UDC 621.372

ANALYSIS OF WAYS FOR EXCHANGING DATA IN NETWORKS WITH PACKAGE COMMUTATION

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ABSTRACT

Context. The important problem of increasing the effectiveness of functioning telecommunication networks with package commutation is considered. Some ways are suggested for improving algorithmic tools for information exchange based on using methods and means of diagnosing errors in packages with data transferred. The object of this investigation is the process of data transfer and determining spoilt packages in messages.

Objective. The objective of this paper is to decrease the average relative time of package delivery and also to increase the probability of faultless information transfer to user on the basis of modelling various data exchange protocols.

Method. A method is suggested for the synthesis of universal, fast-acting multi-channel devices designated for controlling and diagnosing messages in data exchange networks with package commutation. Determining faulty packages is carried out based on using cyclic codes and the signature analysis method, which allows creating simple and sufficiently effective devices for data control. A comparative analysis of data exchange protocols is carried out based on using the method of probability-time graphs.

Results. There have been obtained recommendations as to effective using protocols for information exchange with respect to usage conditions and characteristics of networks with package commutation.

Conclusions. In this research the formalization of information processing based on the signature analysis has been accomplished and the method for the synthesis of multi-channel control devices with localizing errors in message packages has been improved. At that, the approach to data exchange in networks with package commutation has been improved. A comparative analysis of the three main scientific approaches that use cyclic error detecting codes has been carried out with the help of probability-time graphs.

KEYWORDS: package, message, signature analysis, datagram channel, data transfer.

ABBREVIATIONS

PTG is a probability-time graph;

GF is a Galois field;

NOMENCLATURE

H is a state matrix for signature analyzer;

h_i is a column of state matrix H;

$v(t)$ is a input data sequence;

$a_{.i}$ is a i-th coefficient of characteristic polynomial;

$P(x)$ is a characteristic polynomial;

S is a transition matrix for analyzer states;

$Sigv(t)$ is a input sequence signature;

$\sum$ is a sum modulo 2;

v_i is the i-th element of the input sequence;

w is the number of elements in the input sequence;

z is the number of device working cycles;

g_i is a signature of the i-th group (package);

φ, ψ are error syndromes for the input sequence;

E_1, E_2 are etalon signatures;

e_i is an etalon of the i-th group of digits;

T_p is a package transfer time;

T_{pd} is a package delivery time;

T_{to} is a time-out time;

T_{rec} is a receipt transfer time;

P_{pd} is a package delivery probability;

P_{los} is a package loss time;

P_{de} is a package error detection probability;

P_{ne} is a package error non-detection probability;

P_{rd} is a receipt delivery probability;

P_1 is a probability of error appearance in one package;

P_m is a probability of error appearance in several packages;

Z is a formal variable.

INTRODUCTION

A characteristic feature of distributed systems that make them differ from single devices is a possibility of partial failure. A partial failure happens when one component of the distributed system starts malfunctioning. This failure can affect the work of some components, whereby the other components continue functioning normally. If a global failure occurs in a distributed system, it affects all its components and can easily prevent the entire system from normal functioning.

When a distributed system is developed, it is very important to provide means for automatic system recovery after partial failures, the productiveness of the entire system being probably decreased. In particular, whenever a failure happens, the distributed system during the recovery process should work in an acceptable manner, i.e. it should be resistant to failures and stay at some level of its functionality.

The main reason for complicating data exchange networks is related with the fact that digital data transfer systems are sensible to different influences that can cause the appearance of random data, information losses or spoiling [1]. Therefore, it is important to be able to detect many errors in the network of distributed systems when

DOI 10.15588/1607-3274-2018-4-19

the volume of service information does not increase in each data unit.

This aim can be reached by developing universal means for message control. As a basis for this research methods and algorithms for antijamming coding are used. Means for information control with the help of cyclic redundant codes are now broadly applied. Their software and hardware implementation does not course serious difficulties [2].

A cyclic redundant code simplifies detecting the following types of errors. Firstly, hardware malfunctions sometimes cause damage to certain sets of bits. Cyclic redundant codes detect such errors better than check sums do. Secondly, cyclic redundant codes are particularly convenient for detecting error packages [3]. The detection of such packages is very important as they cause many problems that should be eliminated with the help of network hardware tools.

The object of study is the process of data transfer and the detection of damaged packages in messages.

The subject of study can be formulated as methods for searching and diagnosing errors in message packages.

The purpose of the work is to decrease the message transfer time and to increase the probability of faultless information transfer to user on the basis of modelling different data exchange protocols.

1 PROBLEM STATEMENT

The state matrix of a signature analyzer can be built with the help of a characteristic polynomial over the Galois field GF(2). At that, each column of this matrix can be determined according to the following expression [1]:

$$h_i = S^i \cdot h_0, i = 0,1,\ldots \text{w}, \quad (1)$$

where $h_0 = \|10\ldots0\|^{\text{T}}$; the corresponding matrix S uniquely describes the characteristic polynomial [3]:

$$P(x) = a_n x^n \oplus a_{n-1} x^{n-1} \oplus ..a_i x^i .. \oplus a_1 x^1 \oplus 1, \quad (2)$$

where $a_i \in \{0,1\}$.

The process of obtaining a signature for the input sequence $v(t)$ can be represented with the help of the following expression:

$$sigv(t) = \sum_{i=0}^{w} S^i v_i h_0 . \quad (3)$$

Expression (3) can be transformed to the following form:

$$sigv(t) = \sum_{i=0}^{w} h_i v_i . \quad (4)$$

Thus, the input sequence signature equals the sum of those state matrix columns that correspond to nonzero elements v_i.

The problem consists in synthesizing simple in implementation, fast-acting multi-channel signature analyzers for data control that allow detecting spoiled packages in transferred messages. At that, the results of information convolutions should strictly correspond to the classical single-channel device [4].

2 REVIEW OF THE LITERATURE

The development of network technologies substantially increases requirements to the effectiveness of data transfer systems, including an increase in transfer reliability and bandwidth, which has always been attracting attention of specialists in information technologies and telecommunications.

Issues related to assessing and substantiating principles of developing methods for information exchange in distributed computer networks are considered in [1, 5–8]. In these papers concepts of building systems for dynamic control of information exchange have been investigated. Some recommendations for increasing the effectiveness of hardware and software of known and prospective computer nets have been suggested.

In the process of data transfer very high requirements are put forward as to the correctness of message delivery. The satisfaction of these requirements is based on using feedback in combination with anti-jamming codes that are described and investigated in the classical literature on this matter [2, 3].

One of such scientific approaches to using cyclic codes is the signature analysis that is successfully applied not only to information transfer control, but also to checking the working capacity of electronic digital equipment. The usage of this method was substantiated in [4]. In order to decrease time and increase reliability of information transfer, in recent papers [5–12] different methods for data exchange modelling are suggested. In order to increase the speed and broaden the functionality of signature analyzers, in recent papers [13] multi-channel signature analyzers are proposed. Nevertheless, enhancing their possibilities as to detecting and localizing errors leads to a significant increase in information or hardware redundancy.

At present, when requirements to the reliability of information being transferred between various objects increase, the problem of developing simple and effective methods for decreasing the average relative data delivery time becomes very important. Increasing the probability of faultless information transfer to user is of current importance as well.

3 MATERIALS AND METHODS

Managing data exchange can be carried out by selecting a strategy for distributing resources (centralized, hierarchical, decentralized), a method for information support, a method for controlling channel, buffer, information and time resources [1]. When controlling channel resources, it is possible to influence both the parameters of the information channel and the structure and parameters of the multigrip route. The selection of parameters for computer network control is hard to formalize. It is often based on personal preferences of managers and researcher. One of the most important

DOI 10.15588/1607-3274-2018-4-19

directions for such investigations is the analysis of data exchange effectiveness with package commutation based on probability-time graphs [5–12]. Nonetheless, all of them are oriented towards investigating existing rules for information exchange (protocols). Changing protocols is possible on the basis of applying new technologies, methods and tools for data transfer and control.

Improving fast-action of devices for controlling message transfer is of particular importance when data are exchanged via a datagram channel, in which each package is delivered to user and processed as a separate message. The phases of conjunction and disjunction are absent here. After delivering all packages a message is formed on the reception side. The last actions can substantially increase the message delivery time if at least one package is delayed.

Let us consider some possibilities of extending the diagnostic functions of the signature analysis. Let an input sequence be entered into the signature analyzer by groups, each group containing *m* digits. Then formula (4) can be transformed to the following expression:

$$sig1v(t) = \sum_{i=1}^{z-1} S^{m(i-1)} \sum_{j=0}^{m-1} S^j v_j, \quad (5)$$

where the input sequence is checked for *m* digits per cycle. During the first cycle the device processes a group of digits $v_{m(r-1)}, v_{(m+1)(r-1)}, \dots v_{mr-1}$, and during the last cycle the group $v_0, v_1, \dots, v_{m-1}$ is processed. In order that the result corresponds to expression (12), it is necessary to multiply the signature of the first digit group by the matrix $S^{m(r-1)}$, and the result should be added modulo 2 to the second group of digits from the input sequence, which should be multiplied by matrix $S^{m(r-2)}$. These actions are repeated till data checking is not finished and the last group of digits is input.

Let us fulfill a linear transformation of the obtained signature (5) according to the following rule [14]:

$$sig2v(t) = \sum_{j=1}^{z} g_j S^{j-1}. \quad (6)$$

Thus, we have obtained two signatures or two checking code words: $sig1v(t)$ and $sig2v(t)$. As a checking code combination, it is necessary to use two etalon signatures (or two checking words) $E1$ and $E2$, which consist of the set of etalons for digit groups of the information sequence [13]:

$$\begin{aligned} E_1 &= e_1 + e_2 + \dots + e_z, \\ E_2 &= e_1^1 + e_2^1 + \dots + e_z^1, \end{aligned} \quad (7)$$

where $e_j^1 = e_j S^{j-1}$. If an error appears in the *i*-th package, the signature g_i, will change and the error syndromes will be calculated as follows:

$$\begin{aligned} \varphi n &= g_i + e_i, \\ \psi &= g_i S^{i-1} + e_i S^{i-1}. \end{aligned} \quad (8)$$

Thus, in order that both error syndromes coincide, it is necessary to multiply one of them by S^{i-1} or fulfill i -1 shifting cycles in the registry of the signature analyzer. The number of such shifting cycles for the syndrome ψ will show the number of the digit group or the package number in which an error occurred. In case the syndromes have not coincided, a conclusion can be drawn that there is an error in several packages.

A peculiarity of message transfer by packages via a datagram channel implies the possibility for each package to use its own separate route. At that, packages can be delivered to user at different time moments and from different directions. In case each package contains a code word for checking the information being transferred, this check can be accomplished immediately on package arrival. Nonetheless, the presence of check words in each package, although it increases reliability of transferred data, leads to a substantial increase in information redundancy. If a network is reliable and the probability of error occurrence is not high, this redundancy cannot be justified. In order to decrease redundancy, it is possible to use two check words for the entire message and fulfill error searching based on expression (9).

Using such an approach to detecting errors in packages leads to changes in the data exchange protocol. Since feedback is used for improving the quality of serving traffic in many protocols, let us consider the process of transferring and receiving a message in systems with negative answerback feedback.

In Fig. 1 a probability-time graph (PTG) is shown that characterizes the process of message transfer in accordance with the suggested protocol. In this figure the following notation is introduced:

– vertex “0” is the start of message transfer;

– vertex “*i*” (*i* = 1…w) is the start of transferring the *i*-th package of the message;

– vertexes “los”, “cor”, “ne”, “de” correspondingly denote the loss of a package (“los”), its correct reception (“cor”), the reception of a package with an undetected error (“ne”), and the detection of an error in a package “de”.

A sequential transfer of packages in a message is described with the arc f_0:

$$f_0 = Z^{T_p}. \quad (9)$$

In accordance with the protocol a package can be lost. The transition to this state (vertex “los”) is characterized by the following function [1]:

$$f_{los} = P_{los} Z^{T_{pd}}. \quad (10)$$

As a result of the package loss, after the time-out T_{to}, a receipt will be sent to user:

$$f_{to} = P_{rd} dZ^{T_{to}}. \quad (11)$$

DOI 10.15588/1607-3274-2018-4-19

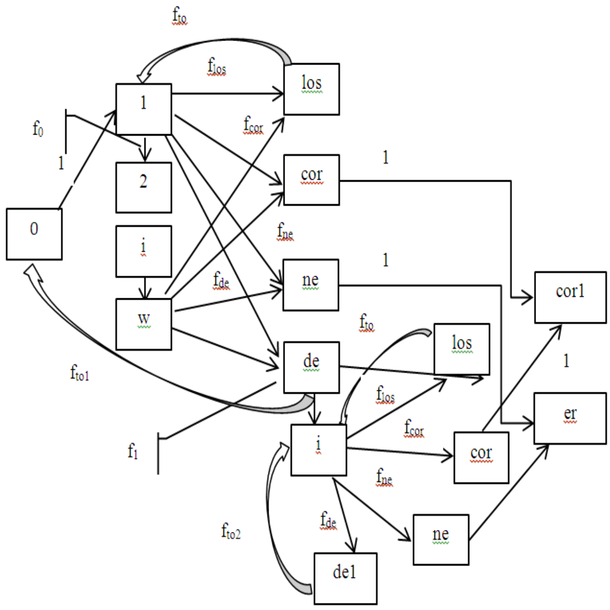

Figure 1 – PTG characterizing the process of message transfer

By analogy the functions describing the transitions to the vertexes "cor", "ne", "de" are defined:

$$f_{cor} = P_{cor} Z^{T_{pd}} ;$$
$$f_{ne} = P_{ne} Z^{T_{pd}} ; \qquad (12)$$
$$f_{de} = P_{de} Z^{T_{pd}} .$$

If there are no errors or an undetectable error occurs, a decision is made regarding the reception of the message (vertexes "cor1" and "er").

The result of this algorithm can be a conclusion as to the correct reception of the message or an error occurred. At that, if an error occurred in several packages, after the time-out T_{to} a receipt will be set to user about the necessity of repeating the entire message (transition from the vertex "de" to the vertex "0"). This process is characterized by the following function:

$$f_{to1} = P_m Z^{T_{rec}} . \qquad (13)$$

If an error has occurred in a single *i*-th package, a receipt is sent about the necessity of its repetition (transition from the vertex "de" to the vertex "i"). This process is characterized by the following function:

$$f_1 = P_1 Z^{T_{rec}} . \qquad (14)$$

When a package is transferred repeatedly, errors can occur or the package can be lost (transitions from the vertex "i" to the vertex "de1" and "los" correspondingly), and also the correct reception or a reception with an error can happen (transitions from the vertex "i" to the vertexes "cor" and "ne" correspondingly). For example, when an error is detected in the package a function characterizing this process is calculated according the following formula:

$$f_{to2} = P_{rd} Z^{T_{rec}} . \qquad (15)$$

4 EXPERIMENTS

Let us consider data exchange process with an unlimited number of repetitions of package or message transfers.

PTG characterizing the process of message transfer is equivalently transformed to the following form (Fig. 2).

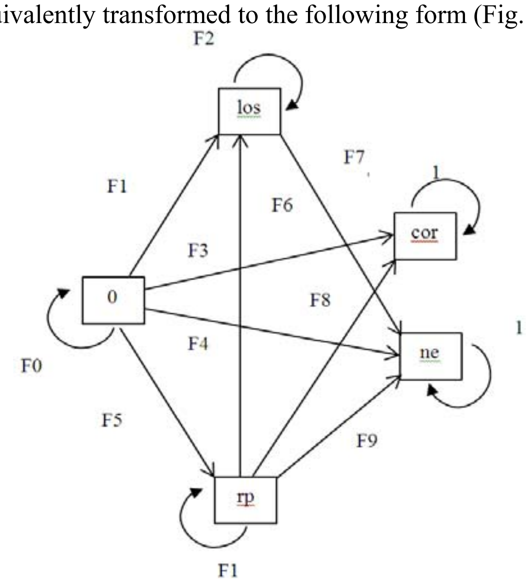

Figure 2 – Transformed PTG characterizing the process of message transfer

In Fig. 2 the following notation is used:

$$F_0 = P_{de} Z^{T_{pd}} \cdot P_m Z^{T_{to}} ;$$
$$F_1 = P_{cor} Z^{T_{pd}} ;$$
$$F_2 = P_{rec} Z^{T_{rec}} ;$$
$$F_3 = P_{cor} Z^{T_{pd}} ;$$
$$F_4 = P_{ne} Z^{T_{pd}} ;$$
$$F_5 = P_{de} Z^{T_{pd}} \cdot P_1 Z^{T_{rec}} ; \qquad (16)$$
$$F_6 = P_{los} Z^{T_{pd}} ;$$
$$F_7 = (1 - P_{rec}) Z^{T_{rec}} ;$$
$$F_8 = (1 - P_{rec} - P_{los} - P_1) Z^{T_{rec}} ;$$
$$F_9 = P_1 Z^{T_{pd}} \cdot P_{ne} Z^{T_{pd}} ;$$
$$F_{10} = P_1 Z^{T_{rec}} \cdot (P_{los} Z^{T_{pd}} \cdot P_{rec} Z^{T_{to}} +$$
$$+ P_{de} Z^{T_{pd}} \cdot P_{rec} Z^{T_{to}}).$$

The generating function corresponding to the graph is the sum of the functions for all paths connecting the start and end vertexes of the graph [1]. Since in this case the end vertex is split into two components that correspond to the correct reception and the package reception with an error, the generating function can be represented as follows:

$$F(Z) = F_{cor}(Z) + F_{ne}(Z). \qquad (17)$$

From the transformed graph (Fig. 2) we can find values of the generating functions:

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$$F_{ne} = 1/(1-F_0)(F_4 + F_1F_7/(1-F_2) +$$
$$F_5/(1-F_{10})\cdot(F_9 + F_6F_8/(1-F_2));$$
$$F_{cor} = 1/(1-F_0)(F_3 + F_5F_8/(1-F_{10})). \qquad (18)$$

According to the obtained generating functions it is possible to find the probability of the correct package delivery, the probability of a package delivery with an error, and also the average time for package delivery with the help of the following expressions [1]:

$$P_{cor} = F_{cor}(Z)|_{Z=1};$$
$$P_{ne} = F_{ne}(Z)|_{Z=1}; \qquad (19)$$
$$T_{av} = F(Z)/\mathrm{d}Z|_{Z=1}.$$

5 RESULTS

A comparative analysis of ways for data exchange in networks with package commutation will be carried out for three main approaches that use cyclic error detecting codes. The following ways are considered:

– for data checking two convolutions (code words) are sent that detect errors according expressions (5–10);

– a data convolution (code word) is available in each package;

– a single data convolution is available in the message.

The first case is described above, on the basis of which PTG is built (Fig. 1, 2) and there have been obtained expressions for calculating the average time of package delivery to user. The second option of data exchange rules is characterized with PTG [12], and there have been obtained expressions for calculating the average relative time of package delivery to user. The third option of data exchange rules can be described with the help of PTG like Fig. 1 when graph vertexes implementing a repeated package transfer are absent. A comparative analysis of the data delivery ways can be carried out with respect to the average relative way of package delivery to user (T_{av}/T_{pd}) depending on the probability of error detection. In Fig. 1 graphs for such dependencies are presented. At that, $T_{av}(P_{de})$ represents the first option of data exchange organization, $T_{av1}(P_{de})$ represents the second one, and $T_{av11}(P_{de})$ represents the third one.

Based on the obtained graphs, we can deduce that when the probability of error detection is low (P_{de} <0.4), for obtaining the minimum time of package delivery to user, we should use the first control option with two code words per entire message. When P_{de} > 0.4 the second option is preferable, with one checking convolution in the package. Such a result is conditioned by the fact that when the error detection probability increases, the possibility of repeating the message but not the package increases, which in turn causes a significant increase in the package transfer average time.

In Fig. 4 a dependence is presented for the average relative time of package delivery both on the error detection probability and on the probability of error detection in one package.

The results presented in Fig. 4 are somehow associated with the results shown in Fig. 3. In particular, the indicators of the package transfer average relative time growth are equal in both figures. Nevertheless, an error detection probability increase in one package by 0.1 on average leads to an increase in the average package delivery time by 10–15%. The error detection probability in a message (in several packages) similarly influences the average package delivery time.

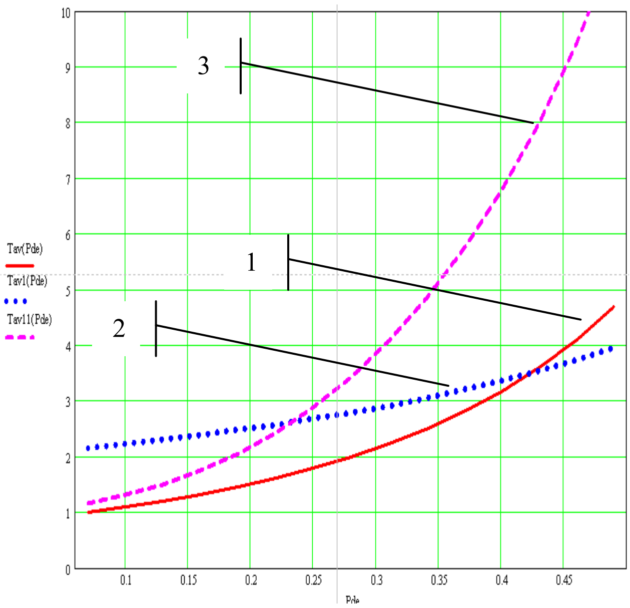

Figure 3 – Dependencies of the average relative time for package delivery on the error detection probability

Notation:

1 – Average time of package delivery when there are two check words in a message;

2 – Average time of package delivery when there is a check word in each package;

3 – Average time of package delivery when there is a single check word in a message

In Fig. 5 some results are shown for investigating the dependency of the average probability of message reception with an error on the probability of the error detection in the route for the three cases of data transfer control. In order to receive data with the minimum error, one should select the second option that uses a check word in each package. When values of the error detection probability are low ($P_{de} < 10^{-2}$) the probability of message reception with an error for the second control option with two check words becomes approximately 5% worse than for the others. This can be explained by the necessity of package or message transfer repetition as compared with the second and third options.

In Fig. 6 some results are shown for investigating the dependence of receiving a message with an error on the probability of error non-detection for the same options of data exchange control.

Fig. 6 shows that in order to receive data with the minimum possible undetected error, one should select the second option that uses a check word in each package. If

DOI 10.15588/1607-3274-2018-4-19

values of the error detection probability are low ($P_{de} < 10^{-2}$), the probability of message reception with an error for the first control option with two check words becomes approximately the same as for the second option. At that, the probability of error non-detection approaches asymptotically to 0.008.

When the network load increases, the number of occupied memory cells in the commutation center buffer devices increases, which leads to decreasing the bandwidth. In Fig. 7 some results are shown for investigating the dependence of the average relative package delivery time on the probability of losing a package in the network, which can happen because of network overload or errors in the address part of the package.

Some research represented in Fig. 7 has been carried out for different values of the package length and time-outs. It can be seen in Fig. 7 that the average relative package delivery time decreases as the size of a package or time-out decrease. Such results reflect a tendency similar to that demonstrated in [1, 11].

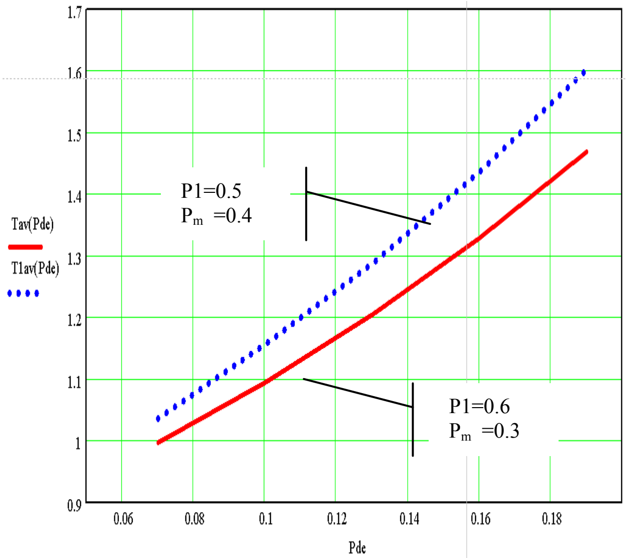

Figure 4 – Dependencies of the package delivery average relative time on the probability of error detection in one package

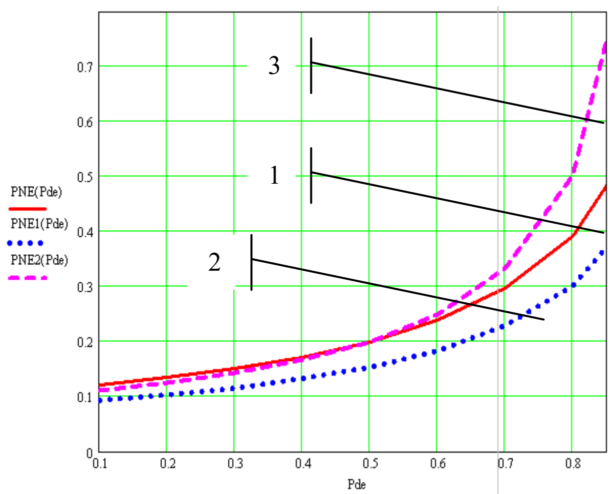

Figure 5 – Dependencies for the average probability of message reception with an error on the probability of error detection
Notation:
1 – Average probability of message reception with an error when there are two check words in the message;
2 – Average probability of receiving a message with an error when there is a check word in each package;
3 – Average probability of receiving a message with an error when there is a single check word in the message

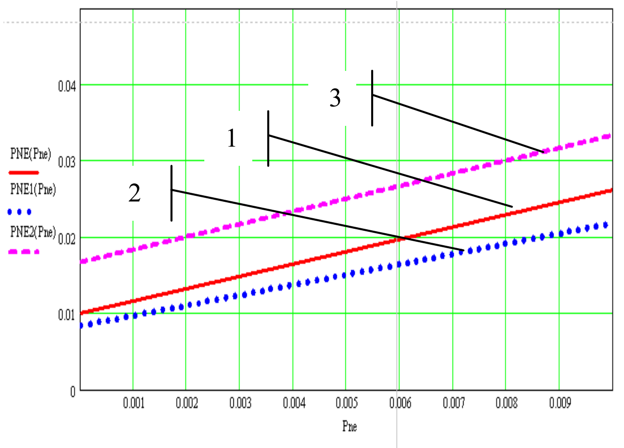

Figure 6 – Dependencies for the average probability of message delivery with an error on the probability of error non-detection

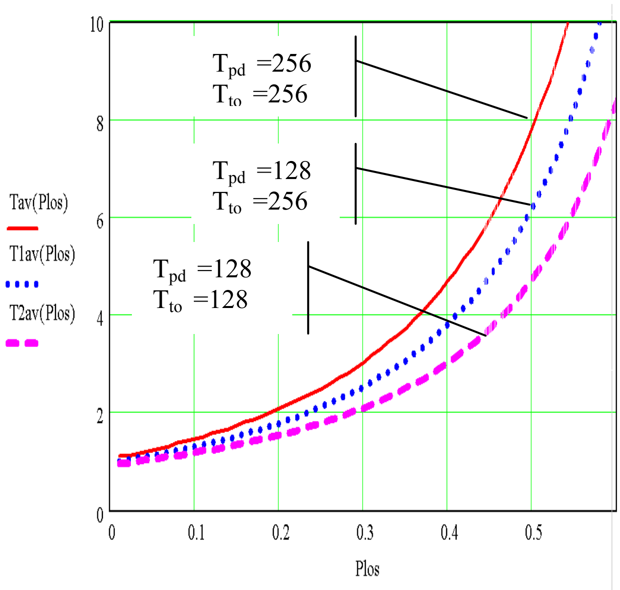

Figure 7 – Dependences of the package delivery average relative time on the probability of package loss in the network

6 DISCUSSION

On the basis of probability-time graphs a comparative analysis has been carried out for the three main methods of controlling information transfer with the help of error detecting cyclic codes. At that, the following ways have been investigated:

– for data checking two convolutions (code words) detecting errors are sent;

DOI 10.15588/1607-3274-2018-4-19

– check data convolution (code word) is available in each package;

– a single check data convolution is available in a message.

The comparative analysis carried out allows making the following inferences:

– if the probability of error detection is low (P_{de} <0.4), in order to get the minimum time of package delivery to user, one should use the first control option (with two code words per entire message;

– if P_{de} > 0.4, the second option with a single check convolution in a package is preferable;

– increasing the probability of error detection in one package by 0.1 on average leads to an increase in the average relative package delivery time by 10–15%;

– if values of the error detection probability are low ($P_{de} <10^{-2}$), the probability of receiving a message with an error in the case of the control option with two check words becomes approximately 5% worse than for the other options;

– to receive data with the minimum error non-detection probability, one should apply the option that uses a check word in each package;

– if values of the error detection probability are low ($P_{de} <10^{-2}$), the probability of receiving a message with an error in the case of the control option with two check words becomes approximately the same as for the option with a check word in each package. At that, the non-detection probability approaches asymptotically to 0.008;

the average relative package delivery time decreases with decreasing both the package size and time-out.

Research has been carried out for different values for probabilities of detecting errors in a package and a message, the length of a package and time-out. All the obtained results do not contradict those received in [1–12] and can be used as a basis for selecting data exchange ways.

In the process of receiving a set of messages of different sizes with different numbers and lengths of packages the signature analyzer should work with time-sharing. For processing each message, it is necessary to provide a time period depending on the length of packages in messages and the number of packages, and also their availability on the user side. At that, according to expression (9), one should flexibly change the matrix S^i.

CONCLUSIONS

In this paper the problem of a comparative analysis for ways of information exchange in package commutation networks has been solved. Recommendations as to the application of different data exchange methods have been formed.

The scientific novelty of this work consists in an improvement of the data exchange methods and the development of a mathematical model for this improvement implementation. The developed mathematical model allows accomplishing a comparative analysis of different protocols for information transfer that apply cyclic codes for detecting errors in networks with package commutation.

A practical importance of this work follows from the usage of the research results for selecting the most effective ways of data exchange in networks with package commutation depending on their parameters, and also possibilities of detecting and correcting errors in messages.

As possible prospects of this research, we consider the investigation of various data exchange protocols and the development of algorithms and software for working with vague input data.

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Received 21.05.2018.
Accepted 06.06.2018.

УДК 621.372

АНАЛІЗ СПОСОБІВ ІНФОРМАЦІЙНОГО ОБМІНУ ДАНИМИ В МЕРЕЖАХ З КОМУТАЦІЄЮ ПАКЕТІВ

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АНОТАЦІЯ

Актуальність. Розглядається актуальна проблема підвищення ефективності функціонування телекомунікаційних мереж з комутацією пакетів. Пропонуються шляхи вдосконалення алгоритмічного забезпечення процесу інформаційного обміну на основі використання можливостей методів і засобів діагностування помилок в пакетах даних, що передаються. Об'єктом дослідження є процес передачі даних і визначення зіпсованих пакетів в повідомленнях.

Мета. Мета роботи зниження середнього відносного часу доставки пакетів, а також підвищення ймовірності безпомилкової передачі інформації абоненту на основі моделювання різних протоколів обміну даними.

Метод. Пропонується методика синтезу універсальних, швидкодіючих багатоканальних пристроїв, призначених для контролю і діагностування повідомлень в мережах обміну даними з комутацією пакетів. Визначення помилкових пакетів здійснюється на основі використання циклічних кодів і методу сигнатурного аналізу, які дозволяють створювати прості і досить ефективні пристрої контролю даних. На основі використання методу імовірнісно-часових графів виконано порівняльний аналіз протоколів обміну даними.

Результати. Отримано рекомендації щодо ефективного використання протоколів інформаційного обміну в залежності від умов застосування і характеристик мереж з комутацією пакетів.

Висновки. У проведеному дослідженні виконана формалізація процесу обробки інформації на основі сигнатурного аналізу та удосконалено методику синтезу багатоканальних пристроїв контролю з локалізацією помилок в пакетах повідомлень. При цьому вдосконалений спосіб обміну даними в мережах з комутацією пакетів. З використанням ймовірнісно-часових графів проведено порівняльний аналіз для трьох основних напрямків, які застосовують циклічні коди, що виявляють помилки.

КЛЮЧОВІ СЛОВА: пакет, повідомлення, сигнатурний аналіз, дейтаграммний канал, передача даних.

УДК 621.372

АНАЛИЗ СПОСОБОВ ИНФОРМАЦИОННОГО ОБМЕНА ДАННЫМИ В СЕТЯХ С КОММУТАЦИЕЙ ПАКЕТОВ

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АННОТАЦИЯ

Актуальность. Рассматривается актуальная проблема повышения эффективности функционирования телекоммуникационных сетей с коммутацией пакетов. Предлагаются пути совершенствования алгоритмического обеспечения процесса информационного обмена на основе использования возможностей методов и средств диагностирования ошибок в пакетах передаваемых данных. Объектом исследования является процесс передачи данных и определения испорченных пакетов в сообщениях.

Цель. Цель работы снижение среднего относительного времени доставки пакетов, а также повышение вероятности безошибочной передачи информации абоненту на основе моделирования различных протоколов обмена данными.

Метод. Предлагается методика синтеза универсальных, быстродействующих многоканальных устройств, предназначенных для контроля и диагностирования сообщений в сетях обмена данными с коммутацией пакетов. Определение ошибочных пакетов осуществляется на основе использования циклических кодов и метода сигнатурного анализа, которые позволяют создавать простые и достаточно эффективные устройства контроля данных. На основе использования метода вероятностно-временных графов выполнен сравнительный анализ протоколов обмена данными.

Результаты. Получены рекомендации по эффективному использованию протоколов информационного обмена в зависимости от условий применения и характеристик сетей с коммутацией пакетов.

Выводы. В проведенном исследовании выполнена формализация процесса обработки информации на основе сигнатурного анализа и усовершенствована методика синтеза многоканальных устройств контроля с локализацией ошибок

DOI 10.15588/1607-3274-2018-4-19

в пакетах сообщений. При этом усовершенствован способ обмена данными в сетях с коммутацией пакетов. С использованием вероятностно-временных графов проведен сравнительный анализ для трех основных направлений, применяющих циклические коды, обнаруживающие ошибки.

КЛЮЧЕВЫЕ СЛОВА: пакет, сообщение, сигнатурный анализ, дейтаграммный канал, передача данных.

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DOI 10.15588/1607-3274-2018-4-19