TELECOMMUNICATIONS

The Method of Determining the Functional Survivability of the Control of the Intelligent Services

N. Kniazieva, L. Zimenko*, T. Kunup

Odessa National Academy of Food Technologies, Odessa, Ukraine
*Corresponding author. E-mail: Zimenko.liliya@gmail.com

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Abstract. In this paper the method for determining the functional survivability of intelligent superstructure, controlling the process of providing intelligent services is proposed. We introduced the next definitions: the multitude of functions of the system *F*, the multitude of functional elements *R* (system resources), the multitude of functional relationships between the elements *Y*, classes of intelligent services *K*, the route μ^q_{AB}, the probability of events E_{AE}, E_l, E_{ly}, E_{lr}. As a result of calculations there have been received the formulae for estimation the functional system survivability of providing of intelligent services, which can be used in engineering of the system of controlling intelligent services, in choosing the control methods, in solving problems of increasing the functional survivability of control system over the intelligent services.

Keywords: *functional survivability, external adverse effect, providing of intelligent service, system state, route, events, probability of a functional failure, number of states of the system, class of intelligent services.*

Survivability is one of the most important properties of telecommunication networks (TCN), which provides their effective functioning. At the same time the problems of providing TCNs' survivability are becoming increasingly important due to the intensive development of telecommunications – transition to Next Generation Network (NGN) and to Future Generation Network (FGN). With regard to the FGN in the ITU documents [1] it is recommended, that engineering, exploitation and development of FGN would be carried out in such a way that to ensure provide the reliability, security, and also survivability in order determining systems capacity to perform its mission in time – to provide the performance of maximal subset of functions to achieve functioning purposes and also an acceptable level of service, even if normal exploitation of the network is complicated with different problems.

Under the survivability of TCN we mean the property which characterizes the network ability to function effectively under adverse external effects due to some adverse external influences or to restore this ability during a certain period of time [2, 3]. Into the development of questions concerning the theory of systems survivability for different applications a significant contribution made V. Vishnevsky, J. Gromov, A. Dodonov, V. Krapivin, I. Ryabinin, V. Popkov, Yu. Stekolnikov and others. It's necessary to note that at this stage of the development of the theory of survivability still there are no conditions that would allow to formulate and to realize a common approach to the solution of problems optimize survivability characteristics of different types of systems. However, there have been stated the principles the control of which leads to a positive effect in ensuring the survivability systems for various purposes [3]:

Principle 1. Systems elements must have low structural significance and high resistance.

Principle 2. Structure of the system should provide the greatest possible or sufficient (in optimization problems) number of states of abilities.

Principle 3. States of abilities of the system should be provided by the smallest possible number of elements.

Principle 4. The different states of the system abilities must be provided by different elements.

In accordance with these principles are proposed methods of providing structural and functional survivability in the systems of different applications, including TCN [2 – 6]. At the same time, it should be noted that the tasks of evaluating and providing functional survivability of intelligent superstructure are not being considered in the scientific literature, despite of the intensive development of intelligent services and to perform certain requirements to the quality of service.

In this paper it is proposed the method for determining the functional survivability of intelligent superstructure, controlling the process of providing intelligent services (IS).

While analyzing the functional system survivability for different applications the following characteristics of the system are being regarded: the purpose of functioning, a multitude of problems at the solution of which system is oriented, and a multitude of resources used in the process of solving problems [2].

Let's define the characteristics of the control system over – the intelligent superstructure.

The purpose of the functioning – is to provide the IS.

Multitude of problems (system functions) – is to control the process of providing IS.

A multitude of resources – is a multitude of functional elements used in the process of providing IS.

To provide the purpose systems functioning usually is used one of the strategies: to provide fault-tolerance (*f*-strategy) or provide survivability (*s*-strategy).

For the formation of *s*-strategy it's necessary to define the multitude of system states $S = \{s_i\}$, in each of which is performed the control process over providing IS of i -th type (IS_i) ($i = \overline{1,n}$, n – is the number of states of the system (IS types)).

According to [2] the following solutions (mechanisms) concerning functioning purpose may be used:

1. Multitude of system functions can't be changed, that is all the functions f_i must be used;

2. In any state of the system must be carried out a certain subset of functions f^* which perform the purpose of the system functioning;

3. In an arbitrary state of the system must be carried

out at least one of the functions from the subset of functions f^*.

We'll define the multitude of system functions: $F = \{f_1, f_2, ..., f_i, ..., f_n\}$ where f_i – is function of control over IS of the i-th type of IS$_i$, n – is the number of types of system functions.

The multitude of functional elements $R = \{r_1, r_2, ..., r_j, ..., r_m\}$, where r_j – is a functional element of the j-th type, m – is the quantity of types of functional elements. Under the j-th functional element we'll understand the j-th type of the system resources. Resources R are used in the process of performing functions F of the system. And here, for each the f_i-th function is used a corresponding multitude of system resources: $\{r_j^{(i)}\} \subset R \; (j = \overline{1, m})$.

Besides, are given the multitude of functional connections $Y = \{y_{st}\}$ between functional elements r_j ($s, t = \overline{1, m}$, $s \neq t$, $j = \overline{1, m}$).

The example of the interaction of the system resources (devices) in providing IS "800" is represented in Figure 1.

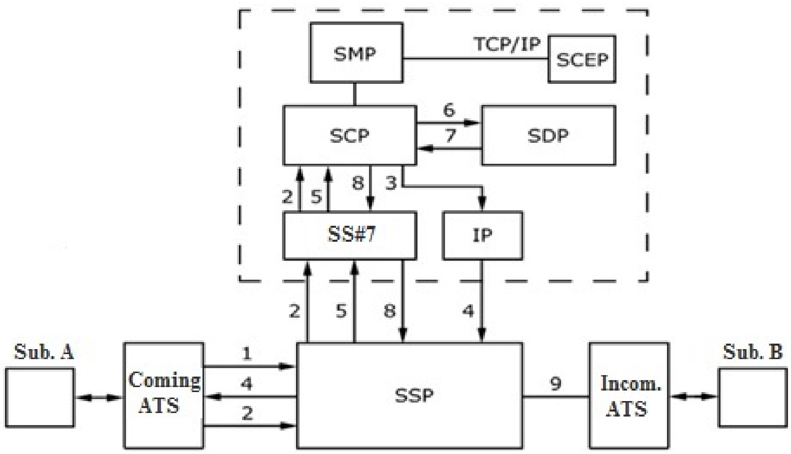

Figure 1. Algorithm of interaction of devices in providing "Service 800" (free call)

Denotations on the Figure 1:

- SSP –Service Switch Point;
- SCP – Service Control Point;
- IP – Intelligent Peripheral;
- SDP – Service Data Point;
- SCEP – Service Creation Environment Point;
- SMP –Service Control Point.

Subscriber A dials a number, SSP (Softswitch) through the Signaling System #7 (SS7) suspends the service phone call and transmits a service request to SCP. Further, the SCP accesses to the server database SDP. The data obtained from SDP, are transmitted to SCP again. SCP sends a voice command using voice interface IP to subscriber B through SSP.

For other IS are used other interaction schemes.

In accordance with the logic and complexity of providing IS we'll combine IS in classes $K = \{K_1, K_2, ..., K_q, ..., K_Q\}$, where q – is the class of IS, Q – is the number of classes. We'll note that K_1 – is the class of IS with maximum complexity, K_Q – is the class of minimum complexity.

For each class K_q is used an appropriate multitude of resources $R^q = \{r_j^q\}$. Here are $j = \overline{1, m}$, $R^q \subset R$, $q = \overline{1, Q}$.

$$r_j^q = \begin{cases} 1, & \text{if the } j-\text{th the recourse is used for providing IS of the } q-\text{th class;} \\ 0, & \text{in the other case.} \end{cases}$$

For each class K_q are given $Y^q = \{y_f^q\}$ – the multitude of functional connections between the elements r_j^q, used in the control process of providing IS belonging to the q-th class. For each q-th class of IS multitude of $Y^q = \{y_f^q\}$ is represented as a matrix M^q size $K^q \times K^q$, where K^q – is the quantity of resources r_j^q, used for the IS of the q-th class.

Element m_{st}^q of matrix M^q is defined as follows:

$$m_{st}^q = \begin{cases} 1, & \text{if there is an interaction of element } r_s \text{ with element } r_t \text{ in the process of providing IS of the } q-\text{th class;} \\ 0, & \text{in the other case.} \end{cases}$$

It's accepted $m_{st}^{q} = 0$, if $s = t$, $s,t = \overline{1,m}$. The elements r_s, r_t – are resources of the s-th and the t-th types of multitudes of R^q.

Thus, according to the representation for each q-th service class of the multitude of functional connections $Y^q = \{y_f^q\}$ as a matrix M^q, is obtained the possibility to form an oriented graph without loops $G^q = (R^q, Y^q)$, where $R^q = \{r_j^q\}$ – are points of graph, $Y^q = \{y_f^q\}$ – are functional connections between graph points.

Corresponding graph is generated for each class of the service. The control process of providing services of the q-th class can be represented by route μ_{AB}^q, including a multitude of used resources of the points and multitude of branches of functional connection:

$$\mu_{AB}^{q} = (\{r_j^q\}, \{y_{st}^q\}). \quad (1)$$

It's noted that in matrix (1) multitude of used connection $\{y_f^q\}$ is pointed by $\{y_{st}^q\}$ to indicate between which resources (s and t) this connection exists (since each element y_{st}^q of the given multitude is the elements of matrix M^q).

Let's represent route μ_{AB}^q as follows:

$$\mu_{AB}^{q} = (r_{jA}^q, y_{A,1}^q, r_{j1}^q, y_{1,2}^q, r_{j2}^q, y_{2,3}^q, \ldots, y_{(t-1),B}^q, r_{jB}^q). \quad (2)$$

Graphically, route (2) is shown in Figure 2:

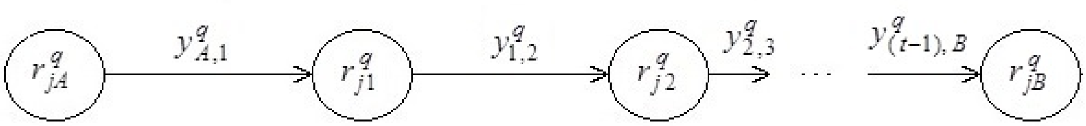

Figure 2. Graphical interpretation of the process of providing the q-th class service

Here $(r_{jA}^q, r_{j1}^q, r_{j2}^q, \ldots, r_{jB}^q) \subset R^q$, $(y_{A,1}^q, y_{1,2}^q, y_{2,3}^q, \ldots, y_{(t-1),B}^q) \subset Y^q$.

Let us note that in the process of providing the i-th service ($i = \overline{1,n}$, n – is the number of types f_i of the system functions, or the number of types of provided IS), some resources r_j^q can be used more than once, i.e. route (2) can be self-intersecting [7].

Each element included into route μ_{AB}^q (2), belonging to the multitude of resources $R^q = \{r_j^q\}$ (points) and functional interconnections $Y^q = \{y_{st}^q\}$, may be exist under external adverse effects.

In accordance with the organization of intelligent superstructure and with the principles of providing IS, the resources R interact on the basis of hierarchical principle (Figure 3) [8]:

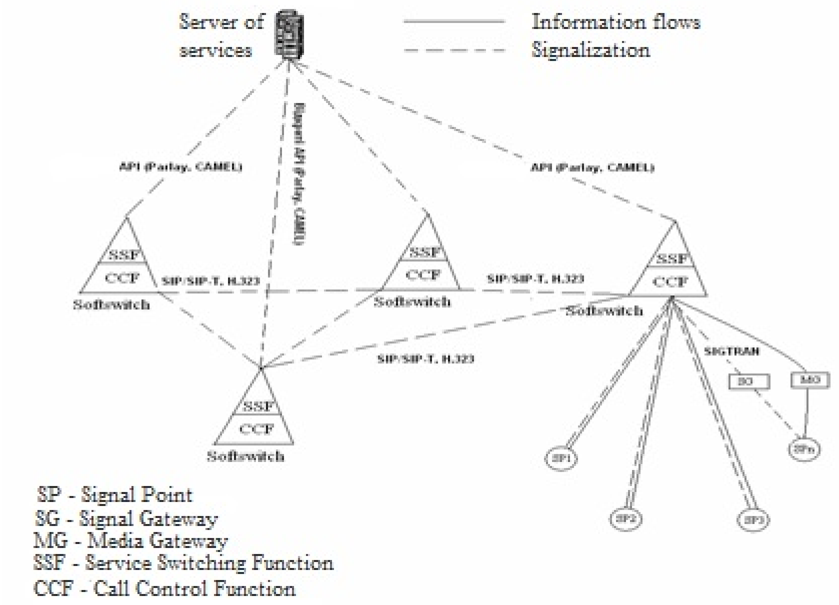

Figure 3. Intelligent superstructure

Here the multitude of R include of the following resources: server of service, SP, SG, MG, Softswitch, SSF, CCF. The multitude of Y – are connections between these resources.

Then formula (2) can be represented as follows:

$$\mu^q_{AB} = (r^q_{jA(l_A)}, y^q_{A,1(l_A+\delta_A)}, r^q_{j1(l_1)}, y^q_{1,2(l_1+\delta_1)}, r^q_{j2(l_2)}, y^q_{2,3(l_2+\delta_2)}, \ldots, y^q_{(t-1),B(l_{(t-1)}+\delta_{(t-1)})}, r^q_{jB(l_B)}), \quad (3)$$

where $l_A, l_1, l_2, \ldots, l_B$ – are characteristics of resources belongings to $r^q_{jA}, r^q_{j1}, r^q_{j2}, \ldots, r^q_{jB}$ corresponding to hierarchal level, $l = \overline{1, L}$;

$(l_A+\delta_A), (l_1+\delta_1), (l_2+\delta_2), \ldots, (l_{(t-1)}+\delta_{(t-1)})$ – are characteristics of the belongings of the functional connections, emanated from points (resource) *A*, 1, 2, …, used in the providing IS on route μ^q_{AB}, the corresponding to hierarchal level. Let's note that the transition from a resource r^q to a functional connection the hierarchal level can vary into δ_s $(s = A, 1, 2, \ldots)$.

The process of providing IS of any class can be represented as a hierarchical system (Figure 4):

Figure 4. Stages of a hierarchical system

As it can be seen, at each odd-numbered stage are located points (points of graph, used resources), and at the even-numbered – are branches of graph – the functional connections between the system resources. Let us define the following quantitative characteristics of the system:

N – is the total quantity of points (may coincide with a value m: $N \geq m$);

B – is the total quantity of branches;

L – is the quantity of hierarchical levels;

L_r – is the quantity of points levels;

L_y – is the quantity of levels of functional connections;

l – is the number of stage (level), $l = \overline{1, L}$;

l_r – are numbers of levels, at which points are located;

l_y – are numbers of levels of functional connections.

Let us assume that levels of hierarchical system are equally attackable. Alsop, equally attackable are points and branches (functional connections) at each level.

In accordance with Figure 4 the number of upper hierarchal level will be denoted by "1", the next level will be denoted by "2", etc. At each level l ($l = \overline{1, L}$) quantity of points r_j or branches (functional connections) y_{st} are different. Let us mark this number g_{l_r} and g_{l_y} for level points and the branches, accordingly: $l_r = \overline{1, L_r}$, $l_y = \overline{1, L_y}$. Will assume that the external adverse effect at the level l_r all points q_l of given level are equally attackable, and also under adverse effect on the level l_y all functional connections of this level are equally attackable.

Let us introduce the following events: E_{AE}, E_l, E_{l_r}, E_{l_y}.

1. E_{AE} – is the appearance of external adverse effect (EAE). The probability of the beginning of this event can be very little, however, always $P(E_{AE}) > 0$.

2. E_l – is the influence of EAE at the l-th system level. This event can take place only at the beginning of the event E_{AE}.

The conditional probability of the beginning of E_l – $P\{E_l / E_{AE}\}$ – under the conditions of the events E_{AE} is defined by the axiom of probabilities in the combination of the events $E_l \cap E_{AE}$: $P\{E_l \cap E_{AE}\} = P(E_{AE})P(E_l / E_{AE})$.

Wherein, $P(E_l / E_{AE}) = \dfrac{P(E_l / E_{AE})}{P(E_{AE})}$, hence is the requirement: $P(E_{AE}) > 0$.

3. E_{l_r} – is the influence of EAE at the point r_j of the l-th level. This event can take place only as a result of the beginning of the event E_l.

The probability of the beginning of the event E_{l_r} can be defined as probability of combinations of all events E_{AE}, E_l, E_{l_r}:

$$P\{E_{AE} \cap E_l \cap E_{l_r}\} = P(E_{AE})P(E_l / E_{AE})P(E_{l_r} / E_{AE} \cap E_l). \quad (4)$$

4. E_{l_y} – is the influence of EAE on the branch y_{st} of the l-th level. This event can only take place as a result of the beginning of E_l.

The probability of the beginning of event E_{l_y} can be defined as the probability of the combination of all the events E_{AE}, E_l, E_{l_y}:

$$P\{E_{AE} \cap E_l \cap E_{l_y}\} = P(E_{AE})P(E_l / E_{AE})P(E_{l_y} / E_{AE} \cap E_l). \quad (5)$$

Having determined the probability of the beginning events E_{l_r} and E_{l_y} in accordance with formulae (4) and (5) and assuming that at the beginning of the event E_{l_r} or E_{l_y} there can be a functional failure of element r_j or element y_{st}, we can determine the probability of failure in the providing IS of the corresponding q-th class $P_{IS(q)}$.

Assuming that the functional failure of at least of one element included into route (3), leads to a failure of providing services of the q-th class, will get the formula for calculation of $P_{IS(q)}$ as the probability of logically connected events, namely, as the probability of at least of one of K independent combined events $E_1, E_2, ..., E_k, ..., E_K$, where E_k – is an event including in a functional failure of the k-th element of route (3), K – is the number of elements of the route:

$$\begin{aligned} &P(E_1 \cup E_2 \cup ... \cup E_k \cup ... \cup E_K) = \\ &= 1 - (1 - P(E_1))(1 - P(E_2))...(1 - P(E_k))...(1 - P(E_K)). \end{aligned} \quad (6)$$

$P(E_k)$ – is the probability of functional failure of the k-th element of route (3).

Let's denote the events included in a functional failure of the route elements (3) under EAE as follows:

1. $E(r^q_{js(l_s)})$ – is a resource failure of the j-th type used in the process of the providing IS of the q-th class according to route (3), comprising point s, located on the hierarchal level l_s. Denotation "l_s" is used to note that point s of route (3) belongs to level l ($l = \overline{1, L}$).

2. $E(y^q_{js(l_s + \delta_s)})$ – is the functional of the failure connection, belonging to route (2), and located on level ($l_s + \delta_s$), connected with level l_s.

Analogically let's denote all other events. Then formula (6) can be written as follows:

$$\begin{aligned} &P(E(r^q_{jA(l_A)}) \cup E(y^q_{A,1(l_A+\delta_A)}) \cup E(r^q_{j1(l_1)}) \cup E(y^q_{1,2(l_1+\delta_1)}) \cup E(r^q_{j2(l_2)}) \\ &\cup E(y^q_{2,3(l_2+\delta_2)}) \cup ... \cup E(y^q_{(t-1),B(l_{t-1}+\delta_{t-1})}) \cup E(r^q_{jB(l_B)})) = \\ &= 1 - (1 - P(E(r^q_{jA(l_A)})))(1 - P(E(y^q_{A,1(l_A+\delta_A)})))... \\ &...(1 - P(E(y^q_{(t-1),B(l_{t-1}+\delta_{t-1})})))(1 - P(E(r^q_{jB(l_B)}))). \end{aligned} \quad (7)$$

Here $\delta_A, \delta_1, \delta_2, ...$ – determine the change of the level number l in moving from the point to the branch on a route μ^q_{AB}.

To calculate the probability of a functional failure of the system as a result of EAE on any route element (3) it's necessary to determine the values of all probable events including into formula (7). Let's remind that the quantity of the elements – points and branches of functional connections, which are on each l-th level, are denoted as g_{l_r} and g_{l_y}, correspondingly. Here must be performed conditions (8):

$$\left.\begin{aligned} \textstyle\sum_{l_r=1}^{L_r} n_{L_r} &= N; \\ \textstyle\sum_{l_y=1}^{L_y} n_{L_y} &= B; \\ L_r + L_y &= L. \end{aligned}\right\} \quad (8)$$

Based on the hypothesis of the equal attackability of all the levels of the system, we'll calculate the conditional probability of the event, included into the adverse effects EAE on the level l_r of system points $P(E_{l_r})$ (9) and the level l_y of the functional connections $P(E_{l_y})$ (10):

$$P(E_{l_r}) = P(E_{AE}) \cdot \frac{L_r}{L_r + L_y}; \quad (9)$$

$$P(E_{l_y}) = P(E_{AE}) \cdot \frac{L_y}{L_r + L_y}. \quad (10)$$

Based on the hypothesis of equal attackability of all the elements of each level under the EAE at this level, we'll receive the formula for the calculation of the conditional probabilities of failure of levels element l_r and l_y – $P^q_{l_r}$ and $P^q_{l_y}$, used in the process of the providing IS of the q -th class.

We'll assume that the quantity of types of the resources $l_r(g^q_{l_r})$ and functional connections $l_y(g^q_{l_y})$ are known, and are used for providing IS of the q -th class, which are at levels l_r and l_y, correspondingly.

Using these denotations, we'll get:

$$P^q_{l_r} = \frac{l_r(g^q_{l_r})}{g_{l_r}} \cdot P(E_{l_r}) = \frac{l_r(g^q_{l_r})}{g_{l_r}} \cdot \frac{L_r}{L_r + L_y} \cdot P(E_{AE}); \quad (11)$$

$$P^q_{l_y} = \frac{l_y(g^q_{l_y})}{g_{l_y}} \cdot P(E_{l_y}) = \frac{l_y(g^q_{l_y})}{g_{ly}} \cdot \frac{L_y}{L_r + L_y} \cdot P(E_{AE}). \quad (12)$$

The probability of at least one of two events E_1 – the functional failure of resources of level l_r (11) or E_2 – the failure of the functional connections of level l_y (12), used in providing services of the k -th class can be calculated as a probability of at least one of two events E_1 and E_2 :

$$P\{E_1 \cup E_2\} = P\{E_1\} + P\{E_2\} - P\{E_1 \cap E_2\}. \quad (13)$$

In the result, the probability of performing the subset of functions f^* – providing IS of the q -th class $P_{f^*_q}$ – is determined in accordance with formula (14):

$$P_{f^*_q} = 1 - (P\{E_1\} + P\{E_2\} - P\{E_1 \cap E_2\}). \quad (14)$$

Here $P(E_1)$ is calculated in accordance with (11), $P(E_2)$ – is calculated in accordance with (12).

For calculation of the probability of performing at least one of the multitude of functions f^* – providing at least one of the i -th services of the q -th class – we'll assume that the quantity of types of resources $l_r(g^q_{l_{ri}})$ and functional connections as $l_y(g^q_{l_{yi}})$ are known, and used for providing IS of the i -th type of the q -th class, which are at levels l_r and l_y, correspondingly.

Using these denotations we'll obtain the method for calculating the conditional probability of failure of the levels element l_r and l_y, $P^q_{l_{ri}}$ (15) and $P^q_{l_{yi}}$ (16), used in the process of providing the i -th services of the q -th class:

$$P^q_{l_{ri}} = \frac{l_r(g^q_{l_{ri}})}{l_r(g^q_{l_r})} \cdot \frac{l_r(g^q_{l_r})}{g_{l_r}} \cdot \frac{L_r}{L_r + L_y} \cdot P(E_{AE}), \quad (15)$$

$$P^q_{l_y} = \frac{l_y(g^q_{l_{yi}})}{l_y(g^q_{l_y})} \cdot \frac{l_y(g^q_{l_y})}{g_{ly}} \cdot \frac{L_y}{L_r + L_y} \cdot P(E_{AE}). \quad (16)$$

Here are $i = \overline{1,n}$, $l_r = \overline{1,L_r}$, $l_y = \overline{1,L_y}$, $q = \overline{1,Q}$.

Having calculated in accordance with formulae (15) and (16) the values of probable resources failure and functional connections, used for providing IS of i -th type, belonging to the q -th class, and filling the results obtained in formula (7), will get the desired value of probable failure of functional system of at least of one of the element, included into the route of this i -th services, that is we'll obtain the probability of interference of functional survivability of the system in providing the i -th service of the q -th class.

The probability of saving the functional system survivability $P_{f^*_q}$, performance of at least one of the quantity of functions f^* (providing least of one of the i -th service of the q -th class) – we'll get as the probability of the opposite event (17):

$$P_{f^*_{qi}} = 1 - (P(E(r^q_{jA(l_A)}) \cup E(y^q_{A,1(l_A+\delta_A)}) \cup E(r^q_{j1(l_1)}) \cup E(y^q_{1,2(l_1+\delta_1)}) \cup E(r^q_{j2(l_2)}) \cup \\ \cup E(y^q_{2,3(l_2+\delta_2)}) \cup \ldots \cup E(y^q_{(t-1),B(l_{t-1}+\delta_{t-1})}) \cup E(r^q_{jB(l_B)})). \quad (17)$$

Thus, we have got the formulae for estimation of the functional system survivability in providing intelligent services – the performance of certain subset of functions f^*, which realize the purpose of the system functioning (providing intelligent services of the q-th class) and also the performance of at least of one of the functions out of subset f^* (providing the i-th intelligent service of the q-th class).

The obtained formulae can be used in the engineering system control over the intelligent services, in the choice of the control principles in solving the problems of increasing functional survivability of the control system over the intelligent services.

REFERENCES

1. Recommendation ITU-T Y.3001: SERIES Y: Global information infrastructure, internet protocol aspects and next-generation networks Next Generation Networks – Future networks Future networks: Objectives and design goals / ITU: Committed to connecting the world. – http://www.itu.int
2. Dodonov A.G. Survivability of information systems. / A.G. Dodonov, D.V. Lande. – K.: scientific thought, 2011. – 256 p.
3. Stekolnikov Yu.I. Survivability of systems.– St.P.: Politehnica, 2002. – 155p.
4. Kniazieva N.A. Improving structural survivability of telecommunication network / N.A. Kniazieva // International Journal “Information Models and Analyses”. – 2013. – №. 2. – P. 275-284.
5. Kniazieva N.A. The method of providing structural survivability of telecommunication network / N.A. Kniazieva // International Journal “Information Technologies & Knowledge”. – 2014. – №. 8. – С. 152-166.
6. Krivosheya D.O. The approach to evaluation of functional survivability hierarchical system of videoconferencing on a wireless cell network / D.O. Krivosheya // Internet-journal «Naukovedenie ». – 2014. – №. 5(24).
7. Kniazieva N.A. Theory of engineering of computer systems and networks. P.2. The methods of analysis and synthesis of computer network / N.A. Kniazieva. Odessa: 2012. -240 p.
8. Shestopalov S.V. Estimation of the total service time of application on additional service management systems / S.V. Shestopalov. // Problems of information and management, – 2009 – №3(27).

ЛИТЕРАТУРА

1. Рекомендация ITU-T Y.3001: Глобальная информационная инфраструктура, аспекты протокола интернет и сети последующих поколений [Электронный ресурс] / ITU: Committed to connecting the world. – Режим доступа: \www/ http://www.itu.int / – 10.03.2012 г. – Загл. с экрана.
2. Додонов А.Г. Живучесть информационных систем. / А.Г. Додонов, Д.В. Ландэ. – К.: Наук. думка, 2011. – 256 с.
3. Стекольников Ю.И. Живучесть систем – СПб.: Политехника, 2002. – 155с.
4. Князева Н.А. Повышение структурной живучести телекоммуникационной сети / Н.А. Князева // International Journal “Information Models and Analyses”. – 2013. – №. 2. – С. 275-284.
5. Князева Н.А. Метод обеспечения структурной живучести телекоммуникационной сети. / Н.А. Князева // International Journal “Information Technologies & Knowledge”. – 2014. – №. 8. – С. 152-166.
6. Кривошея Д.О. Подход к оценке функциональной живучести иерархической системы видеоконференцсвязи на беспроводной ячеистой сети / Д.О. Кривошея //Интернет-журнал «Науковедение». – 2014. – №. 5(24).
7. Князева Н.А. Теория проектирования компьютерных систем и сетей. Ч.2. Методи анализа и синтеза компьютерных сетей / Н.А. Князева. Одесса: СПД Бровкин О.В., 2012. -240 с.
8. Шестопалов С.В. Оценка общего времени обслуживания заявки на дополнительную услугу системами управления / С.В. Шестопалов. // Проблемы информатизации и управления, – 2009 – №3(27).

Метод оценки структурной живучести интеллектуальной надстройки с централизованным принципом управления

Н. А. Князева, Л. Н. Зименко, Т. В. Кунуп

Аннотация. В работе предложен метод определения функциональной живучести интеллектуальной настройки, осуществляющей управление процессом предоставления интеллектуальных сервисов. Для этого были введены понятия: множество функций системы F, множество функциональных элементов R (ресурсов системы), множество функциональных связей между элементами Y, классы интеллектуальных сервисов K, маршрут μ^{q}_{AB}, представляющий процесс предоставления сервисов q-го класса, вероятности наступления событий E_{HB}, E_l, E_{ly}, E_{lr}. В результате расчетов получены выражения для оценки функциональной живучести системы предоставления интеллектуальных сервисов, которые могут быть использованы при проектировании системы управления интеллектуальными сервисами, при выборе принципа управления, при решении задач повышения функциональной живучести системы управления интеллектуальными сервисоми.

Ключевые слова: *функциональная живучесть, внешний неблагоприятный эффект, обеспечение интеллектуальных сервисов, состояния системы, маршрут, события, вероятность функционального отказа, число состояний системы, класс интеллектуальных сервисов.*