. 1).

To provide BCTN servers functioning, it is recommended to installation clear OS Unix family's. For example FreeBSD or Linux, which include the open sources service programmes.

Let us notice, that determining and harmonization of the TCI components makes possible to compose the imitation models for the next formalization. It allows to approve the ways to optimize the present TCI.

TCI intends for granting the telecommunication, information, computing services taking into account QoS which obtains the network users on personal computers, network segments and other network components that integrate in network environment.

The terminal access and the total control BCTN is provided by the complex management and current production jobs from any remote internet point or a point which belongs to TCI. The remote access is provided by the standard network technologies and the protocols that are used for science, educational and others specialized net segments interconnection.

In general, SEE provides the possibilities of accessing to the computing resources, libraries,

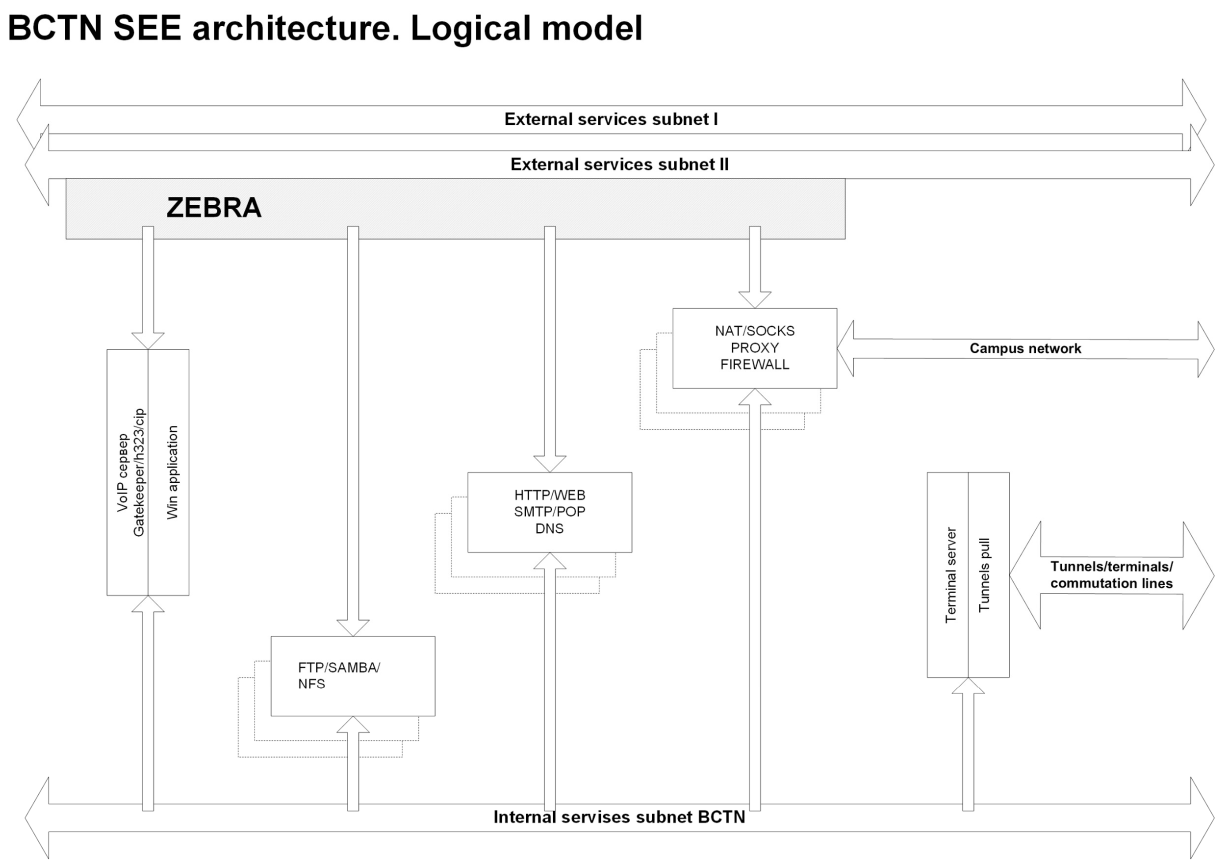

Fig. 1. Logical model, which describes the interconnection between BCTN SEE TCI architecture elements

references, artificial services, service clouds and other common information sources, program data handlers, chats, VoIp conference, communication tools and wide shared tools which are used in global network.

Such structure involves the mechanisms of dispatching and sharing with the network subscribers, users, user groups from SEE TCI or any other internet point.

Here we will define the network subscribers, such as:

- pc of separate users, which are directly plugged into SEE TCI;
- gateway server stations for network segments;
- devices and servers that have the function to support the other network subscribers or segments in autonomous or manually mode.

In accordance to the hierarchically levels here we can define the base elements of TCI as a whole:

– BCTN – the program complex and technical set which includes the server stations and communication devices;

– supporting-control network – the network control screens and the telecommunication structure which is based on the program complex and technical set;

– users network – telecommunication structure, which unite under the departments the local networks users pc, and through the gateways establish the interconnection with supporting-control network and BCTN.

The concentration of function technological loading of SEE on single server station, on one side, solve a very important problem of centralizing the resources, network channels and users network management, from other side, such architecture determines the set of problems which are connected with the service coordination of BCTN and TCI SEE as a whole (Fig. 2).

The tendency of the loading concentration function on the united servers block (SB) determines the next stepped perspectives [8–10].

1. It is provided some set of service functions $S:\{S_1, S_2, \dots, S_n\}$ which availability depends on:

- parameters of the matching programs $p:\{p_1, p_2, \dots, p_m\}$;
- parameters of the network channels loading $c:\{c_1, c_2, \dots, c_k\}$;
- the hardware and system resources $r:\{r_1, r_2, \dots, r_l\}$, which restrict the fixed computer station potential.

Then function $W = F(S, p, r)$ characterizes the total condition of server station and connections the channels $c:\{c_1, c_2, \dots, c_k\}$.

In situation when $\sum_{j=1}^{n} r_j > r_i$ then it means that there will be a moment when the system resources will be exhausted and the server block will stop providing the services for users. SB will stop that service which will cause the resource overloading or full services set. It depends of situation.

2. Interdependence of the set services (in the fault situation with one of this services) causes the stopping of one or full set of services It depends on the stopped services set.

The TCI is damaged as a whole when the value of the totality parameters (S, p, r) deviates from the values which fits the whole system state.

There are some values of the total parameters (S, p, r) when function W responses the satisfaction state of the server stations set. Then the next problems appeare:

- to determine the stable range of function W;
- to study the dynamic and tendency of the changing function values and to gather the forecast about the outing function W from the stable range.

To evaluate the function $W = F(S, p, r)$ and determine the stable range for this function it is necessary to introduce quantity characteristic of the values (S, p, r), and to specify their nature.

Characteristics $r:\{r_1, r_2, \dots, r_l\}$ are the set of components, which constitute the hardware platform physical base of the server station ‘i’. Here we can see the examples and its parameters:

- *CPU* – processor frequency, cache, performance;
- system board – bit rate, chipset type;
- RAM – capacity, frequency, architecture type;
- HDD – capacity, input/output bitrate;

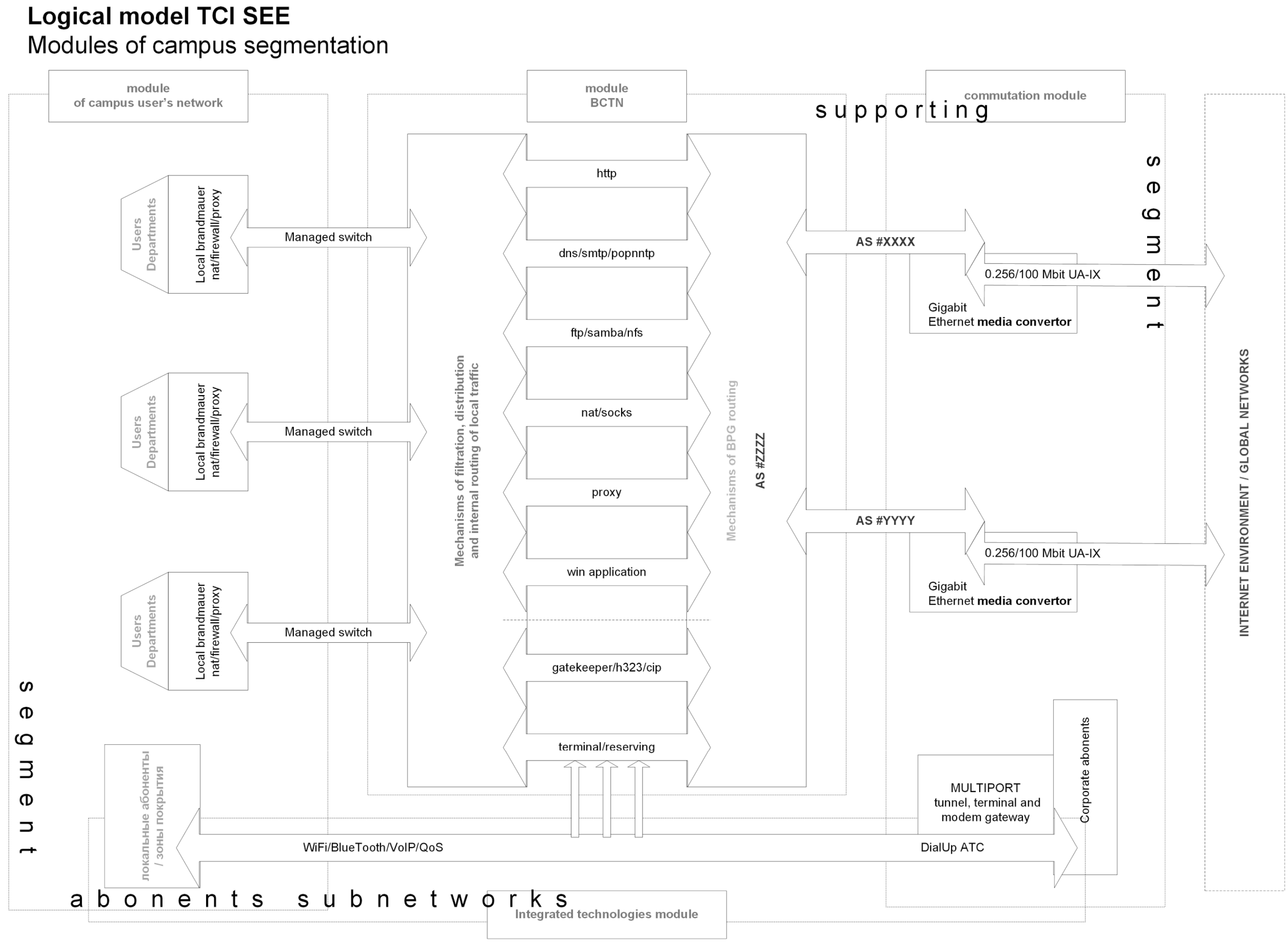

Fig. 2. Logical model TCI SEE

• network interface – specifications of network standard, data transfer rate etc.

Characteristics $c:\{c_1, c_2,\ldots, c_k\}$ determine the quantity network channels and the specifications:

• the main network channels quantity;

• the total network channels quantity;

• traffic capacity etc.

Characteristics $p:\{p_1, p_2,\ldots, p_m\}$ are the set of the components, which form the software complex providing the server station 'i' and their evaluations:

• operation system type – each OS has its own performance coefficient, which reflects the time of reaction for fixed software applications set, depending on their requirements;

• set of the software products, which provides the necessary service – coefficient which reflects the efficiency, pause duration in the query processing, OS resources loading, hardware resources loading and the type of the supporting platform.

Thus, the parameters help to determine the function *W* and to make the server station behavior forecast comparing the *W values* in determined times periods, then:

• value $\dfrac{\Delta W}{\Delta t}$ – will demonstrate the function deviation speed from some base state (in out of request conditions)

• values $\dfrac{\Delta W}{\Delta p}$, $\dfrac{\Delta W}{\Delta c}$, $\dfrac{\Delta W}{\Delta r}$ – will characterize the function deviation speed from the base state using the appropriate parameters.

3. Such approach to formalization loading function of the server station (see point 1) is the reason to study the problem of the optimal information loading finding.

The server station S, which provides n network process P_n, uses the resources $R:\{r_1, r_2, \dots, r_l\} \times \times \{c_1, c_2, \dots, c_k\}$.

The resource consumption R_i to provide the process P_j represents some function: $a_{ij} = f(r_{ij}, c_{ij})$.

Assume, that the vector $X^k = (x_1^k, x_2^k, \dots, x_n^k)$ defines how many and which process is used by the client k.

For n process:

$$\sum_{i=1}^{m} a_{i1} \cdot x_1^k + \sum_{i=1}^{m} a_{i2} \cdot x_2^k + \dots + \sum_{i=1}^{m} a_{in} \cdot x_n^k = \sum_{j=1}^{n} \sum_{i=1}^{m} a_{ij} \cdot x_j^k.$$

Quantity of the resource i which is consumed by client k:

$$a_{i1} \cdot x_1^k + a_{i2} \cdot x_2^k + \dots + a_{in} \cdot x_n^k = \sum_{j=1}^{n} a_{ij} \cdot x_j^k.$$

Taking in to account $\sum_{j=1}^{n} a_{ij} \cdot x_j^k \le b_i$ and vector X we can determine the combinations where resource R_i reaches the limit value and we can build the domain of the client definition.

Thus, in this representation, the question of service delivery to client k with determined QoS becomes the equivalent to question of combinations calculation, when the client belongs to the domain of the definition under the given constraints.

4. Based on the above mentioned arguments, the problems of administration, interconnected services, security and safety tasks, another problem of architecture synthesis with the optimal placement of the telecommunication complex services set arises. Its solving must be based on the reserving quantity or capacity of the server stations and the communication channels taking into account the complex cost restriction.

Formally, the given task can be reduced to the graph construction. The vertices of the graph is the server station which are characterized by potential $R_i:\{r_1, r_2, \dots, r_l\}$ and set of incident edges $c_l:\{c_1, c_2, \dots, c_k\}$, which reflect the communication channels existence for each vertices under the cost constrains of the whole system and other constrains which appear in the similar problems [9].

Solving this task we use the practical experience of the telecommunication complex development, the administrator functionality system and hardware exploitation. Choice of telecommunication complex structure is implemented using the previous evaluation of the telecommunication structure effectiveness.

5. The practical analysis of the telecommunication infrastructure construction SEE demonstrates the necessity of the problem formulation: the general assessment of the multiservice TCI performance. Such evaluation can be carried out considering the different criteria, for example:

- by the total information flow of all services;
- by information flow of services with the maximum priority;
- by the number of the simultaneously serviced subscribers;
- by the quality of subscriber's services.

For the majority of the considered problems, it is difficult to get the clearly analytic solving. That is why for its practical solution, it is possible to imply the models, which can be based on the statistic information analysis.

Considering the problem of TCI architecture forming, we will compare the set of the functional schemeы, which satisfy the main criteria – to provide the certain amount of subscribers by the set of the services function $S_i:\{S_1, S_2, \dots, S_n\}$.

In practice some structural variants can exist, which has the equal services potential, but the different system base, hardware designs, internal interconnections, communication links. From the viewpoint of the designer, except the total cost, such structures may differ in the performance, reliability, management methods, the functional capabilities. Thus, to be able to select the structures, it is necessary to evaluate the quantity of the TCI indicators.

In the second item the definition of the parameters TCI is formulated. It is necessary to make some refinements. The set of services should be optimal placed on TCI server structure. This should be done based on the server station capacity and communication links reserving, taking into account the cost constraints. The designer should take into account some objective additional parameters, which establish the limit of the TCI functioning:

• $p_k : \{p_1, p_2, \ldots, p_m\}$ – harmonized software products, which provide the necessary of the services set;

• $c_l : \{c_1, c_2, \ldots, c_k\}$ – measure the workload of the communication links;

• $r_i : \{r_1, r_2, \ldots, r_l\}$ – hardware system resources, which is restricted by potential possibilities of the given PC;

• $b_k : \{b_1, b_2, \ldots, b_m\}$ – sufficient security levels;

• $d_k : \{d_1, d_2, \ldots, d_m\}$ – complexity coefficient of the particular resource management.

Function $W_j = F(S, p, c, r, b, d)$ characterizes the condition j-structure with appropriate variables restrictions. When we formulate the problem of the optimization as the minimization process, we get the solutions for the appropriate TCI, which are feasible solutions on practice. We must take into account, that precise algorithmic formalization of this assignment is not solvable because of the fuzziness performance assessments of every variable component. That is why, the algorithmic formalizing for the problem of the TCI architecture synthesis is not possible.

In this case, the creation of the TCI learning models or its fragment can be proposed, which are acceptable for the prototype and let to make the evaluation for the changing performance depending on the function W_j parameters changing.

The following parameters for the approximate assessment characteristic of the desired model, in accordance to j structure are proposed:

• maximal number of the subscribers a_j, which are satisfactory to the simultaneously serviced TCI. It is function parameters settings, which is not necessary conditions for TCI functioning;

• costs of the resources r_i, which restrict the potential possibilities of the computer station $\sum_{k=1}^{n} \sum_{j=1}^{m} a_j \cdot x_j^k$;

• the level of the TCI security system;

• the degree of the certain service administration complexity, the maximal necessary estimates by the corresponding services. Here we should consider the missing requirements for all services. This will form the combine criteria.

It is possible that the deviation of the relative estimations of the comparing models turns out to be bipolar. Then the relevant TCI will be acceptable based on the corresponding estimations. This approach allows us to compare TCI with the different architecture and with the equal set of services. As mentioned earlier, the set of difficult questions appear when we construct the relevant models, because of the impossibly of the strict analytical formalization of the questions. In this case we can apply heuristic methods of function W_j parameters estimation which is based on the statistics data, received during the TCI loading changes.

Conclusions

Taking into consideration that the exact TCI copy constructing is impossible, than it is advisable to use the load simulator on the real structures. Such load simulators can be organized in the special users' segment and it generates the predetermined loading and it includes the local and cross-cutting question.

The standard software set is used for the function W_j parameters monitoring. This software allows making the estimation values of the corresponding parameters. Thus, learning process for TCI models consists of the output and clarifying the function W_j. At the initial stage of education, the characteristic tables, which reflects the parameters values depending on the loading, fixing the different TCI specification types are formed. The next stage is approximation of the received date to the corresponding functions, which is used in future for analyses and forecasting of real TCI in the existing SEE.

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