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ABSTRACTS

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Abstracts of the 9th International Conference *RELIABILITY and STATISTICS in TRANSPORTATION and COMMUNICATION* (RelStat'09), 21–24 October 2009, Riga, Latvia.

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PROGRAMME
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Date	Time	Hall #1 (Aud. 130)	Hall #2 (Aud. 230)	Hall #3 (Aud. 100)	Hall #4 (Aud. 710)
21.10.2009	18.00–20.00	Registration			
	19.00	Welcome Party			
22.10.2009	9.00–14.00	Registration			
	10.00–11.15	Opening Session			
	11.15–11.45	Coffee Break			
	11.45–13.00	Plenary Session			
	13.00–14.00	Lunch			
	14.00–15.40	Parallel Sessions			
		Statistical Methods and their Applications - 1	Intelligent Transport Systems	Transport and Business Logistics - 1	
	15.40–16.10	Coffee Break			
	16.10–18.00	Parallel Sessions			
		Statistical Methods and their Applications - 2	Applications of Mathematical Methods to Logistics and Business	Transport and Business Logistics - 2	
23.10.2009	10.00–10.40	Tutor Lecture			
	10.40–11.10	Coffee Break			
	11.10–13.00	Parallel Sessions			
		Statistical Methods and their Applications - 3	Transport Systems - 1	Intelligent Transport Systems (Electronics)	Workshop “COST actions of Transport and Urban Development domain in Latvia”
	13.00–14.00	Lunch			
	14.00–15.40	Parallel Sessions			
		Simulation: Practical Issues - 1	Transport Systems - 2	Aviation - 1	Workshop of the project “Development of the model of Europe-Asia multimodal corridor intelligent transport system for optimization of Latvia-Belarus international logistics chain (TransLaB)”
	15.40–16.10	Coffee Break			
	16.10–18.00	Parallel Sessions			
		Simulation: Practical Issues - 2	Innovations in Education and Research	Aviation - 2	Workshop of the project “Development of the model of Europe-Asia multimodal corridor intelligent transport system for optimization of Latvia-Belarus international logistics chain (TransLaB)”
19.00	Dinner (Restaurant “LIDO”)				
24.10.2009	10.00–12.00	Old Riga Walking Tour			

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Session 1

Transport Systems

PROBLEMS OF TRANSPORT ECOLOGY AND ANALYSIS OF ECOLOGICAL STATISTICS OF LATVIA

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Keywords: ecology, environment pollution, ecological laws, ecological statistics of Latvia, analysis of statistics

Researches by Academician Vernadsky showed that life on Earth is concentrated in a thin layer of biosphere wherein all components are connected into united planetary system. One of the middle and the end of 19th century thinkers wrote: "Lets not flatter ourselves too much with our victories over nature. It revenges every victory."

Mankind has had to find a way out of different ecological situations at different stages of development. For example, extermination of many species of mammals as a result of hunting more than 25 thousands years ago made people turn to farming and cattle breeding.

Negative consequences of transport and industry development (consumption of resources, up to their full disappearance) can be considered in three aspects [1, 2, 3] as it is shown in Table 1.

Table 1

Consumed resources	Ecological factor	Social factor
1	2	3
Energy. Material. Land. Water. Air.	Construction of the enterprises: Pollution of the territory, water, atmosphere, infringement of natural connections, reduction of vital space, reduction of biological productiveness. Transport streams: noise and vibration, fuel exhaust and expense, road accidents.	Death, mutilation and poisoning of people and live organisms. Intensification of stressful loadings of the participants of the traffic. Occupational diseases of drivers. Growth of taxes and expenses for transport (changes in the family budget). Hypodynamia.

According to the United Nations, transport and the industry approximately equally pollute environment. The transport percentage is presented in Table 2 [3].

Table 2

Factors	Transport percentage, %
Consumption of natural resources	20-32
Pollution of atmosphere	50
Water pollution	5
Occupation of terrene	30
Noise	60-80
Dead in a wreck	46

91.3 % of air pollutions result from automobile transport work, 3.7 % – railway, 2.7 % – sea, 0.9 % – river and 1.4 % – air. According to the USA automobile transport produces 60.6 % of air pollutions, industry – 16.2 %, heating – 5.6 %, dust burning – 3.5 %, power stations – 14.1 %. CO impact on a human organism is illustrated on Fig. 1.

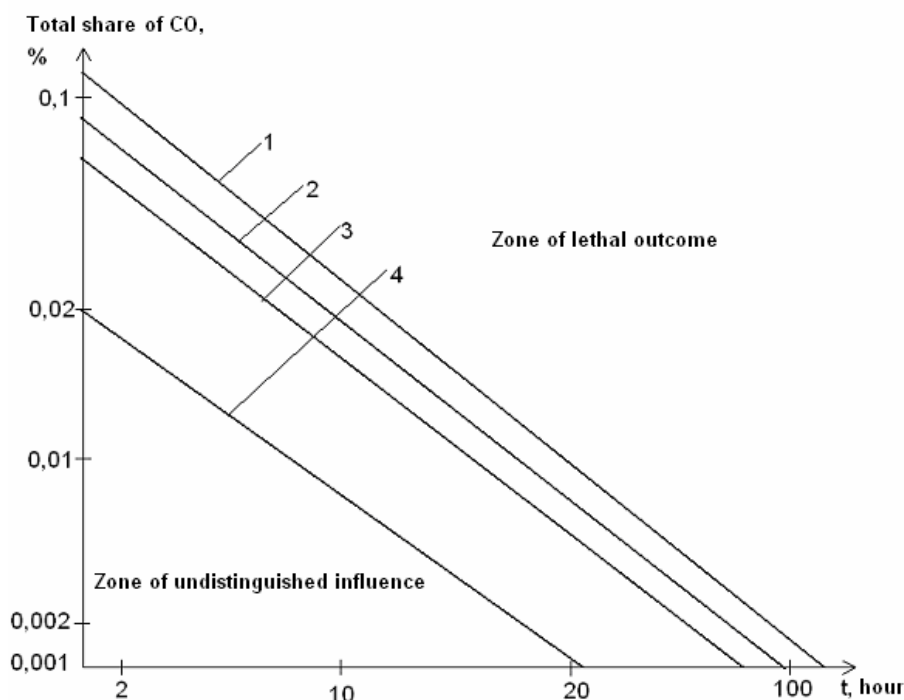


Figure 1. CO impact on a human organism:
 1 – deadly danger; 2 – a headache, a nausea;
 3 – the beginning of toxic impact; 4 – distinguished influence

It is noticed that the ordered traffic, for example, in tunnels leads to decrease of CO (overtaking there is forbidden and speed is lowered). The concentration of CO in pedestrian tunnels, as a rule, is several times less than in adjoining streets (this positive factor reinforces in the presence of a good ventilating system). On 900 miles the car uses as much air as a person in a year.

Many harmful substances connected with action of transport are able to dissipate in the air. For example, nitrogen oxide – it is transferred over 10 km in one hour, carbon dioxide – 100 km in 48 hours. Influence of lead, iron, copper, zinc also affects plants, slowing down their growth, leads to yellowness and dying off of leaves.

Noise is called invisible poison. It leads to emotional disorders, gastric diseases, loss of hearing and other illnesses. Transport produces 45 % of city noise, aircraft – up to 2 %, industry – up to 30 %.

Electromagnetic radiations arise from various devices and the equipment that are installed in the vehicle salon. At the present time the electromagnetic radiations are not regulated. The electrostatic potential of a body and the intensity of an electromagnetic field in a vehicle salon should be under regulations.

Vehicles' manufacturing requires a large quantity of materials so it leads to a large consumption of the natural resources. It is necessary to implement energy-saving technologies and technologies without waste, and also technologies of secondary raw materials processing. It is very important to monitor the condition of the environment change. All of this requires expenses.

Expenses on environment protection are significant, for example, in the USA where adoption of the basic ecological laws at federal level has put the strong base of system whereby any state cannot establish less rigid rules in comparison with national [4]. In the USA the basic volume of regulation inventing activity is carried out through Environment Protection Agency (EPA). In the USA they fairly believe that the more fully business is informed about the measures of the ecological regulation, the smaller costs it will take to realize the main objectives of the ecological policy. The local general plan of nature use usually serves as the management

basis of ecological conditions in regions (municipalities). The financing of the ecological programs at the expense of the implement of special taxes has been gaining a wide enough development during the last years. After EPA some states have undertaken more detailed projects under the comparative analysis of ecological risk. The largest project is known as Californian [4]. In the current article some American approaches directed on the reduction of the ecological problems has been discussed.

In Latvia with the account of experience of the EU countries and the USA are conducted works which are directed on improvement of an ecological situation in the country, in cities and regions. Realization of measures on environment protection, ecological regulation and on performance of corresponding programs demands considerable material inputs. In the article a great volume of information received from Statistical Bureau of the Republic of Latvia is analysed [5]. This data contains data on programs' financing and volumes of pollutions (by various kinds).

For the communication estimation between ecological programs' financing and an ecological situation in Latvia the correlation analysis is used in the study [6].

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THE RESEARCH INTO METHODOLOGY FOR EVALUATION OF TRANSPORT INFRASTRUCTURE INVESTMENTS

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Keywords: evaluation, transport infrastructure, investments, input, output, result

The important part of public policy is the decision-making for investments. Transport infrastructure is the sector, which attracts a lot of public funds. In consequence the main benefits of those investments should be used by society itself. The main questions are as follows: Where to invest? and Why to invest? The programming documents usually include both of answers. The political decisions are based on a lot of economical and social arguments. However the arguments need to be quantified and evaluated after the implementation. So there we need of some measurable indicators.

The use of indicators for monitoring and evaluation in the framework of Structural Funds became established practice in the mid 1990s. From this period a lot of actual guidelines are prepared and successfully used in Western Europe. Lithuania became an EU member in 2004. The tradition of using modern evaluation practice is still poor as in other new member states of EU.

The objective of article is to analyse main transport infrastructure investments for 2007-2013, to find shortage comparing to the Western European practice and conceptualise suggestions for improvement criteria system for transport investment in Lithuania.

The major transport infrastructure investments using EU funds are planned in the national programs. The four programs are under implementation for period 2007-2013 in Lithuania. Seven tasks within the programming documents are related to the transport sector among other economics sectors. Analysis shows that the programs are insufficient for evaluation of the achievements. Moreover some baselines are still not indicated.

The indicators are divided in two groups here: result and product. The measures for 2006 (or 2005) are presented. However 3 result indicators measures and 1 product indicator measure are totally missing for 2006. It is a fundamental question how these measures are planned for 2015 if there is no data available for current situation.

The next one fundamental question is product indicators in the main programming documents. Product indicators are answering the question about implementation of planned projects physical dimensions but not about benefits for society. It means that the aim of the project is the project. It doesn't answer a lot of questions such as: what is the value-added of the project? Is the project cost efficient? Is the project coherent with the other projects? What the benefit is expected? What are negative impacts of the project? So further the main objectives for the planning of transport projects and evaluation of achievements are presented.

But the main shortage is the concept of measurement criteria represented in the programs. Only output (product) and result indicators are taken into account. The theory of evaluation as well as European Guidelines strongly recommends including impact indicators.

One of the most important overall objectives of the programming system for Structural Funds is to facilitate the transition from a primarily input-driven implementation system of socio-economic development to a results-oriented system. The categories of output and result, and impact indicators should be an instrument for this purpose. This consideration explains the important role of ex ante quantification of programme objectives. Impact indicators by their

nature ask for more developed arrangements to obtain meaningful values than it is possible for data that can be obtained from the monitoring system. An improvement in the economic situation, for example, might be due to factors external to the programme. Such result indicators are a necessary building block for a subsequent development of impact indicators. The difficulty is that impact indicators by their nature are often available only after a considerable time lag and they often need substantial methodological input in order to be valid. Output indicators, on the other hand, deliver only information about the physical, not the socio-economic, effects of an action.

ANALYTICAL PLANNING OF TRANSPORT SYSTEM. ASPECT OF ALGORITHM

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Keywords: transport system, decision support methods, analytic hierarchy process, analytical planning

The published material is a fragment of a research that explores decision-making process during developing transport systems conducted by the author. The following material has two objectives: 1) presenting possibility of using method of Analytic Hierarchy Process (AHP), and 2) assessing opportunity of employing AHP algorithm using a standard MS Office suite and applying it to 5-6 level hierarchies and matrices that have up to 15 blocks and lines.

The article shows the transport sector of economy belongs to the service category and continues to exist by selling its services to the other sectors of economy; it depends on the structure and development level of a national economy and the intensity of international trade. When developing a transport sector, it is appropriate to use a concept of transport system, which is a compound of different types of transport and transport network. Per se, this is a public-private partnership (PPP). Government creates legal environment and, as a rule, implements the major investments in infrastructure to assure profits for the partners. The "profit" of the government is the growth of the society welfare due to the PPP input into Gross Domestic Product (GDP). To estimate the impact of the investments in transport infrastructure at the growth of GDP, one may use the method of the paired comparison formulated by Thomas L. Saaty (The Analytic Hierarchy Process, AHP), which is widely used in tasks with multi-criteria choice of solutions, conflict resolutions, and strategic planning.

The method [1] is a systematic procedure for representing essential elements of a problem as a hierarchy. Permitting integration of quantitative and qualitative parameters, it is used to support decision-making. The method allows taking into account the influence of separate individuals, organizations and communities on significance of a selected or evaluated alternative. The procedure of the hierarchy analysis lets a group of people to interact in terms of a problem of their interest, modify their decision, and, as a result, combine group judgments according to the major criterion. Depending on research objectives, a hierarchy of direct and reverse processes can be built. The first one depicts a system's working environment and its possible estimates, such as forecast scenarios, terms of influence, value and effectiveness. Reverse hierarchy is used as a declarative mechanism to identify behavioural outlines a system should follow to achieve desired outcome of a scenario. Combined analysis of direct and reverse hierarchies represents a procedure of analytical planning [2].

As an illustration of application of algorithms [1] and [2] in planning a transport system in Latvia and evaluating a possibility of using the MS Excel for calculation, the author presents the problem of investment impact in transport infrastructure on the growth of GDP as a five-level hierarchy.

Transitional levels of hierarchy are the means of creating GDP, its implementing actors and actors' objectives. The maximum quantity of elements at one of the levels in the matrix is 13. Six-level reverse matrix is developed in order to identify the most effective policies aimed at realization of one of the investment projects. Paired comparisons of the elements in matching hierarchy levels in relation to the upper-level elements were conducted by the author in association with MBA students in order to test the algorithm and prepare questionnaire forms for the complete expertise. Considerably lengthy matrix operations were performed in MS Excel

and some of them were successfully programmed. Semi-automatic calculating tables can be created to fit a specific hierarchy; however, in case of changes in initial settings, these tables require diligent adjustment.

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PUBLIC TRANSPORT ACCESSIBILITY AND RESIDENTIAL LAND VALUE: A CASE STUDY OF RIGA

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Keywords: geographically weighted regression, hedonic price model, public transport

The relationship between public transport accessibility and residential land value is a point of interest of many recent studies ([1] includes an overview of over 150 references). A hedonic price regression model, widely used in this research area, has one very important shortcoming – it calculates an “average” influence of factors on land value in the analysis area (city/region). Usually spatial effects present in data, and the influence of public transport accessibility can be distributed over the area non-uniformly.

In this study we apply a comparatively new modification of regression model – geographically weighted regression [2] – to examine the relationship between public transport accessibility and residential land value (in a form of rent and sell prices) in Riga. The proposed method allows taking into account spatial effects without any artificial manners like qualitative variables for administrative district divisions.

We use information about geographical locations of urban public transport stops and routes (including railways) and also data about transport movement frequencies to calculate a level of transport accessibility in a specific point [3].

Together with the transport accessibility level and a common set of property-specific parameters (size, number of rooms, etc.) we consider additional hedonic properties of a location such as supermarkets and higher school accessibility and distances to natural attractors like large parks, the river, and the seaside.

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MAINTENANCE OF ROLLING STOCK SERVICEABLE CONDITION AS THE FACTOR FOR PROVIDING OF TRAFFIC REGULARITY

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Keywords: maintenance service, queue service, modernization of a maintenance depot

Vehicles must be in a serviceable condition for providing of traffic. The maintenance of vehicles in a serviceable condition means making a regular maintenance service.

The transportation company researched in this article has one of the leading places in the passenger traffic market of Latvia. This company carries approximately 2 millions passengers per year, as well as services 43 inland and 7 international passenger routes. At present the rolling stock of the company has more than 100 buses of various passenger capacities. More than a half of buses have SETRA and MERCEDES brands. More than 35% of vehicles' park consists of vehicles of age less than 10 years.

The basic parameters described the effectiveness of maintenance system are as follows [1, 2]: regularity of traffic ratio; the number of vehicles appearance on a route; ratio of technical readiness of vehicles; rolling stock operating ratio.

As regards the maintenance service of the company the planned – preventive system is used there. Taking into account the features of company's activity (characteristic of route services, features of organisation of internal production services), the types of maintenance services carried out in the company are as follows: vehicle washing and cleaning; daily service; the first maintenance; the second maintenance; seasonal maintenance; regular maintenance.

During the process of maintenance the vehicle diagnostics is made as in general diagnostics so in in-depth diagnostics.

In 2010-2011 it is planned to increase a quantity of routes as well as a quantity of vehicles accordingly. As a result the problems connected with organisation of vehicles' maintenance services are foreseen. On the basis of plans on development of the company's activity some preliminary researches in the field of the organisation of maintenance processes of rolling stock have been made on the initiative of the company's leadership.

At the first stage the reasons of input queuing for maintenance (vehicles coming back from route) and opportunity of a rolling stock deficit (providing by buses in a serviceable condition according to plans of routes) are identified. Further the analysis according to the maintenance activity planning system is made.

Taking into account the rolling stock increasing forecast by 2011, the queue of vehicles waiting for the maintenance service could increase more than 2 times. Thus the operational reserve will not be able to ensure the deficit. The company will have to either to increase the amount of reserve vehicles or to change the existing maintenance system.

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NEW METHODS AND TECHNICAL TOOLS FOR PROCESSING OF BIG DATA BASE ON TRAINS OPERATIONS

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The beginning of Railroad Era in the Baltics

The history of railroad development in Latvia has started from the years of the first major construction surge when the Baltic territory witnessed the construction of Riga-Dinaburga-Mitava-Baltija-Libava line and a few smaller lines of local importance, including the Riga-Bolderaja and Riga-Milgravis lines.

In 1873 the isolated railway lines running throughout the Baltic territory was conducted into one complete network.

Today the Latvian Railway transport – a freight service division for millions is the next priority.

Technical improvements and modernisation take part in our time and attention is paid to investments in the improvement of the efficiency of quality of service both in the passengers and freight service.

Compared to the previous year, the volume of freight handled by Latvian Railway Company in 2009 to a total 60.0 million tonnes.

The railway passes all calibres needed for transportation, loading/unloading and storage of any cargo in the ice free port of Riga, Ventspils and Liepaja.

The Problem Setting up

The procedure of collecting and analysis of information on a position of each object of railway carriage as well as data on freight have an influence on trains operation. The developed Railway Technical Inspection Complex (RTIC) is oriented to different methods of collection and application of information on trains.

The main tasks of RTIC are as follows:

- presentation of necessary information on trains and freight on a large-scale processing in real-time mode;
- provisions of operation flexibility and difference on a big data base processing;
- matching of carrying capacity of RTIC and a railway station.

On the ground of statements mentioned above it is possible to assume that RTIC system has to provide and maintain the necessary level of information for trains operation. This automated freight information system control, the flow of freight and has the ability to provide answers as to conditions and the location of freight in trains.

Coordination and Control

Coordination and control constitute an important part of tasks of managers on all levels.

They need to develop and use design to enable and support the management of trains and freight.

A prerequisite for well-working coordination and control is that managers are informed about the trains set-up.

As managers know very well, decisions are taken in Big Base on Trains Operation.

In this case new Methods and Technical Tools can be used.

Besides the Technical Tools exchange of message for purpose has been supported by technical means and already before information technology and facilities designer to enable the transfer, storing and processing of big data.

The Main Theoretical Results

The RTIC model design begins with the modelling object study and it includes mathematical formalization, information collection for the experimental verification of the quality of the tasks' setting up and solution, its analysis and correction and ends with a model experimental verification.

Optimisation is examined carefully for certain condition in order to avoid possible errors and consequently there is possible to solve the task.

As a rule optimisation depends on parameters under control i.e. $(\lambda_{\Sigma j})$ that specifies the rate of entering and transition of trains through RTIC.

In a railway operation there is significant role of trains processing on a boarder stations because it is highly actual for railroad stations of the Baltic region.

On the basis that RTIC failure does take place for sufficiently short period of time, probability of survival is defined as follows:

$$P(t) = F(t) / \lambda t,$$

where

$F(t)$ – probability density of failure duration,

λt – failure rate of the system (calculated in accordance with the standard procedures).

Practical Realization

Theoretical results of the study of RTIC in trains operation make a basis for network technology of a big data base processing in multi-computer systems of different design and Glonas system to use.

EXPERIENCE OF FORECASTING OF ACCIDENT RATE ON LATVIAN RAILWAY TRANSPORT

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Keywords: weather conditions, forecast, railway, frequency of failures, safety

The results of research on collection and analysis of statistical data on an accident rate on the Latvian railways, and also meteorological conditions conducted by the author for period from 2001 to 2008 are discussed in the article [1].

A software product, allowing on the basis of time series of measured daily air temperature to form a set of indicators, that could influence the frequency of accidents on the railways has been developed in the article. Average and extreme monthly values of temperature and its deviation from the norm, the speed of change, and the amplitudes of fluctuations are exposed among these indicators.

Comparison of the got indicators with data about the number of accidents occurred over the proper months on the Latvian railways allowed to expose dependence between conditions and accident rate and build prognostic model.

Conclusions, based on the comparison of forecast and real observations, and also refinements in the model, got on the basis of the new collected statistics, are presented in the article. New indicators, such as an amount of the temperature over-falls and jumps fixed for a month are introduced in the model. Some recommendations over practical using of the model are also introduced.

Adequacy of the proposed model on the basis of direct comparison of the predicted and observed frequency of accidents on the railways is estimated in the article.

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Session 2

Statistical Methods and Their Applications

ON A MODEL OF NONRECURRENT FLOW OF CLAIMS

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Keywords: nonrecurrent flow, dependence, queueing system

An important element of a probabilistic model is a description of considered random variable distributions. It is supposed usually that all random variables are independent. But numerous statistical data prove the opposite. For example, it has been experimentally stated that characteristics of Internet flows are dependent ones. Analogously, flows of insurance claims for damages have dependent structure. In the first case, a correlation between interarrivals of the claims is described by so called *Batch Markovian Arrival Process*, where a claim circulates in some markovian network before an arrival. In the second case, *copulas* are used usually for a description of the dependence.

In our paper another approach is used. We suppose that interarrival times of flow claims correspond to a certain Markov chain with a set of possible values $I = [0, 1]$. Note that the last condition is not very restricted because a suitable time scaling can fulfil it. If Z and X are lengths of previous and current intervals, then a corresponding transition probability density $q(x/z)$ has the following form:

$$q(x|z) = \frac{1}{1 - \exp(-\lambda)} \left(\delta(z)\lambda e^{-\lambda x} + (1 - \delta(z))\lambda e^{-\lambda(1-x)} \right), \quad 0 < z, x < 1,$$

where $\lambda > 0$ is a parameter,

$\delta(z)$ has one of two possible forms: $\delta(z) = z$ or $q(z) = 1 - z$.

Note the last allows us to get flows with positive or negative correlation between adjacent interarrival times. Such flows often appear in various telecommunication and financial systems.

The stationary probability density $f(x)$ and distribution function $F(x)$ for the interarrival time X are

$$f(x) = \frac{\lambda}{2(1 - \exp(-\lambda))} \left(e^{-\lambda x} + e^{-\lambda(1-x)} \right), \quad 0 \leq x \leq 1,$$

$$F(x) = \begin{cases} 0, & x \leq 0, \\ \frac{1}{2(1 - \exp(-\lambda))} \left(1 - e^{-\lambda x} - e^{-\lambda} (1 - e^{\lambda x}) \right), & 0 \leq x \leq 1, \\ 1, & x \geq 1. \end{cases}$$

The joint distribution function for previous Z and current X intervals between arrivals is calculated by formula

$$H(z, x) = \frac{1}{1 - \exp(-\lambda)} \left\{ e^{-\lambda} (e^{\lambda x} - 1) F(z) + \frac{1}{2\lambda(1 - \exp(-\lambda))} \times \right. \\ \left. \times \left[1 - e^{-\lambda x} - e^{-\lambda} (e^{\lambda x} - 1) \right] \left[1 - e^{-\lambda z} - \lambda z e^{-\lambda z} + e^{-\lambda} (1 - e^{-\lambda z} + \lambda z e^{\lambda z}) \right] \right\}, \quad 0 \leq z, x \leq 1.$$

Gotten results are used for an analysis of the following queueing system. Claims arrive at a single server station in accordance with the above-described flow. Upon arrival, the claim is immediately served if the server is free. Otherwise, one has to wait occupying one of a finite number of places. The service time is assumed to be independent and identically exponentially distributed with intensity μ .

The stationary distribution of the claim number in the system has been gotten. Numerical result shows that the dependence between interarrival times exercises great influence on efficiency characteristics of the service.

The elaborated approach gives a general tool for a construction of wide flows' class with correlated interarrival times.

ANALYSIS DUPLEX POLLING SYSTEM BY MEANS OF POWER-SERIES ALGORITHM

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We consider the duplex system presented by two independent servers and multiple M/M/1-type queues to model the operation of cyclic polling systems in very high throughput wireless mesh-networks. Duplex polling system is a queuing system presented by two independent servers and N queues of M/M/1-type. Each server polls its own group of customers but some queues are common, i.e. can be visited by each server. We suppose that a common queue is not allowed to be served by both servers simultaneously. If a server having finished a switchover to a common queue finds the other server working there it immediately leaves the queue and switches to the following one (correspondingly to its polling cycle).

To obtain the joint queue length distribution, we analyse the Markov's chain describing the system states by means of the power-series algorithm, which is a tool for numerical evaluation of the performance of a broad class of multi-queue models.

COMPUTATION OF UNLOADING TIME FOR TIME-SHARING SERVICE PROCESS WITH READJUSTMENTS

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Keywords: time-sharing queuing systems, Chung’s functional, random environment

In the real world, queuing systems can operate both in heavy-load and overloaded conditions. For these cases, traditional approaches to define control costs become useless. Indeed even the best possible cost can be too expensive for a customer. Chung’s functional for Markov’s chains are introduced and investigated in depth in [1] and provide promising alternative as an objective function for optimal control problems.

Consider service of $m < \infty$ conflict flows with a single server. Customers arrive according to Poisson’s law with intensities depending on a state of an external random environment. The random environments has $d < \infty$ states $e^{(1)}, e^{(2)}, \dots, e^{(d)}$. An infinite capacity buffer exists for each flow. After each service a readjustment occurs. The server has $m+1=n$ possible states $\Gamma^{(1)}, \Gamma^{(2)}, \dots, \Gamma^{(n)}$. When the server is in state $\Gamma^{(j)}$, $1 \leq j \leq m$, a customer from the j -th queue is processed. State $\Gamma^{(n)}$ stands for readjustment. We assume that the environment may change its state only at instants of service and readjustment termination. If buffers are empty at the end of a readjustment the first incoming customer is to be processed. Otherwise, $x \in \{0, 1, \dots\}^m = X$ be the vector of queues’ lengths, a customer from a queue $j = h(x)$ is chosen for service; here function $h(\cdot)$ defines switching policy of the server. Some authors call it *dynamic priorities*. After a service a customer either leaves or returns to a random buffer for additional service. This sort of feedback can simulate both time-sharing service algorithm and unreliability of the device. It has been proved in [2] that the optimal control which minimizes the expected sojourn cost during one service or readjustment period in the stationary regime is of priority type. In particular, priorities to the queues can be assigned by virtue of Klimov’s algorithm [3].

We observe the system at service and readjustment terminations. It is proved that the random sequence describing a server state, queues’ lengths and an environment state at observation moments is a Markov’s chain with the states space $S = \{\Gamma^{(1)}, \Gamma^{(2)}, \dots, \Gamma^{(n)}\} \times X \times \{e^{(1)}, e^{(2)}, \dots, e^{(d)}\}$. A decomposition $S = S_- \cup S_0 \cup S_+$ is called *admissible* [1], when S_0 and S_+ are nonempty, and the sets S_-, S_0, S_+ are pair-wise disjoint. A random variable $\Theta(j, x, k)$ counting the number of transitions of the Markov’s chain from a state $(\Gamma^{(j)}, x, e^{(k)}) \in S_0$ to the set S_+ without visiting S_- is called a *Chung functional* [1]. Assume that a sojourn at each state $(\Gamma^{(j)}, x, e^{(k)}) \in S_0$ is assigned a cost, $c(j, x, k)$. Then define $\zeta(j, x, k)$ to be the total cost of sojourn at all the states visited on the way from $(\Gamma^{(j)}, x, e^{(k)})$ to S_+ given $\Theta(j, x, k) < \infty$. We are interested in computation of the conditional expected value for $\zeta(j, x, k)$ given $\Theta(j, x, k) < \infty$.

In the present paper we consider sets S_0 containing states with moderate (“critical”) queues’ lengths and sets S_+ containing states with small amount of customers in the system.

Then, $c(j, x, k)$ is the expected service or readjustment duration. Hence the conditional expectation of $\zeta(j, x, k)$ given $\Theta(j, x, k) < \infty$ represents *the mean unloading time* for the queuing system under investigation. Linear equations for the conditional expectations over all $(\Gamma^{(j)}, x, e^{(k)}) \in S_0$ are obtained and solved numerically. The (quasi-)optimal switching functions $h(\cdot)$ are discussed.

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**RELIABILITY OF SERIES OF PARALLEL SYSTEMS
WITH DEFECTS.
MINMAXDM DISTRIBUTION FAMILY APPLICATION
TO COMPOSITE STRENGTH ANALYSIS**

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Keywords: composite, fibre, strength, weakest-link model, distribution function

Generalization of extended family of the weakest-link distributions with application to the composite specimen strength analysis is presented. Composite (specifically, mono-layer) specimen for tensile strength is modelled as series system but every "link" of this system is modelled as parallel system with random number of defect items. We consider a composite specimen for test of tensile strength as a bundle of n_C longitudinal items (fibres or bundles) immersed into *composite matrix* (CM), which is a composition of the matrix itself and all the layers with stacking different from the longitudinal one. It is assumed that only longitudinal items (LI) carry the longitudinal load but matrix only redistributes the loads after the failure of some LI. In fact, therefore, our model is a model of unidirectional (more specifically, mono-layer) composite. We divide the composite into n_L parts of the same length l_1 . The total length of the composite specimens is equal to $l = n_L l_1$. The development of the process of fracture of a specimen takes place in one or in several of these parts. We call these links as "cross sections" (CS). So we describe the composite as a *series system of CS*. The process of monotonous tensile loading is described by an ascending (up to infinity) sequence $\{x_1, x_2, \dots, x_t, \dots\}$. Let $K_{Ci}(t)$, $0 \leq K_{Ci} \leq n_C$, is the number of failures of LI in i -th CS with n_C initial number of LI at the load x_t . Then the strength of i -th CS

$$X_i^* = \max(x_t : n_C - K_{Ci}(t) \geq 0),$$

but the ultimate strength of the specimen (which is the sequence of n_L CS) is

$$X = \min_{1 \leq i \leq n_L} X_i^* = \min_{1 \leq i \leq n_L} \max(x_t : n_C - K_{Ci}(t) \geq 0).$$

We consider different versions of cumulative distribution function (cdf) calculation methods and their applications to processing results of test of fibre strands (threads) and strip of them (mono-layer).

Considered extended weakest link distribution family can be used also for reliability of series system with defect element analysis.

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THE CONTROLLED SEMI-MARKOV PROCESSES IN PROBLEM

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Keywords: controlled semi-Markov process, accumulative functional, extremes

The object of research is the controlled semi-Markov process $X(t)$ with a finite set of states $E = \{1, 2, \dots, N\}$. The such semi-Markov process $X(t)$ is defined by a Markov's chain (ξ_n, θ_n, u_n) , $n \geq 0$, where $\xi_n \in E$, $\theta_n \in R^* = [0, \infty)$, $u_n \in U_i$, U_i are some space of control parameters, which σ -algebra A_i of their subsets, $i \in E$.

Then the controlled semi-Markov process $X(t)$ can be defined as the pair

$$X(t) = (\xi(t), u(t)), \quad \xi(t) = \xi_{\nu(t)-1}, \quad u(t) = u_{\nu(t)},$$

where $\nu(t) = \inf(n: \sum_{k \leq n} \theta_k > t)$, $\theta_0 = 0$ is the counting process.

Formulation of the problem. The following two problems arise for the controlled semi-Markov process $X(t)$. First we have to clarify how a certain functional depends on the probability measures, which determine a homogeneous Markov randomised control strategy. Secondly, we have to find the conditional extreme of these functional and determine the structure of the distributions, which prove this extreme.

The examples. *Model of reliability. Model of redundancy maintenance* [2]. *Queueing systems*

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ASYMPTOTIC ANALYSIS OF DISCONNECTION PROBABILITIES IN RANDOM NETWORKS WITH HIGH RELIABLE ARCS

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Keywords: reliability, failure, recursively defined networks

In this paper fast algorithms of a calculation of disconnection probabilities in internet type networks are developed. These algorithms are based on a concept of recursively defined networks and on asymptotic formulas for disconnection probabilities in random networks.

OPTIMAL SAMPLING STEP SELECTION FOR SUPERPOSITION OF RANDOM FLUCTUATIONS WITH NONFINITARY SPECTRUM

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Keywords: aggregate signal, nonfinitary spectrum, optimal sampling

Solving of a wide range of communication and management questions foresees usage of discrete representation continuous processes. Such representation is based on known sampling theorem [1]. In accordance with this theorem mathematical model of a signal is a continuous function with finitary spectrum. However for large number of practical tasks signals represent a superposition of stationary random fluctuations with nonfinitary spectrum. At that separate signal components are statistically independent.

Present report lays down a rule for determination of an optimal (in a sense of time quantization noise dispersion minimum) uniform sampling step value for random fluctuation $S(t)$ with covariance function

$$R(\tau) = \sum_{i=1}^k D_i \exp(-\alpha_i |\tau|) \cos \omega_i \tau,$$

where α_i и ω_i represent $S(t)$ signal i^{th} component covariance function parameters. At solving of sampling task a synthetic approach is used. Its kernel is in establishing of adequacy of dispersion minimization tasks for quantization noise and for random process reconstruction error by a discrete-continuous $K(E)$ filter [2, 3]. It is shown that minimization of reconstruction error dispersion gives desirable value of optimal sampling step T_{opt} for $S(t)$ fluctuation. Based on the got relation T_{opt} are set for two important practical particular cases: 1) $S(t)$ fluctuation represents a sum of narrow-band random processes: 2) $S(t)$ fluctuation is a superposition of harmonic oscillations with close frequencies.

Proposed rule of optimal uniform discretization leads to diminishing of signal sample size at saving substantial information about the signal.

Results of the present research can be useful in digital communication tasks, signal processing, computerized numerical modelling of dynamic systems.

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OPTIMISATION OF LIFE TEST SAMPLING PLANS

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Keywords: time-to-failure distribution, life test sampling plan, optimisation

Life test sampling plan is a technique, which consists of sampling, inspection, and decision-making in determining the acceptance or rejection of a batch of products by experiments for examining the continuous usage time of the products. In life testing studies, the lifetime is usually assumed to be distributed as either a one-parameter exponential distribution, or a two-parameter Weibull's distribution with the assumption that the shape parameter is known. Such oversimplified assumptions can facilitate the follow-up analyses, but may overlook the fact that the lifetime distribution can significantly affect the estimation of the failure rate of a product. Moreover, sampling costs, inspection costs, warranty costs, and rejection costs are all essential, and ought to be considered in choosing an appropriate sampling plan. The choice of an appropriate life test sampling plan is a crucial decision problem because a good plan not only can help producers save testing time, and reduce testing cost; but it also can positively affect the image of the product, and thus attract more consumers to buy it. This paper develops the frequentist approach (non-Bayesian) decision models for determining the optimal life test sampling plans with an aim of cost minimization by identifying the appropriate number of product failures in a sample that should be used as a threshold in judging the rejection of a batch. The frequentist approach rules out the subjectivity of investigator (a limitation of the Bayesian approach) that is introduced through a priori distribution. The two-parameter exponential and Weibull's distributions with two unknown parameters are assumed to be appropriate for modelling the lifetime of a product. A practical numerical application is employed to demonstrate the effectiveness of the proposed approach.

NUMERICAL REALIZATION LOGIT AND PROBIT REGRESSIONS FOR THE GROUPED DATA

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Keywords: logit, probit, regression analysis, MathCAD

Quite often dependent variable in regression analysis accepts only two values consequently this naturally leads to the necessity of a choice of the so-called binary regression. As it is known, at similar statement one comes to model of a kind

$$P(j) = P(y = j) = F(X_i^T \beta) = F(\beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_k x_{ik}), \quad (1)$$

considering, that in equality (1) at the left there is a probability, as function F chooses function of

distribution of a kind $\Lambda(z) = \frac{e^z}{1 + e^z}$ or $F(z) = \Phi(z) = \int_{-\infty}^z \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}t^2} dt$ [1,2].

In the first case we come to the so-called logit regression, in the second one to model probit regression. It is possible to note, that for similar models algorithms of construction of models are quite often realized in the form of ready batch programs that complicates the analysis of results.

In the present work the accent on detailed discussion and direct realization of numerical algorithm for model (1) is done by using the grouped statistical data and a choice logit and probit models. Concrete examples are considered, corresponding programs and results are presented in package MathCAD. The basic criteria of quality of binary models are received and realized as well.

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DEVELOPMENT OF THE INDICATOR OF SERVICE QUALITY AT RIGA COACH TERMINAL

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The research deals with the service quality level at Riga Coach Terminal. This enterprise, being a leader in the services area of passenger bus transportation in Latvia, provides the international, intercity and regional trips. Recent studies on the role of buses and coaches seem to confirm the already excellent safety, environmental and social record of bus and coach transport [1]. In Latvia this mode of transport competes with railway (and private cars also) that's why the quality of services is very important from the all points of view [2].

The main attention is paid to the analysis of quality of service and its components. The approach developed by D. Peña has been used [3, 4]. The theory of linear composite indicator constructing and statistical methods is used for definition of weights of aggregation function.

Suppose that random sample with size denoted n from population of users involves estimates of overall quality of service – y_i , ($i=1, \dots, n$) and estimates of attributes (particular quality index), which define quality of service – x_{ij} , for k concrete attributes X_{ij} , ($i=1, \dots, n$; $j=1, \dots, k$). Assume that these estimates are made on the basis (0-5) scale. The quality of service is unknown variable, which is measured by user's estimation y_i and determined as follows

$$y_i = \mathbf{w}_i^T \mathbf{X}_i + u_i,$$

where $\mathbf{X}_i = (X_{i1}, \dots, X_{ik})$ – estimations of attributes, made by i -th user,

$\mathbf{w}_i = (w_{i1}, \dots, w_{ik})$ – vector of unknown weights,

u_i – error of measuring, which assume is normally distributed $u_i \sim N(0, \sigma_u^2)$.

The restrictions on a vector of weights are the following:

$$w_{ij} \geq 0 \text{ и } \sum_{j=1}^k w_{ij} = 1.$$

Therefore, the task is to get the estimation of the vector of unknown weights for function with restrictions.

The model is applied to the measurement of the quality of service of the Riga Coach Terminal and has been done on the basis of results of questionnaire of transport experts, which was fulfilled in spring 2009. The questionnaire included 7 groups of questions concerned the following groups of quality particular attribute:

- accessibility (availability)
- information
- time characteristics of service
- customer service
- comfort
- safety
- infrastructure and environment.

Totally there are 22 particular attributes of quality distributed on these 7 groups. Also the overall quality of service has been evaluated. As well as particular attributes of quality the overall quality service are estimated on a scale 0-5. In total 44 questionnaires have been returned but some questions remained without the answer in three questionnaires.

The analysis of data descriptive characteristics has been made, relationships between 22 particular attributes are analysed on the basis of the constructed Kendall rank correlation coefficient, the analysis of coordination (consistency) of questionnaire questions has been made by means of Cronbach's alpha coefficient and the regression model with restrictions on parameters for the overall quality estimation has been constructed. A regression model assumes that overall service quality is determined by a linear combination of attribute evaluations with some unknown weights. There were tested some variants of the weights estimating in the research.

The model constructed for a scalar quality indicator, allows comparing the analysed service to the services given by other companies, estimating influence of particular quality indicators on the overall quality evaluation and simplifying monitoring of quality indicators.

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ESTIMATING OF THE SURVIVAL FUNCTION WITH DOUBLY CENSORED DATA

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Keywords: doubly censored data, self-consistent estimators, survival function

Let X, Y and Z be nonnegative variables where X denotes the time of occurrence of a well-defined event such as death, and Z and Y are subject to the restriction $\mathbf{P}(0 \leq Z \leq Y) = 1$. An observation on X is said to be subject to left censoring by Z and right censoring by Y if X is observable whenever X lies in the interval $[Z, Y]$. If X is outside the interval, then we know whether $X < Z$ or $Y < X$ and observe the value of Z or Y accordingly. A random sample of observations on X subject to right and left censoring by Y and Z , respectively, is called a doubly censored sample. Denote $S_X(t) = \mathbf{P}(X > t)$, $S_Y(t) = \mathbf{P}(Y > t)$ and $S_Z(t) = \mathbf{P}(Z > t)$. Let (X_i, Y_i, Z_i) , $i = 1, \dots, n$ be a set of n independent observations on (X, Y, Z) . The available information in a doubly censored sample can be summarized using the n independent pairs (ζ_i, δ_i) , $i = 1, \dots, n$ where $\zeta_i = \max(Z_i, \min(X_i, Y_i)) = \min(\max(Z_i, X_i), Y_i)$ and $\delta_i = 1$, if $Z_i \leq X_i \leq Y_i$; $\delta_i = 2$, if $X_i > Y_i$ and $\delta_i = 3$, if $X_i < Z_i$. We shall consider the estimation of S_X , survival function for X (reliability function).

Let the subdistribution functions and the empirical subdistribution functions be defined as $Q_j(t) = \mathbf{P}(\zeta > t, \delta = j)$ and $Q_j^{(n)}(t) = \frac{1}{n} \sum_{i=1}^n I[\zeta_i > t, \delta_i = j]$, where $I[\cdot]$ is the indicator function. The survival function of ζ is $Q(t) = \mathbf{P}(\zeta > t) = \sum_{j=1}^3 Q_j(t)$.

The following conditions **A** will be assumed to hold.

- A1.** The random variable X_i and the vector (Y_i, Z_i) are independent for each i and the vectors (X_i, Y_i, Z_i) , $i = 1, \dots, n$, are independently and identically distributed.
- A2.** $\mathbf{P}(0 \leq Z \leq Y) = 1$.
- A3.** S_X, S_Y and S_Z are continuous functions of t on $t \geq 0$ and $0 < S_X(t) < 1$ for $t > 0$.

Under conditions **A**, [Chang and Yang (1987)] derived the following system of integral equations relating the survival functions to the subdistribution functions

$$Q_1(t) = -\int_t^\infty (S_Y - S_Z) dS_X, \quad Q_2(t) = -\int_t^\infty S_X dS_Y, \quad Q_3(t) = -\int_t^\infty (1 - S_X) dS_Z. \quad (1)$$

This system is fundamental to our investigation. The integrals considered are Lebesgue-Stieltjes. From integration by parts and also direct calculating it follows that

$$Q(t) = S_Z(t) + S_X(t)(S_Y(t) - S_Z(t)).$$

In estimating S_X with the empirical subsurvival functions $Q_j^{(n)}(t)$, it is reasonable to require the estimators $S_X^{(n)}$, $S_Y^{(n)}$ and $S_Z^{(n)}$ to relate to the $Q_j^{(n)}$'s in a similar way, i.e.,

$$Q_1^{(n)}(t) = -\int_t^\infty (S_Y^{(n)} - S_Z^{(n)}) dS_X^{(n)}, \quad Q_2^{(n)}(t) = -\int_t^\infty S_X^{(n)} dS_Y^{(n)}, \quad Q_3^{(n)}(t) = -\int_t^\infty (1 - S_X^{(n)}) dS_Z^{(n)}. \quad (2)$$

Imposing the conditions on $S_Y^{(n)}$ and $S_Z^{(n)}$, $S_Y^{(n)}(0) = 1$ and $S_Y^{(n)}(\infty) = 0$ system (2) implies that

$$S_Y^{(n)}(t) = 1 + \int_0^t \frac{dQ_2^{(n)}(u)}{S_X^{(n)}(u)}, \quad S_Z^{(n)}(t) = -\int_t^\infty \frac{dQ_3^{(n)}(u)}{1 - S_X^{(n)}(u)},$$

$$Q^{(n)}(t) = S_Z^{(n)}(t) + S_X^{(n)}(t)(S_Y^{(n)}(t) - S_Z^{(n)}(t)).$$

Transforming previous expressions, we obtain

$$S_X^{(n)}(t) = Q^{(n)}(t) - S_X^{(n)}(t) \int_0^t \frac{dQ_2^{(n)}(u)}{S_X^{(n)}(u)} + (1 - S_X^{(n)}(t)) \int_t^\infty \frac{dQ_3^{(n)}(u)}{1 - S_X^{(n)}(u)}, \quad (3)$$

which coincides with (5.1) in [Tsai and Crowley (1985)]. Therefore, $S_X^{(n)}(t)$ is self-consistent and a maximum likelihood estimator for $S_X(t)$. For the algebraic equation (3), the existence and uniqueness of the solution $S_X^{(n)}(t)$ can be established by using the convexity of the log-likelihood function [Turnbull (1974)]. The solution $S_X^{(n)}(t)$ can be calculated numerically by using the EM algorithm [Turnbull (1974)] and [Tsai and Crowley (1985)] or by the Newton-Raphson method to find the maximum point of the log-likelihood function. To study the consistency of the estimator $S_X^{(n)}(t)$, it is necessary to examine whether system (2) determines $S_X(t)$ uniquely [Chang and Yang (1987)].

In the present report for estimation of S_X , based on (ς_i, δ_i) , $i = 1, \dots, n$, we suggest to use the statistics

$$\tilde{S}_X^{(n)}(t) = \sum_{\varsigma_n^{(j)} < t} \frac{Q_1^{(n)}(\varsigma_n^{(j)}-) - Q_1^{(n)}(\varsigma_n^{(j)})}{\tilde{S}_Y^{(n)}(\varsigma_n^{(j)}-) - \tilde{S}_Z^{(n)}(\varsigma_n^{(j)}-)} \quad \text{and} \quad \hat{S}_X^{(n)}(t) = \sum_{\varsigma_n^{(j)} < t} \frac{Q_1^{(n)}(\varsigma_n^{(j)}-) - Q_1^{(n)}(\varsigma_n^{(j)})}{\tilde{S}_Z^{(n)}(\varsigma_n^{(j)}-) - Q^{(n)}(\varsigma_n^{(j)}-)},$$

where $\tilde{S}_Y^{(n)}(t)$ and $\tilde{S}_Z^{(n)}(t)$ are the Kaplan-Meier product-limit estimators, based on (ς_i, W_{2i}) , $\varsigma_i = \min(Z_i, \xi_i)$, $\xi_i = \max(X_i, Y_i)$, $W_{2i} = I[\delta_i = 2]$ and on (ς_i, W_{3i}) , $\varsigma_i = \min(\eta_i, Y_i)$, $\eta_i = \max(Z_i, X_i)$, $W_{3i} = I[\delta_i = 3]$ respectively and $\varsigma_n^{(j)}$ are the ordered statistics, constructed on sample $\varsigma_1, \dots, \varsigma_n$. We show that the estimator $\tilde{S}_Y^{(n)}$ converges in probability (as $n \rightarrow \infty$) to S_X and $\hat{S}_Y^{(n)}$ converges in probability to $-\ln S_X$. Using Yang (1981), it is also shown under

rather weak conditions that the distribution of $\sqrt{n}(\tilde{S}_X^{(n)} - S_X)$ ($\sqrt{n}(\hat{S}_X^{(n)} - S_X)$) asymptotically normal with a limiting variation $\sigma_1^2 = \int_0^t \frac{dS_X(u)}{S_Z(u) - S_Y(u)}$ (respectively

$\sigma_2^2 = \int_0^t \frac{dS_X(u)}{(S_Z(u) - S_Y(u))S_X^2(u)}$). It is worthwhile to note that if $S_Z \equiv 0$, then

$\hat{S}_X^{(n)}(t) = -\sum_{\varsigma_n^{(j)} < t} \frac{Q_1^{(n)}(\varsigma_n^{(j)}-) - Q_1^{(n)}(\varsigma_n^{(j)})}{Q^{(n)}(\varsigma_n^{(j)}-)}$. This is the well-known Nelson-Aalen estimator in

the right censoring case. To estimation a limiting variation σ_2^2 we shall use statistics

$\hat{S}_X^{(n)}(t) = \sum_{\zeta_n^{(j)} < t} \frac{Q_1^{(n)}(\zeta_n^{(j)}-) - Q_1^{(n)}(\zeta_n^{(j)})}{(\tilde{S}_Z^{(n)}(\zeta_n^{(j)}-) - Q^{(n)}(\zeta_n^{(j)}-))^2}$, which converges in probability to σ_2^2 . Our

proposal is illustrated by examples.

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STOCHASTIC MODELS OF DATA FLOWS IN THE TELECOMMUNICATION NETWORKS

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Keywords: stochastic model, BMAP-flow

One of the successful applications to stochastic models in engineering is in the field of telecommunications. Discrete and fluid queuing models have played a major role in the development of computer and communication networks.

There are several branches of telecommunications that use stochastic models and different types of the stochastic models. The study of multivariate character telecommunication processes is an important aspect for many applications.

An aim of the presented paper is to overview the use of the Batch Markovian arrival process (BMAP) -flows in stochastic queuing systems.

The BMAP-flow has been described in detail in the paper, the importance of generating function for this flow has been explained. Some properties of matrix $D(z)$ in a points $z=0$ and $z=1$ has been noted, the closure of a class of BMAP-flows concerning operations of superposition and the elementary randomised sifting is established.

The family of frequently used by researchers BMAP- flows are considered: Markovian Arrival Process (MAP), Markov-Modulated Poisson Process (MMPP), PH - Phase Type process (PH) [1].

The experiments of some foreign authors have shown that the BMAP-flow well describes behaviour of real flows in the telecommunication networks.

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FINDING PREDICTIVE DISTRIBUTIONS AND THEIR APPLICATIONS

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Keywords: past observations, future observation, predictive density function

A lot of work has been done in order to obtain the predictive estimators of the parameters, moments and reliability function associated with various life-testing models, like as follows: exponential, gamma, Weibull's, half-normal, Rayleigh's, Erlang's, generalized gamma, Maxwell's and other distributions, on the basis of the Bayesian approach. The aim of this paper is to present a frequentist (non-Bayesian) approach to find a predictive density function (unbiased or non-unbiased) for a future variable Y with distribution $F(y|\theta)$ based on observations X_1, \dots, X_n from the same distribution $F(x|\theta)$, where a parameter θ is unknown. To obtain the predictive density function, the approach uses either the sampling distribution of a sufficient statistic for θ or the maximum likelihood function of X_1, \dots, X_n . In contrast to the Bayesian approach, the frequentist approach is not in need of a priori distribution. Thus, the subjectivity of investigator (a limitation of the Bayesian approach) is not introduced through a priori distribution. Illustrative examples of applications are given.

DEVELOPMENT AND ANALYSIS OF LOGISTICS PERFORMANCE INDICATOR BASED ON MULTIVARIATE STATISTICAL ANALYSIS

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Keywords: social indicators, scalar, logistics performance indicator, principal components, safety, sensibility

The idea to replace the description of multidimensional object by a scalar value in an "optimal" way, using different approaches on the basis of multivariate statistical methods are accepted in [1,2,3]. The goal of this paper is to develop the indicator of logistical branch, basing on universal algorithm of construction of composite indicators, proposed by the Organization of Economic Cooperation and Development (OECD) [4] and with accent on the multivariate statistical methods. The two-steps nested structure and method of principal components has been used for this indicator construction. The initial data are published by the World Bank (WB) [5]. The working group of experts of the WB carried out a survey in which about 800 professionals in logistics all over the world, operators and agents of the largest logistics companies took part [5].

Detailed analysis of the construed indicator for sensibility and safety is made and dependence of construed indication on other indexes is performed. In the process of construction and analysis the electronic tables MS Excel and statistical package STATISTICA have been used.

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THE ECONOMETRIC ANALYSIS OF THE MUSEUM AUDIENCE OF THE OPEN-AIR MUSEUM IN POLAND ACCORDING TO THE WEATHER

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Keywords: tourism, analysis, museum audience, weather

It is very important to analyse the tourist attractions of museums, which can be studied by the questionnaire surveys or by analysing the numbers of sold tickets. To prepare the forecasts of the museum audience it is helpful to find out the factors, which influence the sold number of tourists. In the case of open-air museums there seems to be interesting to find out if and in which categories of the museum audience (normal tickets, reduced-price tickets and group tickets) the parameters of weather such as temperature, humidity, speed of the wind and so on, are more and less crucial in making decision to visit the museum.

The purpose of this paper is to analyse the audience of museum in three categories of open-air museum in a small village in Poland in the years 2001-2004 to find out which parameters of weather are the most important in making decisions to visit the museum.

FORECASTING NETWORK TRAFFIC: A COMPARISON OF NEURAL NETWORKS AND LINEAR MODELS

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Keywords: telecommunications networks, traffic forecasting, neural networks, multilayer perceptron, ARIMA, exponential smoothing

The object of the research is the time series characterizing the real traffic of both traditional telephone networks (POTS) and packet-switched IP-networks. The reliable forecasts of traffic generated by users (subscribers) allow planning the capacity of transmission channels, avoiding the overload and thereby sustaining the optimal level of quality of service.

A rapid development of packet-switched networks and the transformation of traditional telephone networks into multi-service systems offer new opportunities to a user (subscriber) and expand his/her scope of activities. Though, not only the architecture of telecommunications networks but also the statistical nature of traffic has been changed what implies a strong influence of such effects as long-range dependence and self-similarity.

Such a complicated non-linear method as neural networks is gaining more and more acceptance in the analysis of dynamic behaviour of IP-networks. However, the solution of the task of traffic forecasting is not trivial. It is important to keep in mind that a slowly decaying variance, long-range dependence and self-similarity of the traffic of IP-networks have a prominent influence only in the case of measurements in a very small scale – over the aggregation period varying from milliseconds to approximately 15 minutes. From the point of view of time series forecasting such a fine scale does not make a sense. Therefore, according to the ITU Recommendation E.492 the measurements of network traffic should be averaged over 15- minutes and/or one-hour intervals. In this case we can often speak about the possibility of applying the traditional methods of time series forecasting.

The main aim of the research is to produce the short-term forecasts of traffic loads by means of the mechanism of neural networks (a multilayer perceptron) and traditional linear models such as ARIMA models and exponential smoothing. In most cases the comparison of short-term forecasts produced by neural networks and linear models for different forecasting horizons did not reveal any statistically significant differences.

Therefore, in contradiction to popular belief, the use of such complicated and time-consuming methods as neural networks is not always appropriate. This issue requires further research with the aim of specifying the conditions under which the mechanism of neural networks has to be applied to forecasting the traffic of telecommunications networks.



Session 3

Intelligent Transport Systems

THE ANALYSIS OF POSSIBILITY OF ACOUSTIC SENSORS' APPLICATION FOR MOVING ROAD VEHICLES DETECTING

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Keywords: intelligent transport system, transport flow surveillance, vehicle detecting, acoustic signal, digital signal processing

The increasing traffic in the European Union puts in the forefront the need to create intelligent transport systems of traffic control (ITS) at district, urban and regional scale [1]. Structurally, such systems include a network of sensors of primary or indirect measurements of traffic flows, a control centre and a network of executive components (traffic lights, controlled traffic signs, reversible lanes, etc.). The wider the network of sensors, the more complete information is available for high quality of the intelligent control.

Currently, video, laser, radio frequency, induction, and pressure sensors are mainly used as sensors of traffic flows' parameters. The deployment of a network of such sensors requires significant financial resources, and sometimes also additional construction work. Installation, maintenance and protection of an expensive network of sensors and their channels of communication make the creation of full-scale ITS rather expensive, which is not affordable at all.

In the proposed study, the possibility of using acoustic sensors to measure traffic is discussed. As a detector of acoustic signals, a usual household microphone is used, being the cheapest version of the sensor for the stationary and mobile measuring systems.

Examples of acoustic signals' recordings of different types of vehicles under various weather conditions are presented here. A simple modification of the spectral processing algorithm [2] is applied to the acoustic signals of the microphone with the aim to filter noise components (wind gusts). The results of detection of moving vehicles from the records of the acoustic signal are shown. The restrictions on the usage of acoustic sensors for the estimation tasks of the parameters of traffic are imposed.

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SOME PROBLEMS OF THE EUROPEAN ELECTRONIC TOLL SERVICE INTEROPERABILITY

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Keywords: EETS, interoperability, toll charger, toll service provider, service user, interfaces

The paper refers to some problems of the EETS interoperability. In Europe, different road charging systems are being operated by professional companies making use of state-of-the-art technologies. Interoperability of road charging solutions is a long-term objective of the EC and the directive 2004/52/EC. According to directive EETS should use one or more of the following technologies: satellite positioning, mobile communications using the GSM-GPRS standard and 5, 8 GHz microwave

Based on Directive 2004/52, the European Commission was seeking to establish an open framework for road charging (taxing or tolling) systems in Europe, which enables interoperability at the technical, procedural and contractual level and the EC initialised a process of projects and expert groups which would contribute to the formulation of, and consensus on, a definition of the European Electronic Tolling Service (EETS).

In EETS architecture two charging principles for a tolled infrastructure are supported:

- 1) DSRC-based tolled infrastructure: Charging data is generated in a real-time DSRC communication between the OBU and roadside microwave beacons.
- 2) GNSS enabled tolled infrastructure: Data enabling GNSS tolling is generated in the OBU autonomously and the GNSS charge data is forwarded via the central system of the EETS.

The EETS architecture for interoperability that is based upon work of the CEN and ISO standardization committees and the ASECAP tolling operators' and Member States' Stockholm Group role model (CESARE III).

Architecture defines the technical detail of the interfaces for road charging systems that are interoperable in a manner that they correspond to the interfaces between the business entities that together operate the service: the Toll Charger, the Toll Service Provider and the Service User.

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TIMETABLE INFORMATION SYSTEMS TO FIND OPTIMAL TRAVEL ON PUBLIC TRANSPORT

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Keywords: timetable information system, public transport, optimal travel route

The paper deals with an architecture of a developed timetable information system and describes an original algorithm to find an optimal travel route on public transport.

The level of timetable information service for passengers in Russian Federation is not perfect. It should be noted that the transport network in Russian Federation is the largest in the world and strongly heterogeneous.

Thus, development of the information system allowing to unify an information from the automated systems operating for different transport modes to get a full information on tickets and a route with possible changes is badly needed. In Europe, the mostly spread system is HAFAS used on the rail transport in several countries.

The automated system developed by authors of this paper avoids some disadvantages of the existing information systems. The developed timetable information system provides information on the optimal route in public transport between any places within Russia. Information allows for possible change between routes, intermodal routes, timetable and tickets available. The specialized database includes geographic information, regularly updated timetables of the public transport and implementation of algorithms to work with data. By means of graph creating program, the database has been uploaded with a number of transport graph fragments, which involves the majority of railway stations and stops in Russia and abroad and the main bus stations in several Russian regions.

Two main approaches are well-known for modelling timetable information as the shortest path problem: the time-expanded, and the time-dependent. Special algorithm that is used in developed information system to solve the problem with minimal number of transfers and the earliest arrival time criteria. Algorithm operates with converted data and uses generated transport graph that is similar to time-dependent model extended with auxiliary data. The advantage is as follows: auxiliary data can be recalculated locally. To get timetable information via Internet, we have developed a portal <http://transport.marshruty.ru> to access the timetable information system.

THE STRUCTURE OF KNOWLEDGE OBJECTS FOR KNOWLEDGE REPRESENTATION MODELS IN THE INTELLECTUAL TRANSPORT SYSTEMS

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Keywords: knowledge representation, knowledge models, structures of knowledge objects

The development of logistics centres in the territory of European Union and the perspectives for the creation of such kind of centres in the territory of Latvia actualise the problem of the exchange of “logistical knowledge”.

Information exchange in the logistics centres is complicated because of incompatibility of the structure of knowledge objects and models of their representation in various databases.

Nevertheless designing of intellectual transport systems (ITS) demands a special attention to a choice of knowledge representation models and the structure of knowledge objects [1].

In the scientific literature there is no generally accepted concept of “knowledge object”. The knowledge object is commonly understood as a certain structure of knowledge, consisting of six elements: knowledge type, notably concepts, attributes, values, rules and relationships [2]. So, for example, by definition of M. David Merrill “a knowledge object is a framework for identifying necessary knowledge components” [3].

The main element of knowledge object is its attributes that is the certain characteristics the set of which defines the specifics of knowledge object.

The aim of this research – to reveal possible attributes of knowledge object and to develop the approaches to formation of structure of knowledge object, which would allow creating the effective knowledge presentation model in the intellectual transport systems.

The results of the research will allow to choose the corresponding structure of knowledge objects for modelling the ITS objects and to ensure the exchange of “logistical knowledge”.

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IMPROVEMENT OF RAILWAY SAFETY BY APPLYING THE ADVANCED TECHNOLOGIES

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Keywords: information technologies, mobile transport system, railway traffic management, control and security systems

Only modern transport may reliably perform cargo and ensure efficiency and total safety of the economic process.

Information technologies provide us with new possibilities in organizing transport work.

Information systems can be used for electronic data registration of cargo. The necessity of mobile transport systems analysis is a base at globalisation and integration processes; interconnection of various types of transport means and their management in order to obtain more effective, safe and mobile freight motoring and the creation of the intelligent transport sector.

In the article the railway traffic management, control and security technological systems are examined. It also represents actual usage status of technologies in Lithuanian railway. The effectiveness valuation of these technologies is discussed.

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Session 4

Transport and Business Logistics

LOGISTICS SITUATION IN LITHUANIA – REVISERS' POINT OF VIEW

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Keywords: logistics, transport policy, survey

Surveys of logistics situation in Lithuania have been performed in Vilnius Gediminas Technical University in 2007. This survey discovered mostly relevant problems in logistics: costs policy, logistics competences, and personnel competence development requirements.

Survey results allowed predicating that logistics companies provide evolution in standardized service packages; it will increase from 10 % to 20 %. Warehousing services will be in the same position, but transportation amount will decrease from 60 % to 47 %. Companies are planning that Customized service package will reduce from 11 % to 8 %.

Analysis of relative trends of logistics service outsourcing we can predict that greatest expectations are connected with Logistics IT systems, 3PL/4PL services, international transportation and freight forwarding. In whole all logistics activities are related with additional cost and could be understandable as outsourcing (international transportation, domestic transportation, freight forwarding, order processing, invoicing, warehousing, inventory management, product customisation, 3PL/4PL service). Tendencies are positive for all logistics operations.

Survey results identified not good enough situation in the IT sector because companies are too much using traditional ICT facilities.

Some problematical points were identified on external collaboration of logistics operations: 29 % of the companies disagree and 24 % of the companies do not have clear position about their information systems exchange operational information with selected subcontractors and/or customers.

Contemporary Lithuania's logistics business system sustained very heavy losses from nowadays economical crisis, which started in the second part of 2008.

In the first stages of economical crisis the total consumption become sinking down and it made influence to logistics companies directly – a number of orders started to diminish. This situation made influence to competition in the logistics market. In 2007 the largest threats to logistics services were tightening competition and decrease in the demand of logistics services. It shows that companies' "feeling of the situation" are correct.

Another new actual point for analysis is the personnel. We can expect that personnel cost will decrease and companies will have possibilities to select competent employees from overfull labour market. Plausible that logistics companies will change personnel training policy – they will try to find qualified employees and save money for training. Crisis will have big influence to logistics market in Lithuania. Trade companies are acting in the enough stressful market conditions; the manufacturing companies have found their own place in the market; logistics companies are on the own market formation process.

In general we can predict that crisis will create clearer and stronger logistics market in Lithuania.

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ENHANCING BUSINESS RELIABILITY: IMPROVING VALUE-BASED MANAGEMENT BY MEASURING INVESTMENT ATTRACTIVENESS

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Keywords: indices, measuring, factors, a model "an open country", controllability, adaptability

The reliability of business is one of the key indices characterized the operation results of a working enterprise [1], [2]. The behaviour of the participants of business depends on these results [3] as well as the value made by them [4]. Traditionally such a set of a task comes to the concordance to the assessment of the results and managers' behaviour with the increase in value for shareholders. Such a concordance allows determining weak points, to show the development prospects of an enterprise as well as to assess each manager's contribution. The actual size of value-added of a relative basic variant is used as a measuring instrument. Moreover it is enough to measure the initial value and after that to manage the change of it's sensitiveness to value factors. One should set the targets correctly and follow their observance for the assessment of business reliability in the process of real functioning.

The probability of the business losses appearance under the influence of negative factors and the degree of the influence of such losses on the enterprise's value in the value prospect is defined in the process of value monitoring. However in spite of the perfection of the given business-instrument, the value management procedure of a functioning enterprise in the long-term prospects is limited by the reserve of setting controlled norms.

It is offered to include a new instrument representing the investment attractiveness assessment in such a procedure to overcome the stated drawback. The peculiarity of such an assessment consists in such a fact that it is held for new enterprises which don't have a practical pre-history [5]. The advantages of the investment attractiveness assessment consist in finding grounded norms. The inclusion of the new instrument based on the so-called model "an open country" in the procedure of the model assessment of an operating enterprise allows not only to link the incompatible assessment schemes but to increase enterprise's management by the improvement of controlled processes quality.

The improvement of processes quality leads to the increase in business reliability. The correctness of the given conclusion has been approved on the base of value assessment of the functioning multi-profile transport enterprise. Thus, the adaptability of the offering instrument in the given limits under the accordance of planned targets to obtained final results is shown.

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PRESENT SITUATION AND PERSPECTIVES OF HEAVY GOODS TRAFFIC IN LITHUANIA

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Keywords: heavy goods, transportation, costs, transportation environment

Technological and industrial development very often is connected with the heavy goods transportation. International and local transportation of heavy goods is regulated of set of legal acts.

The transportation cost of heavy goods consists of transportation cost profit, which company expects to receive. Price is related to technological environment. Special equipment for transportation heavy goods is very expensive and it also influences the final cost of transportation. Taxes, which company should pay for transportation of heavy goods, are also one of the components, which influence the cost of transportation. Therefore, it can be argued that the cost is related with the technological, financial and legal environments. It is identified, that in Lithuania heavy goods transportation cost mostly depends from legislative instruments.

Transportation of heavy goods in Lithuania has scarcely ever been analysed. Currently is very important for Lithuania to find a solution and the best transport corridors for heavy goods shipments from West part to the East part of the country. Plans to build new nuclear power stations in Lithuania and Belarus, projects for network of wind turbines as alternative energy source, means that requirements for heavy goods transportation in the nearest future will increase. That's why it's necessary to make deep analysis of Lithuania transport system (Klaipeda seaport, railways, road transport, internal water transport) and inspect all possibilities of transportation such oversize loads.

Usually heavy goods to Lithuania are delivered by sea. The first point which is important for such shipments is Klaipeda sea-port. From sea-port start all other transport modes, which could be useful for carrying not standard loads. The possibilities of transportation of heavy goods by road, railways, inland waterways and trans-shipping of the heavy goods in Klaipeda State Seaport must be inspected. This analysis will help to find the best solution how in cheapest way to transport heavy goods using possibilities of multimodal transport operations.

The quality of heavy goods transportation is related with companies ability for quick and cost effective transportation process.

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SOME METHODS OF DISTRIBUTED DATA BASE RELIABILITY CONTROL IN LOGISTICS INFORMATION SYSTEMS

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Keywords: distributed data base, transaction, reliability, control

In the structure of distributed data base (DDB) are used such abstract notion as consistency. In the article the notion of consistency applied to some methods of DDB reliability analysis are analysed. Consistency of data base (DB) is provided, if in a result of parallel work of transactions T_1, \dots, T_k the same correct result of DB is achieved as when in a result of transaction $(T_{c(1)}, \dots, T_{c(k)})$, where $c: \{1, \dots, k\} \rightarrow \{1, \dots, k\}$ – transposition) work in some sequence. None of the parallel transactions have to "see" DB's contradictory state that can appear during other transactions intermediate implementation stages. Such parallel performance of transactions is called quazisequence.

In order to provide consistency of DB special mechanisms of parallel transactions functioning are necessary. Parallelism of transactions is the phenomenon when between the actions of some transactions actions of other transactions are included. Transposition of transaction actions that do not break the order in each transaction we will call *a schedule*. The task is to find such schedule of parallel transaction groups, which would be equivalent to some schedule of in some sequence working transactions that means a schedule that fulfils criteria of consistency. Schedule that satisfies criteria of consistency we will call *safe* or *correct*.

The safety of the schedule of the transaction group determines the sufficient condition of DB's consistency, which actually is the mentioned above sufficient condition of quazisequence. However this condition is not necessary because not only safety schedules can lead to the DB consistency state. So, there can be two main ways to produce a parallel transaction guidance mechanism: the use of safety schedules to exclude inconsistency appearance and conflict detection with corresponding rollback of some transactions (delivering them back to the state they were in the beginning), if inconsistencies are found.

During the use of DDB the concepts of internal and external consistency are distinguished. Internal consistency is defined by integrity limitations and by DB correct state at separate DDB nodes.

By transaction rollback it is understood that transactions and by transactions modified data elements are put back into the starting position. Rollbacks can be caused by incorrectness in consistency or by integrity limitations, dead end situations, program failures, defects of hardware and user's specialized demands.

To maintain DDB external consistency it is not enough to have transportations services nets guaranty to deliver messages and to launch appropriate processes in the local nets. It is important to guaranty that changes in the DB are made and that they are made correctly. Distributed Transaction Management System should be protected against failures of different kinds.

The safety heightening of distributed systems is provided by special high two phased fixations level protocols modified into a three-phased one.

In DDB parallel transaction management new modified variants of blocking that put some limitations on the system are developed.

The application and testing of the research results has been made in the Oracle environment and it is supposed to be continued.

DEVELOPMENT OF REQUIREMENTS TOWARDS BUSINESS BY ITS PARTICIPANTS AS LIMITATIONS APPLICABLE TO INDIVIDUAL PARAMETERS OF COMPANY'S PERFORMANCE

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Keywords: business value, cash flows, requirements of participants, limitations

Global practice shows that the companies where management processes are considered from the perspective of increasing the final value are most competitive.

In this case, it is important to treat business as a system that consists of several elements (company, state, banks, other companies, population) interacting with one another and united by a common goal; at the same time, each of these elements aims at achieving its individual objectives. The criterion for the level of approaching the goal is the business value, whereas the goal is – utmost meeting interests of the owners under existing limitations for the maximum amount of requirements set by the other participants. If considered from this viewpoint, the value is an opinion of the interested business participant about the company management's capabilities to efficiently manage the company's performance.

Shareholders are the last applicants for a company's cash flows as the sequence of claims of payment participants is strictly defined: suppliers (raw materials and other materials), personnel (salary), creditors (interest payments), the state (tax payments), and management (motivation), shareholders (dividends). This particular sequence provides for interest of all the participants, primarily the owners whose claims have no preset top margin. Claims of all other participants are limited to labour agreements, contracts with suppliers and borrowers, state tax rates.

Therefore, a necessity occurs for each participant to develop clear requirements towards the business, which would acts as limitations applied to specific parameters of the company's performance such as income, operational profit, and profit before tax, etc. This would allow the shareholders obtain comprehensive information needed to make strategic decisions and to see how such decisions affect the value of the company.

The choice of value management methods is rarely defined with exact understanding of the set requirements for which clear limitations are specified. Most commonly, such choice is affected by modern cost management tools. At the same time, each new mechanism not only contributes to understanding of the limitations but also brings in several mistakes. In such cases, judging from the estimated needs of the participants, it is advised to study indefinite situations that might distort the company's balance. This allows discovering reasons of the emerging problems [1]. Therefore, prior to taking direct actions, it is important to improve methodological tools for understanding the true reality and searching efficient managerial solutions based on studying expectations of potential participants interested in the business [2]. Thus, setting of limitations necessary to prepare estimated requirements where problematic situations and threats would be included increases general manageability of the company. As a result, when non-standard situations able to misbalance the company actually occur, previously grounded actions are taken to neutralise the impact of potential threats. This triggers pre-planned enhancement of the company [3]. It is important to note that the decisions made are studied and information related to making such decisions is processed and accumulated. All this serves as a ground for

suggesting new executive requirements and limitations, for approving goals and results, for adjusting business processes, which, in its turn, would facilitate improvement of actual application of the value methodology.

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INSURER'S RISK MANAGEMENT FOR FINANCIAL STABILITY SUPPORT

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Keywords: risk management, insurer, financial stability

The most crucial aspect of insurance business is an insurer's ability to assess risk objectively and to manage risk [1,2]. There is a direct connection between risk taken by the insurance company (insurance risk) and risk related to insurance activity. The insurance activity differs considerably from other types of business. The main difference of insurance business is a tendency of an insurer to take risk of various economic subjects. In terms of the intensifying competition in the market of insurance services, an objective necessity of an adequate assessment of an insurer's activity, the analysis of the investment attractiveness and reliability degree arises [3]. The analysis of an insurer's reliability on behalf of an insured comes to the risk of fulfilment of obligation taken by an insurer. In accordance with the legislation of Latvia, an insurer is obliged to develop own policy of risk management including a procedure of risk assessment. At present, there are no appropriate approved complex methods. For determination of an insurer's policy of risk management an objective analysis of the financial activity is needed that is enough important when performing insurance in terms of the economic crisis. In this paper, some aspects of an insurer's financial state assessment and recommendations for risk management for a specific insurer in terms of the insurance market of Latvia in view of the EU Directives requirements on insurance are given for consideration.

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PRICE DISCRIMINATION AS THE CRISIS IMPACT DAMPER

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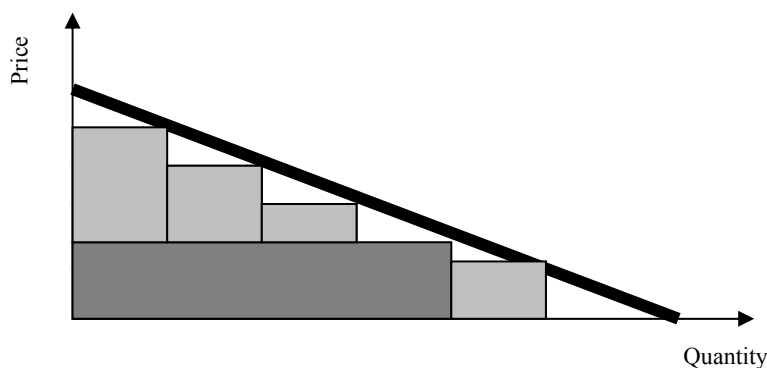
Keywords: price discrimination, economic cycles, consumer surplus

The adoption of pricing decisions and, consequently, the behaviour of the market participants, both on the demand and supply side, is realised through the existence, operation and taking into account the considerable number of factors being essential for each side. In addition to these two sides the process of price formation is influenced by the external environment with the particular role of the overall state of the economy, measured in the terms of the economic cycle phases. In many situations, their role is crucial in the pricing policies of companies. The aim of this paper is to examine the possibilities of price discrimination for softening the negative impact of the economic recession or crisis on the economic conditions of the company and on the society, as a whole.

It is quite obvious that during the economic downturn, and especially during the crisis on the demand side, with the overall reduction of the purchasing power, the growing separation of consumers takes place. On the supply side the problem of the overproduction aggravates the problems of sales resulting in the increased economic threat to producers.

In turn, price discrimination is a powerful tool that enables companies to increase their profits through the full or partial appropriation of consumer surplus. Necessary conditions, typology and the possibility of applying different types of price discrimination [1, 2] allow using the practice of discriminatory pricing and extending the conditions of economic downturn or crisis.

Expanding the range of the types of pricing in the increasing stratification of the consumers in many cases retains the access to goods (services) and consumers with low income. On the supply side the differentiated exception of consumer surplus from consumer groups with different incomes happens as a result of reducing the loss of profits and losses of companies. The figure below shows the increase in income of producers, as well as the availability of goods (services) to low-income consumers.



The dark rectangle is interpreted as the income of producers and consumers in the costs of a single price for the product (service). Light fragments show the growth of income as a result of price discrimination; located over a dark rectangle – for appropriation of consumer surplus; located right part – shows the growth of buyers with low income.

In general, price discrimination is the possibility of damp the impact of the crisis.

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ENHANCING THE INTELLECT OF THE COMPANY: IMPROVING MANAGERIAL PRINCIPLES' METHODOLOGY BY USING OPERATIONAL DEFINITIONS

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Keywords: a set of instruments, system, controllability, notion, procedure, sustainability, technology

The efficiency of adopted managerial methodology depends on formed managerial principles which should have an invariable character [1]. The given property explains the presence of the grounded efficient managerial instruments introducing the peculiar type of the enterprise's intellect. Such instruments should be practically suitable and understandable for people involved in the applied process [2].

The practical implementation of instruments becomes complicated because of the existing difference among managerial enterprise's principles by themselves (the principles of a process), and principles which are external regarding them (the principles of a system). In other words, the enterprise's principles, plunged in reality, become unrecognisable in a more complicated system. That is why an insignificant uncontrolled influence could lead to the loss of controllability. The elimination of this drawback occurs in the course of systematic-ness limit expansion by the investigation of non-systematic factors [3].

The system limits expansion increase in the organization's controllability. The conducted research of the given level of controllability and the degree of principles' permanency indicates of the sustainable growth of enterprise's development and the correctness of the chosen set of managerial instruments. Contrary indications explain non-actuality and imperfection of managerial enterprise's intellect. The four-stage procedure was elaborated for the verification of existing principles and forming new ones. In the format of this procedure the concordance of twenty research phases to twenty stages of activities is carried out.

The concordance is accomplished in the course of cyclic process management by implementing the balanced system of operation definitions. The sense put in principles is opened on the level of notions, which are transformed to concrete actions with the help of above mentioned operation determinants. As results of adopted transformations the technology allowed to determine the level of enterprise's managerial intellect rising on the base of value measuring was elaborated.

The approbation of the offered technology was conducted by example of transport enterprises.

The obtained results allow to judge about the suitability of technology, procedure efficiency, interdependence of operational definitions and organization's controllability.

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BUSINESS STRATEGY DEVELOPMENT IN VIEW OF ENTREPRENEURIAL ACTIVITY

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Keywords: strategy, planning, market relations, uncertainty conditions, unclaimed risk

The enterprise's dialectics and its entrepreneurial activity is the dialectics of a form and content. In modern conditions of economic crisis like in no other time it is necessary to understand that for saving and developing of a content a focus must be placed at the activity itself that has been a purpose of the enterprise's creation.

A development of the strategic plan is a system of consecutive decision-making at the corporative level assuming a determination of a target state, which the enterprise will strive for in its development [1]. But, to determine what out vision of the enterprise is in future, first of all, it is necessary to assess prospects and risks of business it is involved in.

There exists a set of risks that accompanies the enterprise's activity in terms of market economy. But, in spite of a type and area of the activity the enterprise faces the unclaimed manufactured product (service) risk.

The unclaimed product risk rise is influenced by various factors, but traditional approaches to classification of these factors describe just the visible sides of such phenomenon as an unclaimed product. Today such approach to this problem becomes absolutely unacceptable because it is necessary to find out a reason of an unclaimed product, but not its consequences that lie on the surface.

Such approach to classification of the unclaimed product risk factors will allow not only assessing reasons of an unclaimed product, but also will allow assessing prospects of these reasons overcoming.

Having assessment of various risk factors for each manufactured product (service) on the basis of taxonomic analysis of a set of estimates, it is possible to perform a division of products (services) in two subsets – perspective and non perspective.

For decision-making about prospects of product (service) in each area of activity it is necessary to choose a reference product (service) that is considered to be demanded at maximum. Consequently, standardized values of risk category for such reference product 0 will be defined as minimum among all values of the given risk category:

$$Z_{0j} = \min_i Z_{ij},$$

where Z_{ij} – standardized value of risk category j for product (service) i.

Thus, index of prospects of product (service) is interpreted in the following way: product (service) is more perspective the closer its value is to a reference one. At this, the enterprise's management must choose also a threshold value of prospects when they make decision to develop the given product (service) taking into consideration the level of this product unclaimed risk.

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THE GENERAL CONCLUSIONS OF DIAGNOSING MODELS OF SHIPPING COMPANIES FINANCIAL STATE FOR RELIABILITY OF THEIR FUNCTIONING

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Keywords: classification, demands, key fields, stability, decision-making methods

The sustained development of business is impossible without reliable diagnoses connected with a concrete financial state in a concrete moment of time. The degree of reliability depends on existing diagnosing system in the enterprise. The principal defect of traditional diagnosing system is connected with using of bookkeeping registered forms as initial information. At the same time, the obtained ultimate results of financial activity are inexact because of the made errors and accepted assumptions.

The Goal of this paper is the development of financial state diagnosing new approach in short-term perspective. Beforehand diagnosing models classification has been taken. As a result, the demands, which must be suitable for the suggested approach have been determined. At first, it is necessary to take account of the specific features of Latvian transport sector. At second, it must be supplied the methodological unity of weighting indicators. At third, the approach must be based on reconstructed business information, this have a positive attitude towards the quality of delivered diagnosis. To perform the made demands the complex of structural indicators has been developed. This complex takes into account the revealed factors, which influence the key fields of business.

The evaluation of business key fields on the basis of BSC (Balanced Scorecard) lets to determine its financial state. The whole set of diagnoses all over fields gives the right to evaluate the whole financial state of the enterprise. Controlling of the delivered indicators during the time gives the possibility to estimate the stability of the enterprise. Developed criteria of stability were the basis for the evaluation of the enterprise's financial reliability linked to reliable diagnosis level. The evaluation of reliability is made on the basis of the suggested decision-making methods.

The approbation of the method limited of this developed diagnosing new approach has been taken the following example of Latvian transport company, by which the transformation registration information in business by taking into account the revealed logistics financial cycle phase has been used. The received results are the evidence of the efficiency of the discussed approach.

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Session 5

Innovations in Education and Research

INNOVATIVE VIRTUAL EUROPEAN TRANSPORT TRAINING AGENCY

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Keywords: transport, training, education

The creation of a united European transport market without restrictions or barriers to access, based on harmonised conditions of competition, is becoming one of the principal objectives of common transport policy in Europe.

In the same way as transport systems, processes and services operate in an increasingly more European framework, transport education and training need to change their contents taking international aspects and globalization into consideration and move from conventional to networked environments. Even initial transport education processes at vocational and higher education levels must be a part of these dynamic changes to enable their graduates to meet employers' needs and perform at the market.

The establishment of Innovative Virtual European Transport Training Agency (IVETTA) is one of the steps toward this direction.

The IVETTA is an educational network of persons and institutions involved in transport education and training and interested in supporting it by use of multimedia and information technologies. It focuses on enabling transport educators and trainers to introduce any kinds of educational multimedia, new technologies and common standards to their educational processes as knowledgeable consumers or well acquainted supervisors or even to become enthusiastic multimedia developers. For this, there is required not only an appropriate technological infrastructure but also an organizational basis and culture encouraging collaboration and exchange to the benefit of all of the network's members.

The mission of IVETTA is creation of standards for the development and adoption of technologies that enable high-quality, accessible, and affordable transport education and training experiences. IVETTA will be enabling the next generation of Digital Learning Services, combining new forms of digital content, assessment, applications, and administrative services.

Strategic goal of IVETTA is increasing quality and safety of all mode of transport on the base of high quality standards in the life long education and training and common network of training, industry and maintenance organizations.

Paper describes main objectives, innovation strategy focuses, main activities of future network co-operation and results, expected to be worked out by the IVETTA.

THE POPULARITY OF STUDY PROGRAMMES IN AVIATION AREA AMONG THE APPLICANTS TO LITHUANIAN HIGHER SCHOOLS

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Keywords: aviation, higher schools of Lithuania, applicants, joint admission, study programmes, statistical data, competition, competitiveness index, motivation index, average competitive mark, popularity

The integration of Lithuania to the European Union made transport (including air transport) one of the most important branches of national economy. Presently, economic development is hardly possible without an efficient transport system (providing both local and international transportation via aircrafts).

The operation of industrial, construction and agricultural enterprises as well as work efficiency and public opinion largely depend on the reliability and effective performance of air transport systems which is not possible without qualified specialists in aviation area (bachelors and masters).

The paper presents requirements raised for controlling the abilities and level of educating specialists in aviation area. Specialists in aviation area are trained at vocational and higher schools of Lithuania.

Experts in the field of aviation are trained at two university-level higher schools in Lithuania (Bachelors, Masters and Doctors) including Vilnius Gediminas Technical University and The General Jonas Žemaitis Military Academy of Lithuania (the introduced higher schools are located in Vilnius, the capital of Lithuania). Although both study programmes taught at the above- mentioned higher schools cover the area of aviation, there are some differences discussed in the paper.

A brief survey of admission to Lithuanian higher schools is analysed in the article, as well as some statistical data on the popularity of study programmes chosen by the applicants participating in the joint admission programme to Lithuanian higher schools, and the popularity of the study programmes of aviation (competition, competitiveness indices and average competitive marks and motivation indices) available at two higher schools of Lithuania is described.

INTELLIGENT AGENTS' IMPLEMENTATION FOR STUDY PROCESS QUALITY PERFORMANCE INDICATORS' STATISTICAL ANALYSIS

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Keywords: Analytical System, OLAP-technology and Data Marts, complex indicators, quality indicators

The purpose of the paper is to present the methodology and its implementation results in the field of statistical research of TTI study process trends by using intelligent agents.

The article describes how to use mobile agents for data retrieving, computing and monitoring Quality Performance Indicators (KPI), defining the objective, quantitative indicators of the quality of the education process generally and in the selected area.

The studies presented in the article accepted the paradigm of the distributed computing and the underlying mobile agent (mobile agents) as a basis. The mobile agent is understood as the essence combining the data, code and the ability to move between different runtimes.

In this research 3 main tasks of the information management process are being solved:

- Information searching, collecting and processing. A combination of search agents is used.
- Data monitoring. The agents are used for notifying the user of changes in the various data sources in real time.
- Universal access to data. Agents are used as brokers working with different data sources, with mechanisms of the interaction with each other.

Key Performance Indicators, also known as KPI or Key Success Indicators (KSI), help the institution to define and to measure the progress toward organizational goals.

The Key Performance Indicators are quantifiable measurements, reflecting the critical success factors of the organization. The higher school may focus its Key Performance Indicators on the graduation rates of its students. Whenever the Key Performance Indicators are selected they should reflect the organization goals and the key to its success, and they must be quantifiable (measurable).

Considering the educational process and criteria for its quality, the following complex indicators can be integrated:

- quality indicators of educational content;
- quality indicators of earning technology;
- quality indicators of educational results.

From the other side, some investigators focus on the following five complex indicators:

- Graduate Employment;
- Graduate Satisfaction;
- Employer's Satisfaction;
- Student's Satisfaction;
- Graduation Rate.

This investigation is considering only one of the TTI realised programs quality, i.e. the higher professional study program "Transport and Business Logistics".

USE OF SIMULATION MODELLING FOR SUPPORT OF DECISION-MAKING ON PURPOSE OF INTRODUCING NEW PRODUCT TO THE MARKET

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Keywords: modelling, decision-making, discrete-event approach, agent modelling

Modern entrepreneurship exists in the circumstances of extremely intense competition which especially intensifies in the period of economic crisis along with general decrease of consumer demand. In such circumstances the search for new possibilities for business development for many companies is the only possibility of keeping business. One of the ways of such development can be offering to consumer new goods or services. Introduction of new products to the market is always connected with risk because it implies high level of uncertainty. To reduce such risk the company needs to have such tools and technologies that help its management take reasonable administrative decisions immediately. The use of simulation modelling can help develop such tools.

This article describes the simulation model which could be used by the company's management to support the process of decision-making for the purpose of identifying necessary resources and risks in the course of introducing a new product to the market. The object of this research is business process of the company that prevents emergency situations in the radius of 50 km from Riga. The package of simulation modelling AnyLogic 6.3 has been used as a tool. While forming the model two approaches have being used: agent modelling and discrete-event approach. As a result of synthesis of these approaches it is possible, on the one hand, to describe in detail business process of emergency elimination but on the other hand to specify individual characteristics of the company's customers [1].

The use of the offered simulation model allows the company's management to try on different scenarios of development of this model and on the basis of findings to take more well-considered and reasonable decisions.

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Session 6

**Applications
of Mathematical Methods
to Logistics and Business**

INVESTIGATION OF THE MATHEMATICAL MODEL FOR MUTUAL ACQUITTANCE OF ACCOUNTS PAYABLE AND ACCOUNTS RECEIVABLE

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Keywords: Keynesian investment multiplier, debtor's matrix, liquidity function, liquidation of indebtedness, mathematical model of mutual acquittance

In the fundamental work [1] J.M.Keynes for the first time in history investigated possible influence of financial variables on "physical" balance of the goods, services and employment. Keynes's theory has been essentially transformed by D.Patinkin to a series of works conducted since 1947 (see [2]): Keynes's model is deeply transformed by means of including to it the fourth market – a security market, or the financial market.

D.Patinkin's major critical remarks regarding the theory of J.M.Keynes are reduced to the following: the mentioned theory doesn't make any difference between various forms of cash assets – absolutely liquid forms of assets as well as various forms of investments; the model of general balance is deduced without an explanation how this balance is reached (from the definition given by J.M.Keynes, it is impossible to understand, which mechanism returns the price to its equilibrium level in case of deviations); models are constructed on the basis of the flows motion analysis (i.e. acquisition of money or securities), but not on the stock mobility (i.e. aspiration to distribute property between various forms of assets).

The interconnection revealed by J.M.Keynes and D.Patinkin between the total level of production of goods and services (and, hence, the income) and money volume brings an attention to the point of multiplication relation between the total level of production and level of investments. Using Keynes's theory and results of Patankin, J.Denizet has shown in fundamental work [3] some ambiguity of expression of the Keynesian investment multiplier

$$Y = \frac{\text{investments}}{1 - c} = \frac{\text{primary debt}}{1 - c}, \quad (1)$$

where Y – is a volume of production; $c = \frac{C}{R}$ – is a propensity to consumption; C – is a consumption level, R – is an revenue.

The essence of the J.Denizet theory is rooted in the statement that a source, generating the multiplier, is regarded to be not the investments I , but appearance of money in an economic float. Investments represent only a consequence of these additional financial resources. While at ordinary interpretation it is considered to be that exactly additional investments generate simultaneously both additional economic activity and the credit ("if there would be an investments – the credit will be"), J.Denizet suggests on the contrary to recognize that an injection of money or the credit defines simultaneously both investments and manufacture: "if there would be a credit – investments will be". If it is accepted the point of view stating that exactly a cash flow generates the multiplier, then it is necessary to specify a question on a source of the financial resources required by the enterprises in order to make the additional investments.

In this work, based on the ideas stated in works [4-5] (see, also [6-11]) we construct and investigate the mathematical model for mutual acquittance of accounts payable and accounts receivable originated interplant. Besides, in the present work in accordance with Keynesian investment multiplier the concept of "debts' settlement multiplier" is introduced; debts' settlement function is constructed; properties of a "indebtedness's matrix" are established, and on the basis of these properties methods of "refusal impulse" and "credit impulse" for finding of effective trajectories of discharge the mutual indebtedness are offered; the minimum sum required for a complete liquidation of mutual indebtedness between the enterprises is determined.

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ABOUT CHOICE OF MATHEMATICAL APPARATUS FOR RESEARCH OF DYNAMICS OF EXHAUST GASES IN CITY ATMOSPHERE

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Keywords: anthropogenic pollutions, exhaust gases, mathematical statistics, dynamics, partial differential equations, mathematical physics equations

Anthropogenic pollution of atmosphere and water the city environment refers to ecological problems. The first place among anthropological sources of city atmosphere air pollution in big cities occupies auto transport. The role of the major anthropogenic pollution source is constantly increasing in relation to a significant increase of automobile park.

City atmosphere is a complicated dynamical system wherein different physical-chemical processes take place, which intensity depends on concrete characteristics of the city. In order to describe complicated atmosphere processes, which are often turbulent, it is necessary to develop a complex mathematical model which allows solving a wide range of tasks in environment protection field.

The question arises about the use of optimal mathematical apparatus for developing the model. The use of mathematical statistics apparatus [1, 2] is based on the results of single and integral measures of the environment quality. In particular, the determination of the dynamics of the change of concentration of exhaust gases in the city atmosphere is related to a problem of measurement accuracy. Even if increasing the measurement accuracy, the measurement frequency, it is not possible to judge of the condition of atmosphere air in dynamically changing city conditions. As a rule, it is not possible to place control-measuring apparatus into a large amount of points of the city. Moreover, statistical measurements are very costly. There appears a need of searching for another research instrument.

In current work a classical apparatus of partial differential equations and a competent apparatus of mathematical physics are offered as an instrument for city atmosphere pollution by vehicles problem investigation. The choice of these two mathematical apparatus as city atmosphere pollution by vehicles problem research instrument is related to the following factors [3, 4]:

- mathematical physics apparatus allows to use fundamental physics laws (turbulent and molecular diffusion laws, transfer in inhomogeneous mediums laws, hydro and gas dynamics laws etc) for the determination of the dynamics of concentration of exhaust gases in the city atmosphere air upon condition that the velocity of an air flow is not a priori known. Since all mentioned fundamental physics laws are described by partial differential equations, built mathematical model will be unconditionally described in terms and symbols of differential equations;
- partial differential equations apparatus allows analysing these equations, to investigate their correctness, stability against small changes in the initial data, to build a solution by numerical or mathematical methods.

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ANALYSIS OF PROBABILISTIC MODELS OF COMMUNICATION NETWORKS

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Keywords: random access, unsteady flow, asymptotic analysis

The improvement of data processing is one of the most challenging problems for computer network creators and developers. When choosing structures and characteristics of computer networks in practice, frequently priority is given to the classical techniques and decisions [1]. However, a closer research and disclosure of potential opportunities of networks of data transmission, is promoted by carrying out mathematical modelling [2, 3]. Mathematical modelling gives the possibility to predict the behaviour of the network under certain conditions without the physical realisation of the network itself.

We investigated the processes in real computer networks of casual access [4]. In such networks one main problem is the maintenance of multiple accesses to the general environment of data transmission. Hence, a major role is played by the knowledge of laws and the parametric parities taking place at the distribution of a resource.

In this work, mathematical models of computer networks of casual access in the form of mass service systems with a source of repeated calls and the notification about the conflict with marcovize streams of entering requirements are constructed. A modified method of asymptotic analysis to investigate mathematical models of casual access network, both at transitive and at stationary level of functioning, was developed [5]. We investigated stochastic and temporal characteristics of the quality of the functioning of computer networks such as the p.d.f. of the number of messages in the source of repeated calls, the average time of stable functioning, throughput capacity, etc.

From the practical point of view, our conclusions are based on analytical methods, the results of experimental tests, imitating modelling and numerical analysis. The practical value of the work consists in the results of scientific research to promote the carrying out a complex analysis, an optimisation and a disclosing of potential opportunities of telecommunication systems of data transmission.

Thus, in the work, we develop theoretical background and provide scientifically solid technical decisions that are applicable in the efficient design and optimisation of computer networks, operated by reports of casual access.

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STRATEGIC CAPACITY PLANNING USING STOCK CONTROL MODEL

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Keywords: capacity planning, stock control, stochastic demand

Process of strategic capacity planning could be viewed as the stochastic model of stock management. Let us suppose that the need of product in the year τ ($\tau = 1, 2, \dots$) is described as a stochastic process Q_τ with independent increments. Let us refer to the increment $Q_{\tau+1} - Q_\tau = \omega_\tau$ as the “demand” in the year τ of the planned period, where the value of production capacities at the beginning of the year τ is equal to M_τ , the difference $M_\tau - Q_\tau$ will be referred to as the “level of stocks” in the year τ .

As the growth of capacities developed in the year τ is used to meet the need for products of the year $\tau+1$, the value of delay of supply in respect of the present model of stock management is equal to $\lambda = 1$ (the consignment ordered in the segment τ is supplied in the segment $\tau + \lambda$).

Let us introduce the following symbols reflecting different stages of the process of replenishing of stocks:

i_τ – the level of available stocks at the beginning of the segment τ until supply of the previous year; $i_\tau = M_{\tau-1} - Q_\tau$ or, this may be considered as the level of stocks at the end of the first year;

q_τ – the quantity of stocks ordered in the segment τ , or the growth of production capacities in the year τ ;

h_τ – the level of stocks at the beginning of the segment τ available to meet the demand in the segment of τ , that is, the available amount of stocks i_τ plus the supplied amount of stocks ordered at the beginning of the segment τ , or $h_\tau = i_\tau + q_{\tau-1}$; hence, h_τ is the level of available stocks after supply of the previous year; let us consider that such are stocks at the beginning of the year τ ; if $\omega_0 = Q_1$, then the level of stocks at the beginning of the year τ is expressed by means of the demand $\omega_{\tau-1}$ in the following manner: $h_\tau = M_\tau - \omega_{\tau-1}$;

j_τ – the level of available stocks at the beginning of the segment τ plus the amount ordered until the beginning of τ and by the taking of the next decision on replenishing of the stocks; that is, $j_\tau = i_\tau + q_{\tau-1}$; we can see that the numerical values of h_τ and j_τ are equal, however j_τ stands for the value of stocks expected or planned by the taking of the decision, whereas h_τ stands for the actual value following the replenishment; the numerical values of the variables j_τ and h_τ are in this case identical, because the model does not identify as separate (there is no such necessity) the ordering in the year τ (taking of a decision regarding q_τ) and the delivery of the stocks ordered in the year τ , we can regard both as taking place simultaneously, from 31 December of the year $(\tau - 1)$ to 1 January of the year τ ;

y_τ – the planned level of stocks at the beginning of the year τ plus the amount ordered in the segment τ , however without taking into account the demand of the current year, that is, $y_\tau = h_\tau + q_\tau$ or $y_\tau = M_\tau - Q_\tau + q_\tau$.

The amount of stocks available to meet the demand in the segment $\tau + 1$ will be equal to

$$h_{\tau+1} = y_\tau - \omega_\tau. \quad (1)$$

Therefore, in order to meet the demand of the year τ $\omega_\tau = Q_{\tau+1} - Q_\tau$ and by the taking of a decision regarding the next period $\tau+1$, we obtain the level of available stocks h_τ . Following a decision concerning the value of growth of capacities q_τ , the level of stocks will be equal to y_τ , and to meet the demand of the next year we will have $h_{\tau+1} = y_\tau - \omega_\tau$ according to (1).

In the model of stock management, the objective function takes the form of the discounted aggregate amount of costs expected in each period.

The use of stock management model allows identifying the type of optimal strategy of production capacities. Namely, the optimal strategy of development for the infinite planning period is determined by two values: s and S . The development of capacities takes places only when the level of stocks decreases to the critical level s and the stocks are replenished up to the level S . In the case of a finite planning period, the optimal strategy of replenishing of stocks depends on the initial level of stocks and is determined by the set of pairs (s_τ, S_τ) , i.e., the planning period of each year has its own critical level of stocks s_τ and the level S_τ up to which the stocks are replenished.

INVESTIGATION OF NON-DETERMINED URBAN TRAFFIC FLOW IN THE PRESENCE OF "INTELLECTUALLY-DIRECTED" FORCES

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Keywords: non-determined urban traffic model, traffic flow density, sensitivity coefficient, "intellectually-directed" forces, conservative force field

In contrast to the previous authors' research works [1-5], in present paper it is supposed that in transport system there exist "intellectually-directed" forces which influence the vehicles to drive in the certain direction. As in the given work it is proceeded the determined traffic flows motion, the assumption of "intellectually-directed" forces presence in transport system while constructing the mathematical model obliges to take into account probabilistic vehicle "jumps" from any node of a discrete grid to the neighbouring nodes to the left and to the right under the condition, that the difference between these pair probabilities is directly proportional to the "intellectually-directed" influencing forces. In order to describe above-mentioned forces the concept of "conservative force field" is introduced:

$$q\left(m + \frac{1}{2}, n + \frac{1}{2}\right) \approx C \cdot \frac{p_1 \cdot U(m, n) - p_2 \cdot U(m+1, n)}{\Delta t},$$

where q is the traffic flux level; C is the proportionality coefficient; $U(m, n)$ is the vehicles quantity at time moment $n \cdot \Delta t$ at point with coordinates $m \cdot \Delta x$, i.e.

$$U(m, n+1) \approx \frac{U(m-1, n) + U(m+1, n)}{2}; p_1 \text{ and } p_2 \text{ are the jumping probability of vehicles to}$$

the neighbouring nodes, at that $p_1 + p_2 = 1$.

Finally, after performing of limiting transition from probabilistic discrete model to the non-deterministic continuous model, the equation is obtained, that occurs to be similar to the well-known Fokker-Plank equation in the statistical physics.

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Session 7

Intelligent Transport Systems (Electronics)

FILTER AND MATRIX STRUCTURE ALGORITHMS OF SIGNAL PREDICTION

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Keywords: discrete signals, linear signal prediction, high selective filters, transfer function, hankel matrix, zero of matrix determinant

This work developed the new algorithms and corresponding programs complex for predicting the discrete consecutions.

The only demand of the filter – based algorithms for discrete time sequences means that that they should be within the known frequency band. Therefore the synthesis of prediction filters can be realized by means of the well-known methods, for example, by the MATLAB Filter Design Toolbox. The work suggested the variants of predictors, which are designed on the basis of FIR and IIR – filter structures.

The matrix method is intended for predicting the discrete consecutions which can be well approximated with finite set of harmonic components with the space-tapered frequencies. Being new, this method has no analogy in the domain of design point wise predictors. This method is distinguished by the relatively simplicity and easy calculations for predicting the next samples of time sequences.

The application significance of this research work is confirmed by the fact that it can be used in the areas where it is necessary to know the next sample values of the observed time processes, for example, in the aviation controller service – for predicting the aircraft motion path and for preventing the air incidents in advance.

This work made the review of the well-known linear prediction methods and compared these methods in accuracy according to the specified class of the discrete consecutions.

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NUMERICAL ALGORITHMS TO PERFORMANCE ANALYSIS OF MULTI-PARAMETRIC CAC IN MULTI-SERVICE CELLULAR WIRELESS NETWORKS

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Keywords: cellular networks, call admission control, quality of service, calculation algorithm

There are three solutions for channels allocation problem in cellular wireless network (CWN): Fixed Channel Allocation (FCA), Dynamic Channel Allocation (DCA) and Hybrid Channel Allocation (HCA). Advantages and disadvantages of each of these are well known. At the same time, owing to realization simplicity, FCA scheme is widely used in existing cellular networks. In this paper models with FCA schemes are considered. Quality of service (QoS) in the certain cell with FCA scheme could be improved if rational call admission control (CAC) strategies for the heterogeneous traffics are provided. Use of such access strategy doesn't require much resource, therefore this method could be considered operative and more defensible for solution of resource shortage problem.

Apart from original (or new) calls (o-calls) flows additional classes of calls that require special approach also exist in wireless cellular networks. These are the so-called handover calls (h-calls). This is specific only for wireless cellular networks. The essence of this phenomenon is that moving MS, that already established connection with network, passes boundaries between cells and gets served by new cell. From a new cell's point of view this is h-call, and since the connection with MS has already established, MS handling transfer to new cell must be transparent for user. In other words, in wireless networks the call may occupy channels from different cells several times during call duration, which means that channel occupation period is not the same as call duration.

Mathematical models of call handling processes in multi-service CWN can be developed adequately enough based on theory of networks of queue with different type of calls and random topology. Such models are researched poorly in literature. This is explained by the fact, that despite elegance of those models, in practice they are useful only for small dimensional networks and with some limiting simplifying assumptions that are contrary to fact in real functioning wireless networks. In connection with that, in majority of research works models of an isolated cell are analysed.

In the overwhelming majority of available works one-dimensional (1-D) queuing models of call handling processes in an isolated cell of mono-service CWN are proposed. However these models can not describe studying processes in multi-service CWN since in such networks calls of heterogeneous traffics are quite different with respect to their bandwidth requirement and arrival rate and channel occupancy time. In connection with that in the given paper new two-dimensional (2-D) queuing models of multi-service networks are developed.

In order to be specific we consider integrated voice/data CWN. In such networks voice calls (v-calls) are more susceptible to possible losses and delays than data (original or handover) call (d-calls). That is why a number of different CAC strategies for prioritisation of v-calls are suggested in various works, mostly implying use of guard channels (or cut-off strategy) for high priority calls and/or threshold strategies which restrict the number of low priority calls in channels.

In this paper we propose the refined approximate algorithms to performance analysis of multi-parametric CAC in a single cell of un-buffered integrated voice/data CWN. Our approach

is based on the principles of theory of phase merging of stochastic systems. The proposed approach allows overcoming an assumption made in almost all of the known papers about equality of handling intensities of heterogeneous calls. Due to this assumption the functioning of the CWN is described with one-dimensional Markov chain (1-D MC) and authors managed simple formulas for calculating the QoS metrics of the system. However the assumption of the same mean channel occupancy time even for both original and handover calls of the same class is unrealistic. The presented models are more general in terms of handling intensities and the equality is no longer required.

In this paper we provide simple algorithms to calculate approximate values of desired QoS metrics of the model of integrated voice/data networks under CAC based on guard channels strategy and give results of numerical experiments, which indicate high accuracy of proposed approximate algorithms.

COVERAGE ENSURING FOR WIRELESS NETWORK SERVICE AREA WITH OBSTACLES

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Keywords: wireless networks, coverage, service area, obstacle

Service area coverage problem has existed and still remains a fundamental issue in construction of wireless networks. Most of known investigations, concerned with optimal (in sense of ensuring of necessary coverage level at every point in service area) deployment of networks' nodes, i.e., with optimal network topology, study the problem on the assumption that wireless network service area is free from obstacles, impeding normal propagation of information signals [1-2]. As a result, suggested network topologies become far from optimal at presence of obstacles within serviced area. More realistic solution presumes taking into account of obstacles within the serviced area. Possible approaches for efficient placement of wireless network nodes on condition that service area contains obstacles are discussed at present work. Problem is examined from two points of view: as a probabilistic task, as well as a task of computational geometry.

The investigation is resulted in some algorithms and considerations for near to optimal deployment of nodes within network service zone with obstacles.

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PSEUDOCEPSTRAL ANALYSIS OF ELECTROMAGNETIC TRANSIENTS USING EMPIRICAL MODE DECOMPOSITION

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Keywords: non-stationary signal, logarithmic spectrum, cepstrum, empirical mode decomposition

An increasing interest in non-stationary transient electromagnetic (EM) signals analysis has permanently observed in areas such as radar, communication systems, natural EM phenomena and many others. A linear model is frequently introduced as a description of that signals. It has supposed that the signal is formed through linear combination of some pulses which arrive to the observation point along non-coincided paths. Mutual delays of pulses depend on differences of these paths' lengths, features of propagation trace for every separate pulse as well as properties of radiation source. Just the delays determine the inherent structure of the transient. Therefore, evaluation of delays from the observed time series is one from primary steps to decide goal inverse problem, namely reconstruction separate traces and radiator characteristics using appropriate signal processing method.

Frequently, only unique non-repeated realization of transient is available. Natural EM phenomena as pulses (spherics) radiated by lightning discharges are just the exact case. Collection of methods for estimating delays of their internal structural components is rather poor. A common way used is to apply the cepstrum analysis. It is conceptually based on three steps: (a) direct Fourier transformation (FT) to find the signal spectrum; (b) calculating the logarithmic spectrum; (c) inverse FT of the latter to compute the cepstrum. Mathematically, the FT possesses known lacks itself. Particularly, FT is not fully adequate for non-stationary signal processing. In addition, cepstral algorithms run successfully if the following conditions are kept: (1) signal has sufficient duration; (2) inherent structure of it is periodical; (3) signal-to-noise ratio should be sufficiently large. As a rule, natural EM transients have not complied with conditions (1) and (2).

The aim of this paper is to develop alternative approach to process non-repeated EM transients in order to estimate their inherent structure. The proposal is based on empirical mode decomposition (EMD). Originating from analysis of signal envelopes EMD permits to expand any signals (including non-stationary and non-linear ones) into a little amount of quasi-harmonic components named intrinsic mode functions (IMF). Instantaneous frequency analysis of IMFs is accomplished with Hilbert's transform. The result is an analogy of FT spectrum. After logarithmic of the latter it is proposed to apply the EMD to expand the log-spectrum into new IMFs too. Instantaneous frequency analysis of their IMFs creates a certain "quasi-cepstrum". It demonstrates an estimation of inherent structure of the signal under the consideration.

As a result it is worked out the set of Matlab programs to illustrate the use the EMD procedures for EM transient processing and to compare it with FT. Some conclusions are presented for the spherics registered on different distances from lightning strokes.

INFLUENCE OF GENETIC ALGORITHM PARAMETERS ON SOLUTION OF INVERSE STRUCTURAL PROBLEM FOR RADAR SUBSURFACE PROBING

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Keywords: radar, roadways, radar monitoring, inverse problem, genetic algorithm

The interpretation of radar measurements in form estimation of electrical and physical properties of the explored object is an inverse problem of radar subsurface probing, which is in general ill-posed and non unique. Available method of the inverse problem solution for radar monitoring of roadway coverage utilize comparison of direct solutions for a roadway coverage structure with the measured data in frequency domain in a range where inverse problem has a single stable solution [1]. For practical using of this method mathematical model of radar reflected signals forming channel is developed [2], as well as, electromagnetic model of roadway internal structure.

The inverse problem is investigated numerically, using simulation of reflected signal forming channel model for shock excitation of transmitting antenna. For search of global minimum of aim functional is used genetic algorithm [1, 3].

Results of the reflected signal spectrum calculations compare with these for model signal spectrum, which calculated for all search range of data on electrical properties of probing object.

The decision process of reverse problem is completed, if aim functional A will become less, than value of threshold α [1]. The value of threshold α is set with the use of middle power of spectral constituents, used for the calculation of aim functional A [4]. The value of roadway coverage electro physical parameter determined as a mean value 100 results of inverse problem solution.

A genetic algorithm has characterized the set of parameters and operators. It is necessary so to set the values of these parameters and operators, to minimize the errors of reconstruction of roadway coverage electro physical parameters. We investigated influencing on reconstruction accuracy of the model parameters of the following factors: number of population into generation, coding alphabet of an estimated parameters, number of bit per parameter, probability of mutation, method of selection. Dependences of reconstruction relative errors of roadway coverage electro physical parameters are collected from these factors.

Influence is explored of number of spectral constituents, used for the calculation of aim functional A , on a reconstruction error of the roadway coverage electro physical parameters.

Signals and their spectral density, expected with the use of the reconstructed electro physical parameters, will be presented in this work. The main results of the reconstruction are the following:

- the optimum ranges of genetic algorithm parameters are certain, in sense of reconstruction minimum errors of the model parameters;
- influence of genetic algorithm operators is estimated on results and time of decision of reverse structural problem of radar probing;
- the got dependences can be used for development of reverse searching problem algorithm of radar probing;
- estimations of efficiency of genetic algorithm operators must be taken into account during its hardware representation.

These results has an important practical influence for technical realization of genetic algorithms on base of Programmable Logic Integrated Circuits or Signal Processors.

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Session 8

Aviation

SPATIAL COMPETITION FOR PASSENGERS AND ITS INFLUENCE ON EFFICIENCY OF EUROPEAN AIRPORTS

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Keywords: stochastic frontier, efficiency, airport, spatial competition

This study deals with estimation of European airports' efficiency values and their interrelation with a level of competition for passengers between airports.

We apply a stochastic frontier model [1] to estimate efficiencies of airports. The method is based on construction of a production frontier for a sample of airports and estimation of individual airports' efficiency values as distances from this frontier. We use a classic production approach to airport activities, where an airport enterprise uses labour resources (a number of employees) and infrastructure (a number of runways and check-ins) for transportation of passengers.

Classic economic theory asserts a strong relation between a level of competition and enterprises' operation efficiencies. We investigate this statement in case of imperfect spatial competition for passengers between airports.

Measurement of a competition level is another main task of this research; we propose a new method for estimation a level of competitive pressure on airports. The method is based on overlapping of airport's potential catchment's areas [2], and we propose an adaptive approach for catchment's area definition. A standard approach based on a fixed distance/travel time circles is not working well in a heterogeneous environment.

Also we use a re-sampling jack-knife technique to test the reliability of airports' efficiencies estimates.

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FATIGUE-PRONE AIRFRAME INSPECTION PROGRAM CONTROL

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Keywords: inspection program, Markov's chains, reliability

Failure probability calculation for inspection program control is offered to do using theory of Markov's chains. The inspection process with n inspections is presented as Markov's chains with $n+4$ states. First $n+1$ states, E_i , $i=1, \dots, n+1$, represent aircraft operation in the appropriate interval between two consequent inspections. Three additional states represent aircraft withdrawal from the service due to the successful end of service when the specified life period is over, E_{n+2} (or SL-state); due to fatigue failure, E_{n+3} (or FF-state) and crack detection during a inspection, E_{n+4} (or CD-state). The basic transition probability matrix (MTP) of this process should be defined taking into account that simultaneously there are N aircraft in operation. It supposed that when the first crack is discovered in the fleet we can make repair of corresponding aircraft (we suppose that this repair eliminate the possibility of this aircraft failure up to SL) and after additional analysis of a new discovered crack we change the frequency of inspections of the remaining $(N-1)$ aircraft. Suppose that in the following we will not change the inspection program for any aircraft. The possibility of change of frequency at the n inspections can be described by introduction of n “quasi-absorbing” states, which really are the beginning of new MC. So to initial inspection program with n inspections now corresponds one stem-MC and n branch-MC. Stem-MC has $(n+1)$ transient states, 3 initial absorbing states (SL, FF and CD) and n additional “quasi-absorbing” states (E_{CD1}, \dots, E_{CDn}). MTP of branch-MC is similar to basic matrix of MC. If crack was detected at k -th inspection of N aircraft (“branch” appears after k intervals of operation) then the first k lines of branch-MTP coincide with the same lines of basic MTP. The following m lines correspond to new planned m inspections and the last three lines – to 3 initial absorbing states (SL, FF and CD). Branch -MTP should be calculated for one aircraft in operation. The optimal changes of initial inspection program can be founded by analysis of new information realised after discovering of fatigue crack. We suppose that the strategy of corresponding decision-making is fixed before the beginning of aircraft park operation. Thus, there are n possibilities to switch to the new inspection program, generating a set of $(n+1)$ possible realizations (or scenarios) of the random inspection program, $\{IP^0, IP^1, IP^2, \dots, IP^n\}$. Let $b = \{b_0, b_1, b_2, \dots, b_n\}$, where b_i , $i=1, \dots, n$, is a probability to discover a crack during i -th inspection in accordance with initial program, $i=1, \dots, n$, $b_0 = 1 - \sum_{i=1}^n b_i$. The total failure probability of the random inspection program can be presented as a sum of at least one failure probabilities of all scenarios multiplied by the probabilities of these scenarios to realize: $p_f = p_{f0} + \sum_{i=1}^n (b_i \cdot (1 - (1 - p_{fi})^{N-1}))$, where p_{f0} is a failure probability of at least one aircraft in accordance with initial inspection program; p_{fi} , $i=1, \dots, n$, is a probability of failure of one aircraft with the inspection program chosen after crack discovery at i -th inspection of initial inspection program.

DIAGNOSTICS MODELS IN EXPERT SYSTEMS OF MEASURING THE STATUS CONDITION OF THE AIRCRAFT POWER PLANTS

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The specific features of modern air gas-turbine engines (GTE) are the complexity of their construction, wide application of automated electric systems, of developed mechanization and of sophisticated laws of control for achieving the required characteristics. High sophistication of the aviation technical means suggested a great variety of the methods of controlling and diagnosing GTE, both instrumental and mathematical methods included.

One of the promising trends of the GTE effective control and diagnostics is application of complex intellectual computer technologies, namely, the systems based on different knowledge of hybrid expert systems (ES) [1]. Hybrid ES present different types of knowledge, such as conceptual, expert and fact-graphic, and the corresponding methods of their processing.

The main task in developing hybrid systems is to find the best combination of different forms and methods of knowledge processing in the process of taking decisions of the diagnostics ES, that is the actual task of the present paper is research of an optimal combination of different mechanisms for processing knowledge with the aim of increasing quality, mobility and efficiency of ES in solving the tasks of the GTE diagnostics and control under the condition of uncertainty.

Integration of the ES in the onboard system of the engine control and diagnostics and in the ground automated control systems allows efficient evaluation of the GTE status condition in the current moment and revealing the correspondence of its parameters to the tactical-technical requirements, and working out recommendations for its further exploitation if necessary.

A diagnostic task, in its general case, is the task of revealing the degree of correspondence of the technical object to the necessary requirements and we can differ between two main tasks: a direct diagnostic task or the task of controlling the technical condition and a reverse diagnostic task or the task of detecting the fault.

A diagnostic model is any knowledge used in the process of solving a diagnostic task and presented in a particular form. Each diagnostic model used to reveal the defect is required for as follows: building the algorithms of diagnosing and building a pattern model of the diagnostics object.

In solving a reverse task, which is a search and detection of the defect, the knowledge base should normally include three types of knowledge [1]:

- *knowledge of possible defects*, of their causes and of their direct and indirect indicators;
- *knowledge of the structural organisation of the diagnostics object*; this is knowledge of the functional processes occurring in the object of diagnostics;
- *knowledge of possible diagnostic experiments*.

In the given paper there are considered some types of diagnostics systems: mathematical, stochastic and logical, which could be used in developing expert systems for evaluating the aircraft power plants' technical state as demonstrated by the engines TB-3-117 and PS-90A.

The considered diagnostics models give us three kinds of knowledge, which allow qualitative diagnosis of the air engine. The first diagnostics model (Bayes' scheme) is based the probability-statistical methods, its disadvantage is that quite a lot of statistical material is needed; but after that material has been accumulated, it is conducive to the correction of the other two models. The diagnostics model based on diagnostics matrixes may also in its turn

bring about correction of the logical diagnostics model. Such mutual models' complementation allows full realisation of the defect search and detection and measurement of the engine technical status condition.

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METHOD OF AUTOMATIC BALLOON COORDINATES DETERMINATION USING THE CORRELATION EXTREME SYSTEM

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Keywords: balloons, navigation, magnetic field, correlation extreme systems

Balloons are successfully used for the scientific researches for a good while. Application of balloon gives great possibilities to the researcher.

Some Russian scientists such as Ciolkovskiy specified prophetically of them: "Under reaching exemplary a 40 km of height above the head of aeronaut remains only 1/400 stake of all mass of atmosphere" [1]. This circumstance appears very comfortable for the performance of astronomic and geophysical supervisions. On all these reasons a balloon with appearance of new generation of research rockets and space satellites has not lost the value. Interest to it does not weaken the importance of carrying out of scientific experiments presently.

To the terms of autonomous exactly enough determination of coordinates regardless of time and distance of flight most fully satisfies the correlation extreme system (CES), principle of action of which consists in comparing of measurable intensity of the in-use physical field of Earth to a priori information about this field, kept in a memory [2].

On a balloon as signals of such rough system it is possible to use information about a prognosis trajectory, compliable for every flight, namely prognosis speed V_{pr} to prognosis direction φ_{pr} .

Analysing all variety of the spatial and superficial fields of Earth from point of application in balloon CES, it is foremost necessary to stress upon the magnetic field of Earth (MFE).

This choice is made by that MFE it is well enough studied, its maps are made, the methods of count of elements of MFE are developed upwards [4].

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SURVEILLANCE DATA REGRESSION ANALYSIS

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Keywords: surveillance data, regression analysis, prediction

The possibility of data regression analysis from different surveillance sources is being discussed. Special attention is paid to surveillance data analysis from multilateration systems and its conversion from Decart to polar coordinates. Analysis has been made in MATLAB program. Aircraft that had been passing Latvia on 14th of April, 2009 was taken as an example.

Stated analysis showed regression for different types of surveillance data sources. This possibility to use regression analysis for prediction of aircraft trajectory calculation will be used in the following steps of the research work.

It is widely known that for the moment the so-called Kalman and alfa-beta filter is being used for such prediction. Regression in power of 10 (for example) can be used instead. In this case only a question of operating speed of computers could arise.

The second moment that should be considered is an analysis of manoeuvring targets whose the following point would not be possible to predict.

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DEVELOPMENT OF META-MODEL FOR ATC SERVICE PROCESSES BY USAGE OF MULTIDIMENSIONAL MODELLING METHOD

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Keywords: multidimensional modelling, modules of metaframe, questionnaire and dimension tables, ATC modelling cubes, metric controlled Meta model cubes, practical examples

Business Processes supported by IT Services is one of the critical factors of the mission of modern Air Traffic Control Providers (ATC). Particularly ATC companies are highly dependent on their technical process know-how and on delivering a safe and efficient ATC Services. During research of dissertation by different ATC providers it has been observed that no general meta-model for ATC technical services exists.

On the base of multidimensional modelling method the approach for modelling and design of a general ATC meta-model in context to ITIL Standard and ISO 20000 standard has been performed. The results of this research are used of further optimisation and increasing of harmonization of the ATC technical service processes.

The focus of research is to develop a universal high level multidimensional model for technical ATC services, because over medium term period it will be essential on the European ATC market to change from a national oriented ATC provider to a global European ATC service provider, which is able to support the ATC Business on a standard technical service process model. With respect to the Single European Sky program from the European Commission and the activities of different national ATC service providers to create international functional airspace blocks a metaframe or meta multidimensional process model of technical services should be the basis for standardization of ATC technical services and be able to change from a national ATC-provider with their own best practices to a European global ATC provider.

An essential prerequisite for globalisation of European ATC market is to develop a global and standardized ATC process model. Based on the developed ATC meta-model technical services can be designed and described by dimension tables, the information cubes. The ATC meta-model shall be the basis for high level description by scientific methods and can be used as input information for the specific ATC process management and monitoring.

The goal of meta frame model by multidimensional modelling is to investigate into standardization of ATC technical process landscape, to design specific key performance parameter for evaluation and benchmarking and to derive technical expertise for a migration of own specific technical processes to a general standardized meta process model of AIS Services. For that reason the research will present different number of data / information cubes and dimensional tables. The main result of the research is the developed Meta ATC Process model.

RESEARCH AND ANALYSIS OF ANOMALOUS MAGNETIC FIELD OF EARTH'S STATISTICAL DESCRIPTIONS IN HIGH GEOGRAPHICAL LATITUDES

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Keywords: magnetic field, high latitudes, statistical descriptions

Anomalous magnetic field of Earth (AMFE) has been well enough studied, there are maps, made from data of surface, marine and air surveys. There are air magnetometer, intended for measuring of the magnetic field aboard aircrafts (Ferro probe, proton, quantum) and possessing good static and dynamic properties [1; 3].

At the same time AMFE in northern regions higher 60 has specific features.

The first feature consists in the following – on this territory located both north part of the Eurasian continent and adjoining to it exterminating the Arctic Ocean. Each of these regions possesses the characteristic structure of AMFE. The second feature is as follows – in high breadths most intensive and most credible to variation (indignations) of AMFE.

The purpose of this article is to research and analyse the statistical descriptions of AMFE in high geographical latitudes.

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Session 9

Simulation: Practical Issues

APPLICATION OF ENGINEERING MATHEMATICS AND OPERATIONS RESEARCH TO SOLVE MODERN LOGISTICS PROBLEMS

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At the beginning of the presentation the versions of interpretation of concepts of the “engineering mathematics” and “operations research” applied in the area of science and education are discussed. The present idea about a correlation between mathematical modelling, computer simulation and optimisation is explained. Dynamics of the logistic systems development, starting from the 70-ties till our days from the point of view of problems` character, for which solution the mathematical methods are used, is shown. Typical setting of calculation and optimisation problems that are met in the area of production, transport and commercial logistics are considered.

As a conclusion of the presentation a set of optimisation problems that appear within the frames of the project for creation and operation of the electro-mobile in the region of Harz in the central Germany are discussed.

MICROSCOPIC DISCRETE EVENT URBAN TRAFFIC MODEL VALIDATION USING SIMULATION

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Keywords: discrete event, simulation, validation, n-lns, Petri nets

In this abstract a microscopic discrete event urban traffic model validation using simulation is presented. In a previous study a hierarchical microscopic model [1] was developed. This model integrates the event oriented and agent-based approach. An urban traffic system (UTS) could be described using the proposed model with the next definition:

Definition 1. The UTS is a 3-tuple, defined by $UTS = (3\text{-LNS}, \{Si\}, \{Agti\})$ where:

- 3-LNS is the environment and agent (vehicle) definition using the 3-LNS Petri net formalism (see Fig. 1).
- $\{Si\}$ represents the set of descriptions for the streets on the system.
- $\{Agti\}$ represents the set of descriptions for the agents on the system.

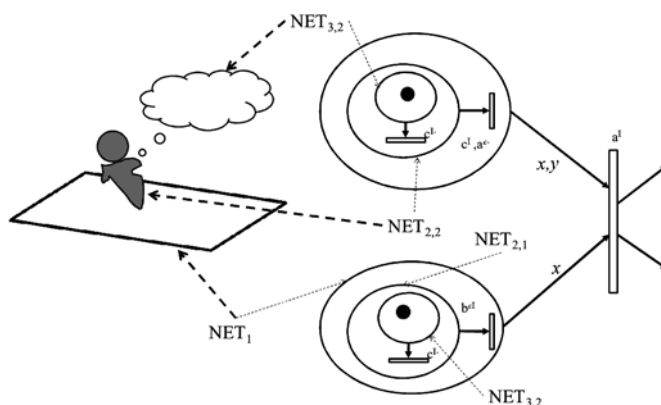


Fig. 1. Multi-Agent Event Oriented System

Usually simulators are designed using time step approach and are validated using real data and is verified that the flow/density relationship (fundamental diagram) are conserved and established that the simulator generates a valid behaviour. However, the model used in this paper uses the event oriented approach, doing more complex the process to obtain these validation graphs and their corresponding analysis. In order to validate it, a library known as *CiudadelaSim* [1] was developed. The system is open-source and free, and is an effort from CINVESTAV Computer Science Department. *CiudadelaSim* may be downloaded at <http://sites.google.com/site/ciudadelasim/>. *CiudadelaSim* is not derived from any other toolkit, but rather was built from scratch from multi-agent event oriented principles previously proposed [1]. Our design philosophy was to build a fast, orthogonal, minimal model library to which an experienced Java programmer can easily add features, rather than one with many domain-specific, intertwined features which are difficult to remove or modify.

This model is evaluated via one relatively simple case study using *ciudadelaSim* [1] library that is an implementation of the UTS model. After preliminary site visits, with help from personnel from Guadalajara Transport Department (GTD), a case study location was identified.

The selected test site first was coded into SUMO simulation program. The SUMO [2] is an open source microscopic road traffic simulation package. It was primarily designed for urban street networks, but it might also be used for highway traffic simulations. The data collected and provided by GTD was introduced to SUMO and then obtained the corresponding queues and service level for the case study. To account for variability in field data, multiple days of data were collected.

The test case consisted of two main arterial with two actuated signalised intersections. The study site experiences heavy congestion even during non-peak periods. Due to its congested traffic conditions, the network was expected to have unique driving behaviours. Fig. 2 shows a map of the site, and also displays locations of field data collection (PM XXX).

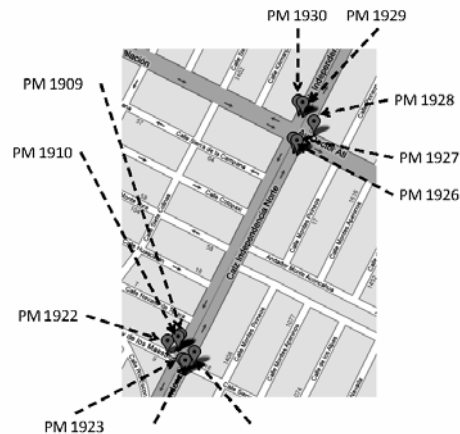


Fig. 2. Data Collection Locations of Test Site :Av. Doctor Atl-Calz. Independencia and Av. de los Maestros-Calz. Independencia Norte

The density-flow relationship for one of the main arterials obtained from the *CiudadelaSim* simulation is shown on Fig. 3. The x axis shows the density and y axis the flow. Observe how the fundamental diagram of flow-density is conserved. Also the queues length obtained with SUMO tests coincides with the ones obtained with our simulator.

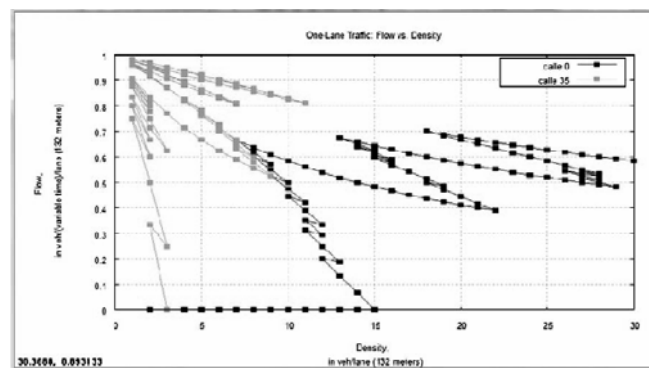


Fig. 3. Density-Flow Relationship Diagram

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EVENT SIMULATION FOR RELIABILITY AND FUNCTIONAL ANALYSIS OF DISCRETE TRANSPORT SYSTEMS

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Keywords: discrete transport system, reliability, Monte-Carlo simulation

The paper describes a novel approach to analysis of discrete transport systems (DTS) realized using Scalable Simulation Framework (SSF). The proposed method is based on modelling and simulating of the system's behaviour. Monte Carlo simulation is a tool for proper reliability and functional parameters calculation. No restriction on the system structure and on a kind of distribution is the main advantage of the method. The system is described by the formal model, which includes reliability and functional parameters of DTS.

The model is based on the real transport system of the Polish Post. The DTS is modelled as a triple:

$$DTS = \langle C, BS, TI \rangle, \quad (1)$$

where: C – is client model, BS – is business service provided by the system, and TI – technical infrastructure of the system.

The technical infrastructure of DTS could be described by four elements:

$$TI_{DTS\text{CNTT}} = \langle N, V, TT \rangle, \quad (2)$$

where: N – set of nodes; V – set of vehicles; TT – vehicles' time-table.

Set of nodes: We have a single central node and a given number of ordinary nodes. The distance between each two nodes is given.

Vehicles: is described by following functional and reliability parameters.

Time-Table: Vehicles operate according to the time-table exactly as city buses or intercity coaches.

Business service (BS) of the DTS is the transportation of mails from any node to any other node in the system.

The model is a base for development an event-driven simulator. It has been implemented using the Scalable Simulation Framework (SSF). The simulator allows as follows:

- determining what will cause a „local” change in the system,
- making experiments in case of increasing system performance,
- identifying weak point of the system by comparing few its configuration,
- better understanding how the system behaves.

Based on the results of simulation it is possible to create different metrics to analyse the system in case of reliability, functional and economic case. The availability and average availability of the system is introduced – defined in a functional way by delayed tasks realization. The metric is discussed as a function of different essential parameters when the DTS is organized. The authors point out the problem of influence of the reliability parameters for final system functional measures (required time of delivery). The proposal of the economic quality measure related to the discrete transport system is also presented. The paper includes some exemplar systems – based on real Polish Post DTS. Results received from real systems allow for critical situations analysis related to DTS. The critical situation is understood as

sudden shortage of some system resources resulting in the transport system performance degradation. The problems described in the paper are practically essential for defining an organization of vehicle maintenance and transport system logistics.

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DEVELOPMENT OF RIGA-MINSK TRANSPORT CORRIDOR SIMULATION MODEL

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Keywords: transport corridor, macroscopic model, simulation

For the last years relationship between Latvia and Republic of Byelorussia has become very close. This conclusion is based on the statistical data which describe goods turnover between two countries. Another reason is connected with the fact that both Latvia and Republic of Byelorussia are transit countries and this opportunity is highly used by both of them. The object of research is a transport corridor between capitals of these two countries, Riga and Minsk. In this paper only part of this corridor from Riga to Latvian border is described; it is connected with lack of data about the second part of transport corridor. The main goal of described research is to locate bottlenecks of this corridor and estimate different indexes of its functioning. Also different development scenarios should be implemented and compared using simulation models.

The simulation models are selected because of their flexibility on playing different scenarios and analysis possibilities. The traffic could be simulated on different levels [1]. These levels are as follows: microscopic, mesoscopic and macroscopic. Because of simulation object complexity and its physical distribution the microscopic models could be applied only for simulation some parts of transport corridor [2], but not for whole transport corridor. The mesoscopic models could simulate such distributed objects [3], but the traffic mesoscopic models are not widely distributed. Macroscopic models are specially designed for simulation such models [4]. Macroscopic transport model consists of two models: demand model, which describes journeys and network model, which describes transport infrastructure. These models are used as an input for impact models which is presented by public transport model, private transport model and emission model [5]. This hierarchy of models could describe the technology of simulation on macro level. The base steps could be described as follows:

- Nodes and nodes parameters definition – nodes present crossroads and junctions.
- Link and link parameters definition – links present roads in the model.
- Transport zone definition.
- Connector's definition – connectors define connection between transport zone and transport infrastructure.
- Origin-Destination matrix definition (OD matrix) – presents information about journey number from one zone to another.

For Riga-Minsk transport corridor simulation model construction PTV VISION VISUM 11.0 [6] software has been used. The transport infrastructure, which consists from nodes and links, is created based on scaled map of the simulation region. The transport zones are defined according border check point location. Totally 13 transport zones have been defined. OD matrix is calculated basing on traffic observation and TFlowFuzzy method application for model calibration.

This paper presents the description of use macroscopic model for modelling of transport corridor and also presents the numerical results of simulation for different scenarios. The output results are presented graphically and like matrix of different indexes.

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APPLICATION OF AGENT BASED SIMULATION APPROACH FOR THE BANK DEPARTMENT FUNCTIONING ANALYSIS

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Keywords: system analyses, agent-based simulation modelling, business process organisation, bank to bank transfers, budget, process efficiency, experimentation

In the conditions of deterioration of the economic conjuncture for financial stability maintenance of enterprises, a primary targets are business processes optimisation and efficiency increasing. One of the extremely effective ways of the system analyses is the simulation modelling. It is one of the powerful tools of the system analyses and optimisation. The simulation is used for designing systems, i.e., to explore the implications of different design alternatives. Depending on the level of the system description abstraction there can be used different approaches of simulation: system dynamic, discrete-event simulation and agent-based simulation [1]. The last one is the modern approach for the complex system investigation with the high level of its particularity. The agent-based approach usually is used for the exploring the system which behaviour is a result of different types of dynamic entities interactions [1, 2]. The multi-agent metaphor, perceiving a dynamic system as a community of autonomously interacting entities, has started permeating many application areas of modelling and simulation [1]. This paper presents the results of agent based simulation approach application in the bank's area.

It was considered the problem of the bank to bank payment department efficiency increasing and annual budget minimisation. The main bank department responsibility to process and investigate bank to bank payments using SWIFT telecommunication network, advise customers via phone and email. During the workflow investigation some hypothesis has been proposed that the present logic of work organisation causes inefficient distribution of the resources and as result high expenses and time delays. The last one is very crucial index of payments processing efficiency. It was decided to implement the model of the department functioning using the agent-based approach. There were implemented several types of agents: operators, SWIFT messages, phone calls and emails. They interact and influence each other and as a result the model reproduces the logic of real system functioning. The model is implemented on the base of simulation modelling tool AnyLogic, which supports the agent-based approach [4]. The implemented model can be used as forecasting tool which gives possibility, by changing the input parameters, to estimate different scenarios of work organization at the bank departments.

The results of experimentation allow defining different options of working process organization, which gives the capability to reduce expenses and to improve efficiency of work.

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THEORETICAL SIMULATIONS OF NANO-ELECTRONIC DEVICES: *QUANTUM DOTS, NANOWIRES AND CARBON NANOTUBES*

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Keywords: Carbon nanotubes, CNT-Ni interconnects, *ab initio* electronic structure calculation, nanowires, quantum dots, effective media approximation, multiple scattering theory

The miniaturization of electronic devices, the high integration level and increase of the operation frequencies and power density require the use of adequate materials and innovative chip interconnects and vias, to avoid a bottleneck in the existing technologies. Fundamental efforts are directed on the special kinds of nanosystems such as quantum dots, quantum nanowires and nanotubes. Quantum dots, also known as nanocrystals, are a non-traditional type of semiconductor with limitless applications as an enabling material across many industries. They are unique class of semiconductor, because they are so small, ranging from 2-10 nm. (10-50 atoms) in diameter (Figure 1).

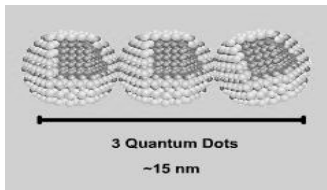


Figure 1. Quantum dots

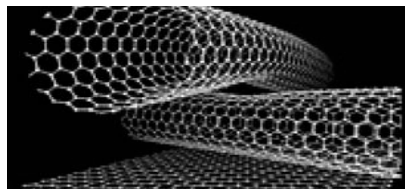


Figure 2. Carbon nanotubes

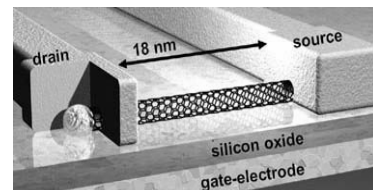


Figure 3. Model of nanoelectronic device

Basic attention is paid to carbon nanotubes (CNTs), including their contacts with other conducting elements of a nanocircuit. Due to the unique physical properties, CNTs attract permanently growing technological interest, for example as promising candidates for nanointerconnects in a future high-speed electronics (Figures 2,3).

Discovered in 1991 by Iijima and co-workers, carbon nanotubes have quickly become one of the most popular materials in nanoscience and nanotechnology, drawing the interest of researchers worldwide. Many potential applications have been investigated, largely based on theoretical and experimental results, including: conductive and high-strength composites; energy storage and energy conversion devices; sensors; field emission displays and radiation sources; nanometre-sized semiconductor devices, probes, and interconnects. In this seminar, the speaker will provide an overview of on-going research of carbon nanotubes, including: controlled synthesis, structural characterization, electronic manipulation, and potential applications.

The scattering theory approach gives a possibility to calculate an electronic structure and elastic properties of condensed media, which should be considered as a static phenomenon. At the same time, this approach is convenient for the electron transport simulation which is a dynamical problem. A computational procedure developed for these calculations [1] is based on construction of the cluster potentials and evaluation of the *S*- and *T*-matrices for scattering and transfer, respectively. Certain simplifications are necessary to obtain reliable results. For instance, CPA (coherent-potential approximation [1]) is considered as an effective-medium-approach (EMA). The specific conductivity (σ) can be evaluated through the Kubo-Greenwood

formalism [1-3] or in simple cases using the Drude-type formula. The temperature and frequency properties and are also considered.

Simulations of conductivity and resistivity of CNT are performed using the multiple scattering theory and effective media cluster approach.

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SIMULATION MODELS OF RELIABILITY ESTIMATION OF INFORMATION SYSTEMS

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Keywords: reliability, information system, Markov's chain, availability, downtime, stochastic Petri nets

Now, elements of information system have a high reliability. But structures of information systems are often complex. Therefore reliability of providing information and data (for example, from servers) are possible be much worse than the reliability of elements of system. The methods of increase of reliability of databases are known [1] but the scales of systems are increased. Lately, the questions of improvement reliability of large-scale storage systems get more attention (see, for example, [2]). Some developers use special structure methods for increasing reliability [3]. The typical schemes of information systems of enterprises and their reliability models are considered in the report. Stochastic Petri nets (as simulation models) and theory of markovian random processes had been used for evaluation of reliability indexes.

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SIMULATION FOR MEASURING INSULATION RESISTANCE IN THE ON-BOARD POWER SUPPLY SYSTEM

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Keywords: on-board power system; model; insulation resistance

1. Introduction

The circuits of functional hardware connections to the source of current in the real on-board systems are of network type. Obviously, the power network is a long line of discrete inhomogeneities. In practice, the preferred type of connection of functional systems with a power supply is a parallel connection of devices with bus power [1].

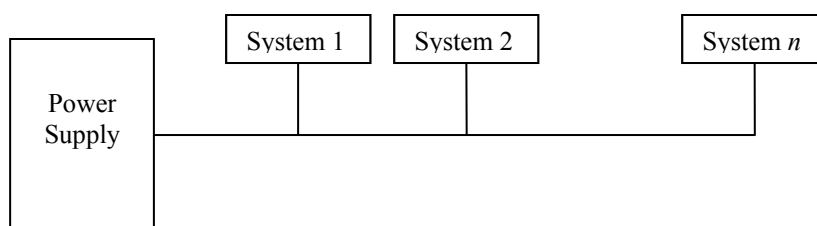


Fig. 1. The structure of the on-board power supply network

During the operation, consumers can be connected and disconnected from the on-board power network. In such a situation, an important function of control system is a continuous insulation resistance testing.

It is known [2] that the homogeneous line is described by differential equations of the form:

$$-\frac{\partial U}{\partial x} = L^* \frac{\partial I}{\partial t} + R^*$$

$$-\frac{\partial I}{\partial x} = G^* U + C^* \frac{\partial U}{\partial t}.$$

Here R^* , L^* , G^* , C^* -, respectively, the unit values of resistance, inductance, conductance and capacitance of the isolation. Due to the capacity and insulation resistance of each connected user, in this context when switching users, the changing process occurs. The duration of the transition process in the network is in dozens or hundreds of times greater than the length of the transition process that occurs in chains of consumers.

2. The equivalent circuit model to determine characteristics of on-board power network

We will take the assumption of homogeneity of the electrical characteristics of the cable [3]. Through the analysis of the equations can be shown that the general equivalent electrical circuit of on-board power supply network can be greatly simplified.

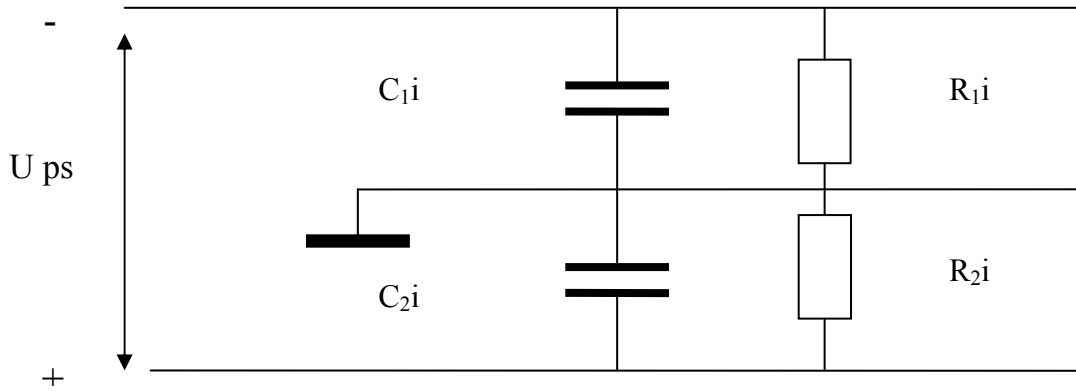


Fig. 2. Simplified equivalent circuit of on-board power supply network

On Figure 2 is presented the equivalent electrical circuit. Here C_{1i} , C_{2i} , R_{1i} , R_{2i} , ($i = \overline{1, n}$) of capacity and insulation resistance between the bus (+) and the case; bus (-) and the case.

Model of on-board power supply network of Figure 2 with great accuracy makes it possible to describe transient processes occurring in the power when changing insulation resistance between the tires and body. Commutation of consumer makes the following features:

At time t_j , where $j = \overline{0, k}$, number of connected users is changing, it leads to a change in the network parameters $C_{1i}, C_{2i}, R_{1i}, R_{2i}$, where $i = \overline{1, k}$ the number of time intervals $\Delta t_i = t_{j+1} - t_j$, during which the values do not change their values. To monitor the condition of insulation on-board power supply network is necessary in each time interval Δt_i ($i = \overline{1, k}$) to determine the values R_{1i} and R_{2i} .

Such a model can be described by a system of transcendental equations [4], numerical solution of which can be quite complex and resource intensive process for the on-board test systems, in this regard, the method of measurement is introduced, which allows to move to the solution of algebraic equations.

To determine R_{1i} and R_{2i} on measurements of voltage during the transition process is necessary to introduce an artificial switching resistance R_L on a bus and case. In this case the system of algebraic equations allows for the measurement of voltage in the transition process to determine the value of insulation resistance between the body and tires, without waiting for the end of the transition process.

$$R_{1i} = U_{PS} R_L \left(\frac{2U_{5i} - U_{4i} - U_{6i}}{U_{5i}^2 - U_{6i}U_{4i}} - \frac{2U_{2i} - U_{1i} - U_{3i}}{U_{2i}^2 - U_{1i}U_{3i}} \right)$$

$$R_{2i} = U_{PS} R_L \frac{(U_{2i}^2 - U_{1i}U_{3i})(2U_{5i} - U_{4i} - U_{6i}) - (2U_{2i} - U_{1i} - U_{3i})(U_{5i}^2 - U_{4i}U_{6i})}{[U_{PS}(2U_{2i} - U_{1i} - U_{3i}) - U_{2i}^2 + U_{1i}U_{3i}][U_{5i}^2 - U_{4i}U_{6i}]}$$

where U_{PS} – DC voltage, U_{1i}, U_{2i}, U_{3i} – voltage between the case and the tire (+) at the relevant time, the first, second and third measurements, U_{4i} – tension between the shell and the tire (+) at time of connection of additional load R_L , U_{5i}, U_{6i} – voltage between the shell and the tire (+) in consecutive points in time when the additional load is connected. i defines the state of the object of control $i = \overline{1, k}$.

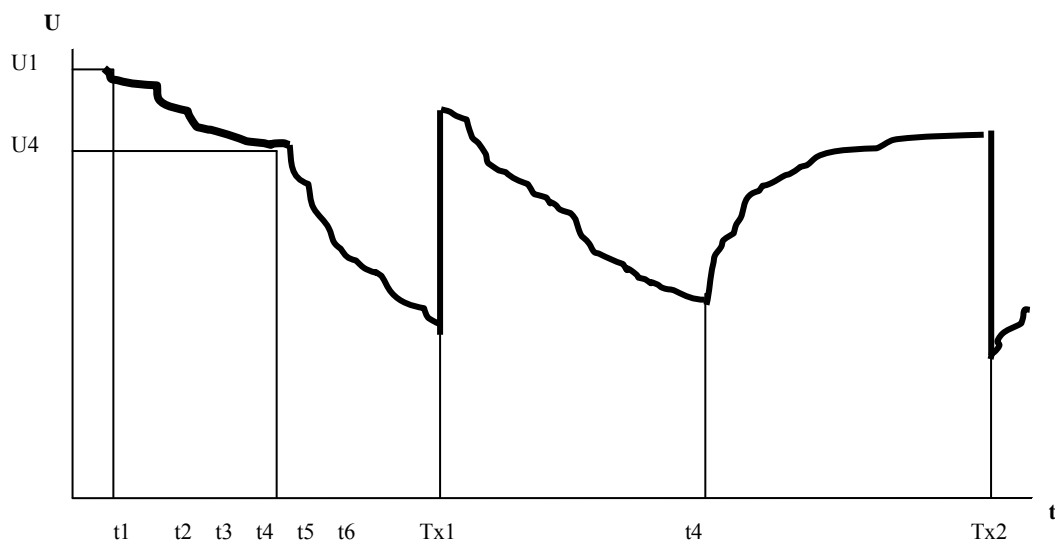


Fig.3. Time-voltage measurements to determine the parameters of power network.
 t_4 – point of connection of additional load. Tx – the time of consumers switching

3. The main results of statistical modelling

We have study the errors of indirect measurements of insulation resistance on the basis of statistical modelling of transient processes in the on-board catering. We consider two cases for the distribution function of model parameters on-board network (R_1, R_2, C_1, C_2), and it was considered a uniform and normal distribution parameters. The distribution of time intervals between changes of state of the on-board network has to be uniform. As a result, modelling it was found that mean square error of measurement does not exceed 3% and the probability of detecting an emergency condition of on-board network ($R_{1,2} \leq 50K\Omega$) is not worse than 0.997. The most optimal time interval between the values measured and the additional resistance load are 0.1 seconds and 100Ω , respectively.

Conclusions

In the on-board power system is extremely important the availability of test systems what provides a continuous control of insulation resistance in an environment when the connection and disconnection of consumers in some random moments of time take place. Transient processes in such a system is quite complex, but with an acceptable degree of precision on-board power supply system can be simplified with equivalent circuit and a method can be proposed for continuous measurement of insulation resistance. Statistical study of the proposed method showed acceptable accuracy and it was defined the optimal parameters, typical for this method.

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CREATION OF MODELS OF AN ADJUSTABLE CROSSROADS ON GPSS

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Keywords: traffic light, adaptive steering, simulation

Introduction

Creation and introduction of any expensive system prior to begin working it out it is necessary to make sure of its necessity. Modelling is for this purpose applied. Modelling is made for revealing of properties of objects, forecasting of the future condition or behaviour of object, a finding of dependences between characteristics and parameters, definition of optimum values of parameters of objects.

Model structure

At construction of model on the basis of the theory of mass service it is possible to present a crossroads as system with four serving devices and four streams of demands. The scheme is shown on Figure 1.

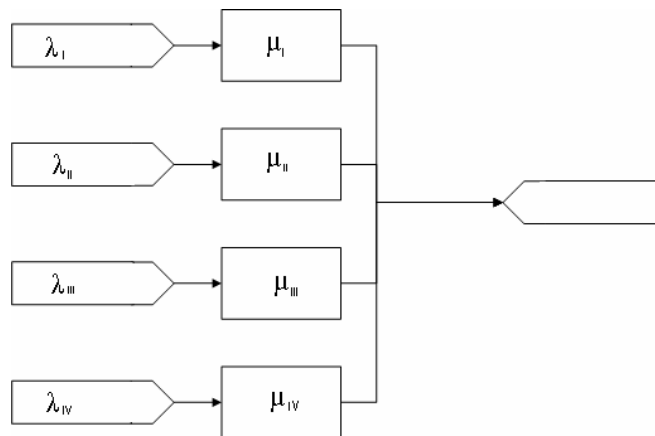


Figure 1. Modelling of crossroads

Delay time in serving devices depends on duration of phases of a traffic light, and as transient time. Intensity of streams on roads varies not only in a current of days, but also has casual character as a whole.

But that most precisely and to develop model it is possible to enter analogue of the road controller: the block of management of phases (Figure 2). Thus, arriving demands in system first of all analyse a current phase and depending on it or expect in turn, or pass further in serving device. In such model a role of the serving device in realisation of a delay of passage of a crossroads by vehicles.

In the block of management phases put logic of work of a traffic light. In this rigid regulation the quantity of phases and their duration is set. If flexible regulation algorithm key parameters are set. Realisation of the mixed scheme of regulation when flexible management covers not full number of directions is possible.

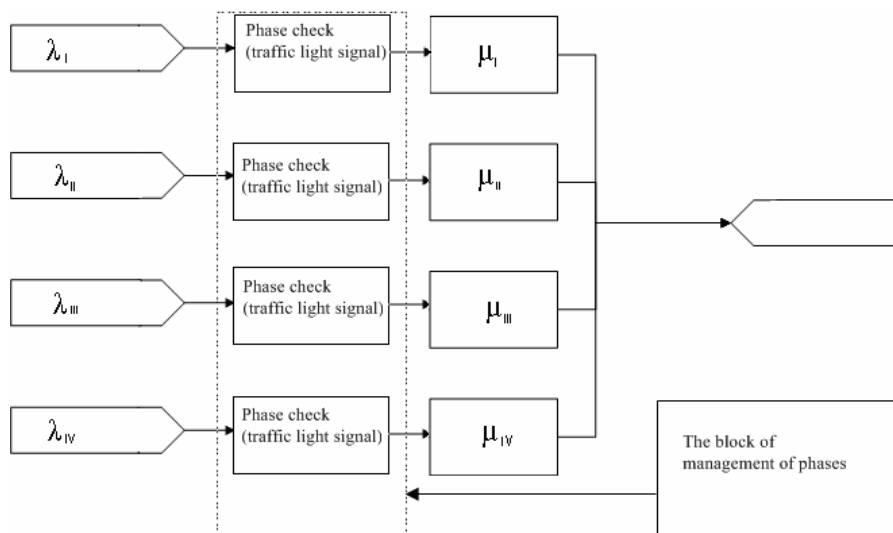


Figure 2. Modelling of a crossroads

Simulation modelling

Simulation – the most powerful and universal method of research of the systems, which behaviour depends on random factors. Such model this formal description of logic of functioning of investigated object, character of interaction of its elements in time, considering essential relationships of cause and effect of object. The object is reproduced with the maximum adequacy with preservation of structure and structure of elements, internal processes and character of their course in time. Simulation models are usually realised in the form of programs in terms of universal languages or modelling languages.

One of languages of the simulation modelling chosen for working out of the given model is GPSS (General Purpose Simulation System). It is among the problem-way-focused languages of modelling intended for the description and simulation of discrete objects. All standard problems of simulation modelling are automated (are hidden in interpreter GPSS) [1]. The system includes the source language for the description of models and the task of modes of modelling and the corresponding software providing the interface, modelling and statistical processing of results. Besides, for realisation of the block of management by phases language PLUS (Programming Language under Simulation) was used. It is simple, but the powerful programming language which is the important part of language GPSS. It gives the chance to use the subroutines written on special syntax PLUS, in models and to receive to the programmer the control over modelling performance that does language by even more flexible. It is possible to change parameters of system and to carry out some blocks of language GPSS in a global context of model.

References

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INTERNET AUTOMATED DESIGN SYSTEM OF CONTROL AUTOMATICS OF SCHEMES

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There are many advantages of this work. Firstly we can faster design automatics of schemes. Secondly the automated design system by means of programming allows making simulation of control automatics of the scheme and seeing an operating efficiency of automatics. And also all automatics of the schemes can be controlled by Internet.

In a basis of application of the automated design system created with use of artificial intellect technologies, in particular expert systems – to keep designer's knowledge, to work with them and to make decisions. As a result users of Internet automated design system have information and help support based on knowledge of more qualified experts about the object of designing is presented on Fig.1. [1]. Such interaction of designing algorithms with expert system allows automating those procedures, which are solved on the basis of designer's knowledge and cannot be presented in the form of algorithms [2].

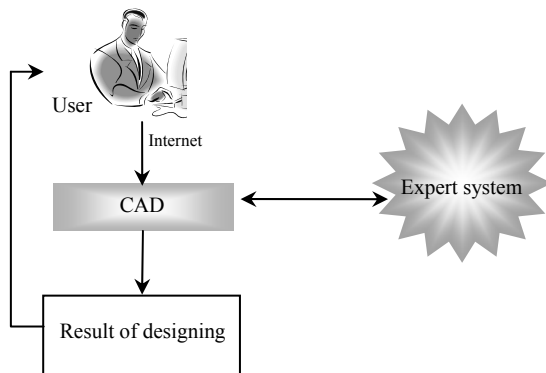


Fig. 1. Automated design system structure

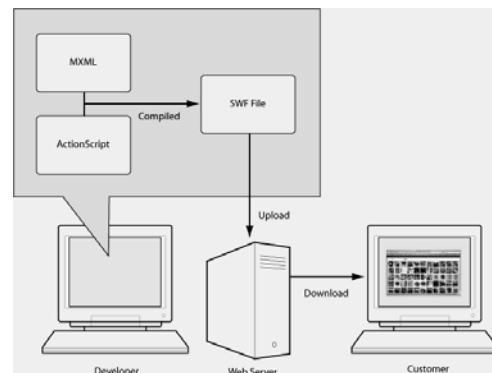


Fig. 2. Adobe Flex3 structure

The major aspect of development of modern automated design systems is their orientation to information integration and interoperability with other systems and software. Unfortunately it imposes certain restrictions of the methodical character, which must be taken into consideration at system engineering [3].

In the designing of control automatics of schemes and control schemes and reports of equipment are indispensable. For this purpose it is necessary to create the automated design system of control schemes and reports of equipment, using Adobe Flex 3, programming language Java, PHP 5 and database Oracle. Adobe Flex 3 is a software development kit released by Adobe Systems for the development and deployment of cross-platform rich Internet applications based on the Adobe Flash platform. Flex applications can be written using Adobe Flex 3 Builder or by using the freely available Flex compiler from Adobe (Fig.2.). Traditional application

programmers found it challenging to adapt to the animation metaphor upon which the Flash Platform has been originally designed. Flex seeks to minimize this problem by providing a workflow and programming model that is familiar to these developers. MXML, an XML-based mark-up language, offers a way to build and lay out graphic user interfaces [4]. MXML is used mainly to declaratively lay out the interface of applications, and can also be used to implement business logic. Interactivity is achieved through the use of ActionScript, the core language of Flash Player that is based on the ECMAScript standard (Fig.3.).

Simple dynamic data-driven applications load external data from a range of sources. The next section of this chapter covers the types of data you’re likely to work with in this sort of application. Dynamic applications also often provide mechanisms for updating the existing data and adding new data. Changing the external data source is enough to update the content in this type of application; there is no need to recompile the SWF file [5].

Adobe Flex 3 data access components use remote procedure calls to interact with server side environment, such as **Java and PHP**, to provide data to Adobe Flex application and send data back to server side resources. In this article we will see how we can use Adobe Flex data access components in our Flex application.

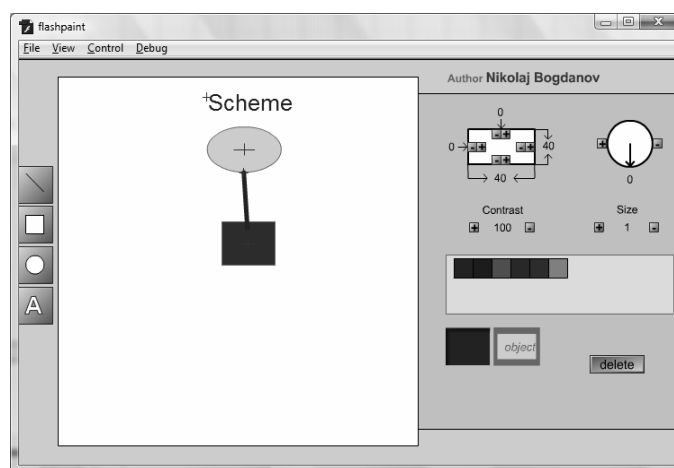
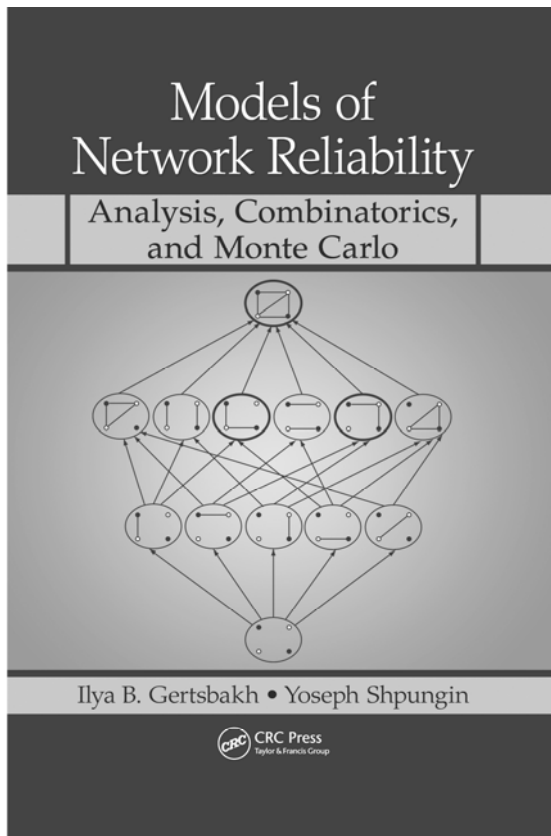


Fig. 3. Flash automated design system

This system of creation of control schemes and reports of equipment will help more quickly and without mistakes to design control schemes and reports of equipment and some users can use this designing system using simultaneously one general database.

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Models of Network Reliability : Analysis, Combinatorics, and Monte Carlo

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CRC Press

After a brief introduction to Monte Carlo Method and a concise exposition of basic Reliability Theory ideas, the book studies a collection of principal network reliability models, such as terminal connectivity for networks with non reliable edges and/or nodes, network lifetime distribution in the process of its destruction, network stationary behavior for renewable components, importance estimation of network elements, and network optimal reliability synthesis. The solution of most problems is presented in a form of efficient Monte Carlo algorithms and is widely illustrated by many numerical examples and tables, including medium – size computer networks. The book, authored by two Reliability experts with a lasting teaching experience, is written in a reader-friendly manner and is designed for Industrial Engineering Operations Research, Computer Science and Reliability Theory students, researchers and engineers. With a stress on intuitive explanation of basic ideas, the book has end-of –chapter problems and exercises and is complemented by a Solution Manual for teaching instructors.