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ТА СИСТЕМИ УПРАВЛІННЯ**

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Наукові редактори: докт. техн. наук, проф. **Л.Б. Петришин** (ПНУ, АГН);
докт. техн. наук, проф. **П. Лебковський** (АГН).

Рецензенти:

д.т.н., проф. **І.Т. Когут**;

д.т.н. **Д. Саля**;

д.т.н., проф. **В. Кубіньски**.

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Method For Determining the Structural Survivability of Intelligent Superstructure with Decentralized Control Principle

Liliya Zimenko (ORCID 0000-002-1866-8370)

Odessa National Academy of Food Technologies, Odessa, Ukraine
zimenko.liliya@gmail.com

Abstract. This work is devoted to developing the method for determining structural survivability of intelligent superstructure (IS) with decentralized control principle (DCP) in providing intelligent services in Next Generation Network. To evaluate structural survivability here is proposed a middle-weighted value of the upper and lower limits of the structural survivability.

Keywords: Structural survivability, intelligent superstructure, the upper limit of survivability, the lower limit of survivability, decentralized control principle.

1 Introduction

Providing intelligent services (800 service, service VAS – Value Added Services, services of added value, Freephone – the call paid by those who make a call, Rate Service – calls with added payment, checking outcoming calls, etc.) is actual. To control intelligent services (IS) are used intelligent superstructures (IS) with centralized control principle. But this architecture has some significant drawbacks, so there should be used decentralized control principle. Due to the necessity to ensure continuous processing of IS applications in various conditions including the cases of adverse effects (AE) at IS with DCP, definition and ensuring the structural survivability of such system is an important task.

2 Definition and ensuring structural survivability of intelligent superstructure

According to [1] the survivability of the system – is the system's ability to save and restore its basic functions at a set volume and during a set time in case of changes in the structure of the system and / or algorithms and conditions of its operation because of external adverse.

The intelligent superstructure – is the device that controls the intelligent services – are additional services of telecommunications network, while providing them there happens change of the service call process.

In DCP for serving the applications of IS can be used universal servers for servicing all kinds of applications, and specialized servers – for servicing a certain class of applications.

General view of DCP, in which specialized servers are used, each of which serves a certain class of applications for IS is shown in fig. 1 [4]:

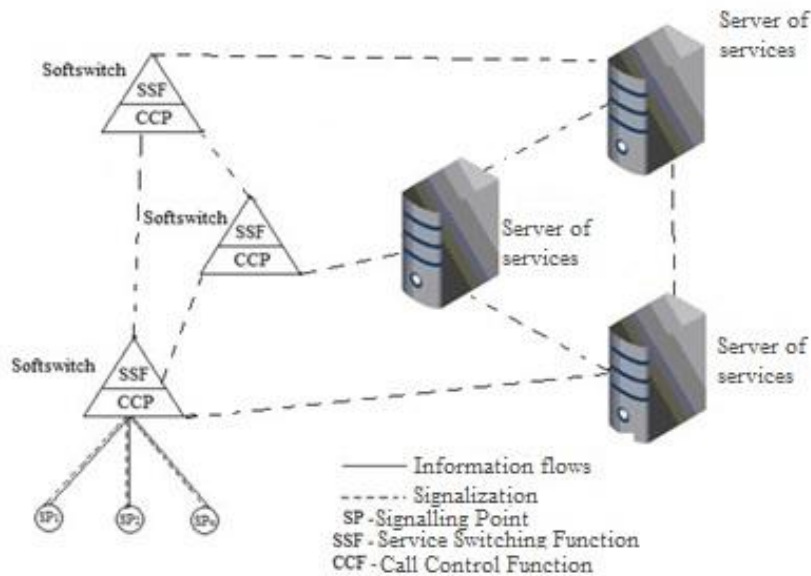


Fig. 1. Intelligent superstructure with Decentralized Control Principle

When servicing the application of IS, the application from the Softswitch comes to servicing server which directly connected with it. If the server is free and serves this class of applications, it serves the application. If the server does not serve this class of IS applications, then the application is sent to the Softswitch, which is connected with server.

Fig. 1 shows the Softswitches, which are interconnected. At one level between Softswitches are equal links while when they are used there can be formed set of routes of service of applications for IS $M_{st} = \{m_{st}^k\}$ where $k = \overline{1, K}$, K – a number of several routes between points s (users) and t (servers of services).

The presented in this work method of providing structural survivability of IS with DCP realizes a current approach with usage of the proposed indicator of structural survivability, which is determined on the basis of the upper and lower limits of structural survivability, the achievement of which is provided by the introduction of structural redundancy.

The indicator of structural survivability of IS (P_{IS}) is defined as the average weighted of the upper and lower limits of structural survivability. The upper limit of a structural survivability is based on the use of set of routes to service IS applications – P_{ULSS} . While calculating P_{ULSS} the routes are considered to be independent and form a parallel structure. The lower limit of a structural survivability is determined on the basis of a set of sections which are formed for determining set of routes – P_{LLSS} . While calculating P_{LLSS} all the sections form a consequent structure. Indicator of P_{IS} is calculated according to the formula (1):

$$P_{IS} = \frac{P_{ULSS}w_{ULSS} + P_{LLSS}w_{LLSS}}{w_{ULSS} + w_{LLSS}}, \quad (1)$$

where w_{ULSS} and w_{LLSS} – are significant coefficients which determine the importance for calculation of P_{IS} indicators P_{ULSS} and P_{LLSS} , respectively.

The method of determination of P_{IS} consists of the following parts:

1. Let's determine the upper limit of a structural survivability in the case of intact at least of one k -th path m_{st}^k from set of routes M_{st} for servicing IS applications (2):

$$P_{ULSS} = 1 - \prod_{m_{st}^k \in M_{st}} (1 - \prod_{b_{xy} \in m_{st}^k} p_{xy}), \quad (2)$$

where b_{xy} – is section of the route m_{st}^k , $k = \overline{1, K}$, K – is the number of set of routs; p_{xy} –probability of intact the section b_{xy} , which belongs to the rout m_{st}^k at adverse effect.

2. Let's determine the lower limit of a structural survivability (3) as the probability of intact of set of cuts d_{st}^l which divide a set of routs M_{st} of servicing application on IS:

$$P_{LLSS} = \prod_{d_{st}^l \in M_{st}} (1 - \prod_{b_{xy} \in d_{st}^l} (1 - p_{xy})), \quad (3)$$

where b_{xy} – the section of the cut d_{st}^l ($l = \overline{1, L}$, L – is number of cuts which divide a set of routes M_{st}).

Next, a method of ensuring the structural survivability is as follows:

I. The indicator of structural survivability (formula 1) we compare with the required indicator P_{REQ} :

$$P_{IS} \geq P_{REQ}, \quad (4)$$

P_{REQ} – is the required indicator of structural survivability of IS.

If the condition (4) is completed, it means that the required indicator of structural survivability have been reached, the system IS services satisfies the requirement for structural survivability. If condition (4) is not done there is a removal to the procedures of ensuring the necessary indicator of structural survivability.

II. The task of ensuring structural survivability of IS is formulated as a linear programming problem, when having solved it the optimal structure reserved route sections (cuts) is formed: to minimize the objective function (5) in the performance of limits (4):

$$C_{SYS} = \sum_{i=1}^n c_i m_i \rightarrow \min, \quad (5)$$

where C_{SYS} – is the cost of the system of reserve sections;

i – is the number of the section in the system;

n – is the number of sections in the system;

c_i – is the cost of i -th reserved section of the system;

m_i – is the frequency of reservation of the i -th section of the system.

The solution of the presented optimization problem is as follows.

Find the optimal structure vector of reserve $M(m_1, m_2, \dots, m_n)$ which provides minimum functions (5) under the limit (4).

III. The optimal system that is reserved will be shown as follows. First, we find the one section which provides the most significant growth of structural survivability value in the whole when you add a reserved element to it. The evaluation of the effectiveness of reserve section is performed by using a gradient method based on indicator (6), which is calculated for each i -th section when the frequency of its reservation is increased on one figure [3]:

$$g(m_i + 1) = \frac{p_i(m_i + 1) - p_i m_i}{c_i \times p_i(m_i)}. \quad (6)$$

where $p_i(m_i + 1)$, $p_i(m_i)$ – is the indicator value of the i -th undestroyed sections when its frequency of reservation $(m_i + 1)$ and m_i respective.

The need for reservation for each section is determined by taking into account its impact on the change of values P_{ULSS} and P_{LLSS} , by using indicators $g_{ULSS}(m_i + 1)$ and $g_{LLSS}(m_i + 1)$ which are calculated according to the formula (7) for set of routs (indicator $g_{ULSS}(m_i + 1)$) and for the sets of sections (indicator $g_{LLSS}(m_i + 1)$). As a result, for each i -th section is formed an average weighted value (7), the maximum meaning of which amongst all derived average weighted values determines the number of the section for increasing it on one figure in the frequency of it reservation at this step:

$$g_{av} = \frac{w_{ULSS} g_{ULSS} + w_{LLSS} g_{LLSS}}{2}, \quad (7)$$

where g_{ULSS} and g_{LLSS} – are for values of the upper and lower limits of structural survivability.

At the second and each next step is searched such section (including the one to which there has just been attached a reserved element), when adding to it another reserved element again gives the greatest relative growth of indicator value of structural survivability of the system in the whole. The process of reservation continues until you reach the condition (4).

Thus, the presented method allows determining and providing structural survivability of IS with DCP.

3 Conclusions

The method for determining structural survivability of intelligent superstructure with decentralized control principle for providing intelligent services on the basis of using the upper and lower limits of structural survivability of IS, has been proposed here and it allows to obtain data about the maximum possible values of the system survivability. Also there has been represented the method of providing structural survivability on the basis of using structural redundancy.

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