

GPS Satellite System Integration in Monitoring of Automobile Transport in Latvia

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Abstract. This paper is the result of authors' activities in the field of research and implementation of global positioning system (GPS) technologies in the Latvian car industry. The subject of study is the characteristics of Latvian motor vehicle management. Topicality and importance of this issue are related with new GPS applications to motor vehicle monitoring. In order to solve this issue, the authors proposed an original mathematical model of satellite receivers' use in vehicles.

Keywords: management technologies, service efficiency, capacity, global positioning system, queuing system, monitoring.

I. INTRODUCTION

In this work, there is considered the use of computer networks in modern means of navigation. The main factor, which determines the working quality of navigation means, is the speed. The modern means of navigation are based on high-speed computer networks. The estimation of the productivity of such kind of networks is the topical task nowadays. The main type of navigation monitoring is the automatic dependent surveillance. This method is widely used in Japan, USA and Western European countries (Sweden, Denmark, Germany). In the near future, this method of navigation surveillance will be used in Latvia as well. The outcome of this work is a proposed methodology, which allows to design the computer network of navigation monitoring in Latvia.

II. NEW SERVICING STANDARDS

Regular research carried out in Riga Technical University [1-3] present gradual criteria changes according to which the GPS service is selected. Low price and high quality of goods are undoubtedly the most important ones on the list; however, those are not desired characteristics, but rather the mandatory standard of a competitive service instead. Nowadays consumers pay more attention to additional criteria, such as time of delivery, possibility of getting ordered goods in the determined period as well as high-quality information maintenance of order delivery process.

Nowadays not all companies are able to offer delivery of goods to their clients on the day of order receipt (common practice is delivery on the following day). However it is evident that presently service standards tend to become stricter and a company's position in the market depends on the ability to meet these standards.

III. NEW OPPORTUNITIES

Dispatcher services using the abovementioned modern systems obtain the following options for managing motor vehicles:

- analyse information and take decisions based on the data shown on the scalable *electronic map*;
- store data on the movement and status of the objects under control and prepare reports based on this information, including the data visualised on an electronic map;
- receive detailed reports about non-routing and emergency situations requiring operative response.

Furthermore, in case of an incoming call from a client the dispatcher has complete information about the status of the order at the present moment and is able to answer any questions, including the estimated time of arrival (this information can also be shown online, thus clients can get free access to it).

As a consequence the efficiency of vehicle use increases, transport logistics improve; transport management is carried out, strict control is implemented over improper vehicle use and the number of failed deliveries decreases which enables the company to reduce the "order-delivery" cycle and improve the level of services provided to the clients accordingly.

IV. PROBLEMS WITH EVALUATING EFFICIENCY OF MOTOR VEHICLE MONITORING SYSTEMS BY USING GPS

One of the main problems in improving the efficiency of GPS use in the motor vehicles is the problem related to evaluation of efficiency of such systems. Efficiency of these systems can be evaluated by mathematical calculations using queuing systems. The vehicle GPS signal receivers as such can be interpreted as separate systems of queuing which receive queries about their locations from the system dispatcher. GPS signal receivers can generate queries to the system dispatcher. Management of queries received from GPS receivers is shown in Fig. 1 as a schematic image from the perspective of queuing. Each queuing system shown in Fig. 1 is a device that manages the GPS queries. Queries are managed on a first in, first out basis in rotation and return from GPS receiver to a dispatcher, then they are transferred back to GPS receivers from a dispatcher. One of the characteristics of this query management scheme is the availability of different rules on query management by GPS receivers. This diversity on one part can be explained by diversity of queries and the diversity of the receivers' characteristics. Unfortunately, in terms of applying queuing systems, the network device diversity is recorded extremely rarely or considered if there is a

correlation between the rules on query behaviour when queuing for service and the diversity or with other queues [5–7].

As to GPS efficiency evaluation, cases should be taken into consideration when the types of queries do not depend on the status of query in the queue. Therefore this research suggests characteristics calculation method for GPS systems on the basis of the assumption that management in the network nodes is subordinated to management rules.

Approbation for use of this method for corporate computer network analysis is reflected in various works of the authors [8 - 10]. Along with analytical researches presented below, the authors carried out the experimental methods of GPS system assessment [11] and the researches based on simulation modelling methods [12]. This research suggests selecting the mathematical tool of queuing stochastic networks as a basis for studies of the characteristics of GPS receiver network consisting of several nodes. In these networks, queries can select a network node for management randomly. It is suggested to perform the analysis of computer networks first based on the fundamental queuing system with the hyper-exponential management law and the superposition of Poisson query stream acting at the system input and then a transition to a stochastic network of queuing systems takes place. This method enables studying the networks with hierarchical organisation of the structure where subnets can be used as service units.

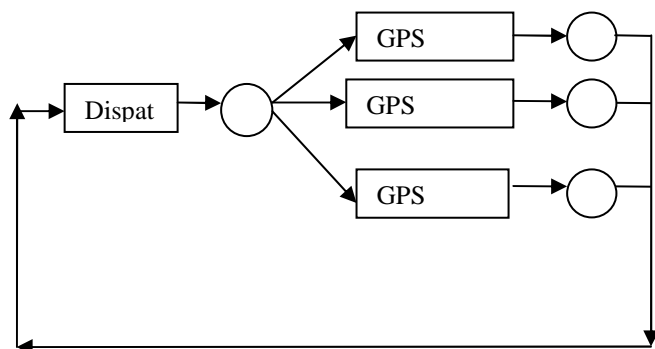


Fig. 1. GPS receivers.

V. STATEMENTS OF A QUESTION

The closing system mentioned above, may have peak periods in which traffic is very heavy, so that queues build up which, however, are taken care of later in the system. We may then be interested in total throughput or in peak like maximum queue length. In all those examples the only way to interested in the steady state response of a on-line computers networks can we chose between replicating run and continuing one long run. We feel that in practical studies steady state, off-line computer networks are an exception, where as in theoretical studies such systems prevail.

If we replicate runs and new set of random numbers for each run then each run yields one independent observation, e. g. the average waiting time in run “1”, then:

$$x_i = \sum_{j=1}^m w_{ij} / m \quad (1)$$

Where w_{ij} denotes the waiting time of customs j in run ($i=1,2,\dots,n$)

Traditional techniques can be applied to estimate the standard deviation of the response:

$$Z_x = \sqrt{\sum_{j=1}^n (x_j - x_i) / (n-1)} \quad (2)$$

In this equation we forget how x_i was composed individual observation w_{ij}

As initial conditions for on-line computer networks we simple take the nature.

All conditions.

- Replicated runs yield independent observations so the analysis problem, problem standee-state behavior and problem off-line computer networks simulation.
- The practical problem is to detect whether the system one is simulating has such renewal states. There are also some diagnostically and statistical estimation problems, since the point confidence intervals are not using straightforward formulas like equations. (2).
- For a single prolonged run we distinguish 2 approaches: the measurement extractor and the analysis tools.

VI. THE MEASUREMENT EXTRACTOR

The goal of this tool is an on -line collect of information in the Operations Systems computer networks. A listing might be received with a monitoring in the computer networks. Statistics we can be gathered at three levels:

The user job level - here we can measure the programs called for job step: compilation, execution, lines printed etc., the run time option selected and called diagnostics;

The system level – here we measure job traffic, service time, resource allocation, job and task queue lengths;

The I/O level – here we measure channel and I/O equipment activities.

They are suggested from analytical and simulation models of the on-line and off-line computer networks and of workstations and console lights and from reflection on what parameters are likely to be important. The general approach is essentially that of a diagnostic there is a transfer of control to a routine, which collects data and stores it for later analysis. The sampling rate and amount of data collected must be low enough so that the overhead due to the monitoring is acceptable. We distinguish two types of monitoring computer networks: system accounting programs and periodically run or to obtain information off packages programs. The accounting programs and periodically run must be some special problem.

The normal accounting information which cam users and is collected in computer network for billing is an extremely rich source of data for monitoring process. But the information from billing source is not full. An accounting programs cam a very detailed profile of user job with rude precessions.

Most of equation (2) observable can by means of packaged software monitoring, but at greater cost in time. The problem software monitoring it is operating employing program in the same option operation system of on-line and off-line computer networks.

The software monitoring is not yet used regularly and it must be installations by loading important program modules. Several kinds of collect subroutines are considered, we give below the list collects programmed in the current version.

- A. Evaluation of the load workstation: operator dialog; batch processing commands; primary and secondary commands; steps accounting; supervisor calls.
- B. Evaluation of the files manipulation: logical input-output; opens and closes of files.
- C. Evaluation of the task management: workstation queues; system task activity; utilities and command for workstation activity and queues in the system activity.
- D. Evaluation of the computer utilization: CPU occupation; peripheral and channel occupation and core memory occupation.
- E. Evaluation of the system reliability: system error; server's errors; user aborts and various value overly.

VII. THE ANALYSIS TOOL

A measurement off-line and on-line computer networks accompanied of analysis. The analysis tools importance was often undervalued. These essential problems of analysis measurement in off-line and on-line computer networks are:

- Probability, in order to perform analysis on different computer or network systems,
- Easy modification, because results of a first analysis may conduct to modify several parameters for the next analysis,
- Easy utilization, because this tool is used on various centers.

The detecting system will be assumed in the standard monitoring mode. The monitoring mode may be described as follows on Fig. 2.

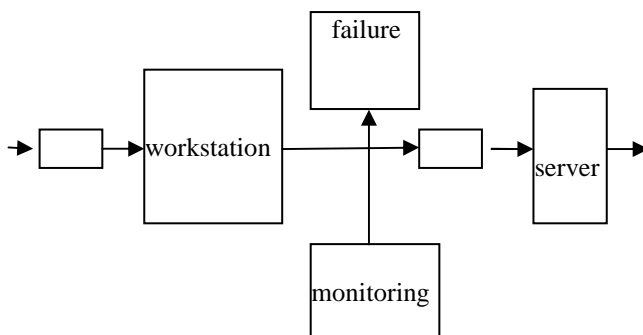


Fig. 2. Described monitoring mode.

It is assumed that requests for monitoring and failures occur according to two processes. The time sharing those processes

shout of the Figure 2. One process it is independent failures Poisson process of rate $\lambda=1/Y$. Y it is average time of $y=a+b$. Second process it is monitoring process. A monitoring process may be assumed from Geometrical process of rate $p=1/x$. X it is average time from equation (1).

The date base system under monitoring mode of operation can be considered as a server to request for monitoring system (for example in server of Windows XP).

The stationary probability distribution for the data base monitoring system can be obtain for generating function which has many generation. For Figure 3 stationary probability can be obtain for generating function which has two generations.

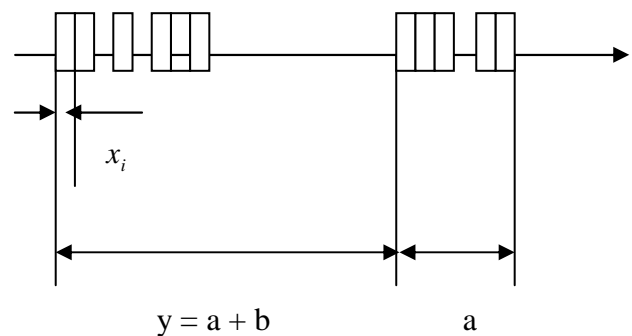


Fig. 3 Generating function which has two generations.

First generation function it is generation function from failure process. This is function can be obtain of equation:

$$Q^{(1)}(s) = \exp(-\lambda + \lambda * s) \quad (3)$$

The generation function for monitoring process it is function of second generation. For geometrical distribution this is function has equation:

$$Q^{(2)}(s) = \sum_{j=1}^{\infty} p * [(1-p) * Q^{(1)}(s)]^{j-1} \quad (4)$$

This is equation it is geometrical progression from which we will give expression for general function of monitoring process

$$Q^{(2)}(s) = p / [1 - \exp(-\lambda + \lambda * s) + p * \exp(-\lambda + \lambda * s)] \quad (5)$$

This is result give become equation from arrival number measurement for one monitoring séance.

From equation (5) describing state transitions and distribution stationary probability f the system measurement, bet we showing the becoming the arrival number measurement and standard deviation for this number. The described the

arrival number measurement for one séance measurement can be becoming from first derivative equation (5) for s=1. From this transformation we have:

$$\begin{aligned} \alpha_{(s=1)} &= dQ^{(2)}(s)/d(s) = d\{p/[1 - \exp(-\lambda + \lambda * s) + p * (-\lambda + \\ &\lambda * s)]\}/d(s) = \\ &= [(p - p^2) * \exp(-\lambda + \lambda * s) * \lambda] / [1 - \exp(-\lambda + \\ &\lambda * s) + p * \exp(-\lambda + \lambda * s)] = [(1 - p) * \lambda] / p \end{aligned} \quad (6)$$

For described the standard deviation can be becoming from second derivative equation (5) for s=1.

Skip the operations of derivative we have:

$$\begin{aligned} \psi_{(s=1)} &= d^2 Q^{(2)}(s)/d(s)^2 \\ &= [(1 - p) * \lambda * (2 - p)] / p^2 \end{aligned}$$

The different of measurement system have different values and have the different parameters, but the different characteristics this system can be design in statistical terminology for equation (6) and (7). In this paper we discuss selected analysis and measurement that seem of practical use in the design and diagnostic off-line and on-line computer network in general. The equation (7) given use compare several off-line and on-line computer networks.

VIII.SUMMARY

The organisation which is focused on the long-term business activity and the quality of its processes must follow development trends in the information technologies, make progress in this area and react timely to the changes in this area in order to optimize its processes and increase the overall work efficiency.

During the last few years organisations have had huge amounts of unstructured content, including documents, e-mail messages, video clips, instant messages, web-sites and many others. This information is often in disorder which prevents the organisation from using these valuable assets efficiently in order to share knowledge, improve relations with its clients and increase efficiency of processes.

Many companies currently have the following widespread issues:

- processing of and search for documents is not efficient and requires too much time;
- business processes are not managed efficiently;
- lack of an integrated information source or its insufficient activity;
- increase of costs related with compilation, copying, sharing and storage, as a consequence, the company suffers from the inefficient work organisation.

Implementation of a GPS system in a company is a complicated and time-consuming process requiring a tedious analysis, studies and thorough preparation.

Eventual risks should be precisely assessed during implementation of automation systems as it is in any

management process. Risk evaluation is an important stage of work. Adequate selection of the system, implementation terms, costs and further use of the selected system by personnel depends on this stage. Apart from the eventual risk evaluation the manager should calculate risk probability and severity and elaborate a plan for minimizing all of assessed risks.

This research also demonstrates risk management in case of GPS system implementation as a case study of a particular organisation. For instance, the risks that are ranked as medium status "Improper GPS system, strategy" and "Work interruption" have the following indicators: 0.08 and 0.10 accordingly.

Implementation of a new company content management system has also revealed the necessity to upgrade the employees' qualification. This matter can be solved by organizing special trainings. Moreover, various levels of motivation, such as salary revision, payment of bonuses, bonus system and free education are offered in order to increase responsibility of the company's employees and willingness to master the new system faster and with a serious attitude

As a result of studies of the offers in the GPS system market, individual needs of the company, risk analysis and evaluation and proposed measures to minimize them, experts' evaluation of the organisation's maturity level and necessary optimization calculations, the decision was made to use web-sites for the project implementation. The expert group acquired the following result when evaluating the significance of the most important advantages as per the degree of their significance:

- reduction of the time spent by employees - 94%;
- business process optimization - 84%;
- improvement of the employees' work quality - 81%.

Determinant choice criteria were (as per the degree of significance, according to the evaluation of the expert group): project payback rate - 93%, low maintenance costs - 78% and functional characteristics of the system - 77%.

Implementation of GPS system provides significant advantages; however, this process is rather complicated, as various factors have to be taken into consideration. Further effect is mostly determined by the adequate choice of the system and the realization of the implementation process. If the system is selected correctly and the implementation process is carried out successfully, the employees of the organisation are able to use their working time more efficiently and do more work thanks to the reduction of time for routing operations. The systems also enable optimizing activities of particular departments and the organisation as such and obtain analytical information which is used for making various important managerial decisions.

CONCLUSION

The polls carried out show that the use of modern positioning systems for transport and motor vehicle control systems is economically feasible.

Thus it is evident that the economic effect from their implementation in large companies performing thousands of deliveries every day will definitely exceed the costs for its

purchase, implementation and maintenance. Furthermore, it will be much easier to manage the transportation company.

Development of an integrated transport management system enables to solve a local task of reducing the "order-delivery" cycle and creating a positive image for the company in the eyes of the clients due to accurate execution of undertaken obligations related with order execution terms, minimization of the delivery failure risk and the opportunity of creating a flexible feedback system.

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Viktors Boicovs, Marga Zivitere. GPS satelītsistēmas integrācija Latvijas autotransporta vadībā

Darbā tiek apskatīta datortīklu izmantošana mūsdienu navigācijas līdzekļos. Galvenais faktors, kas nosaka navigācijas līdzekļu darba kvalitāti, ir ātrums. Mūsdienu navigācijas līdzekļi balstās uz liela ātruma datortīkliem. Šādu tīklu ražīguma novērtējums šobrīd ir visaktuālākais uzdevums. Galvenais navigācijas novērošanas veids ir automātiskā atkarīgā novērošana. Šādu metodi plaši izmanto Japānā, ASV, Rietumeiropas valstīs (Zviedrijā, Dānijā, Vācijā). Tuvākajā nākotnē dotā navigācijas novērojumu metode tiks izmantota arī Latvijā. Darba materiālos tiek piedāvāta metodika, kas ļauj veikt navigācijas novērojumu datortīklu projektēšanu Latvijā.

GPS pielietojšanas sekas ir transportlīdzekļu efektivitātes paaugstināšana, autotransporta loģistikas uzlabošana, autotransporta vadības nodrošināšana vienlaicīgi ar stingru transporta līdzekļu kontroli un neveiksmīgu piegāžu skaita samazināšanos, kas ļauj būtiski saīsināt ciklu „pasūtījums - piegāde”. GPS sistēmas realizācija nodrošina būtiskas priekšrocības; tomēr šis process ir sarežģīts, jo ir daudz faktoru, kurus jāņem vērā projektēšanas stadijā. Turpmāko efektu visvairāk nosaka adekvāta sistēmas izvēle un procesa realizācija. Ja sistēma ir izvēlēta pareizi un process tika realizēts veiksmīgi, organizācijas darbinieki var efektīvāk izmantot savu darba laiku un paveikt darbu daudz īsākā laikā. Sistēma ļauj arī veikt darbības, kas tiek izmantotas dažādu svarīgu kardinālu lēmumu veikšanai, optimizācijai.

Виктор Бойцов, Марга Живитере. Интеграция спутниковой системы GPS в управление автотранспортом Латвии

В представленной работе рассматривается использование сетей компьютеров в современных средствах навигации. Главный фактор, описывающий качество работы средств навигации - скорость. Современные средства навигации построены на основе высокоскоростных сетей компьютеров. Однако, проблема оценки производительности таких сетей является наиболее актуальной задачей. Основным видом навигационного наблюдения является автоматическое зависимое наблюдение. Такой метод наблюдения широко используется в Японии, США, в странах Западной Европы (Швеции, Дании, Германии). В ближайшем будущем данный метод навигационного наблюдения будет использован в Латвии. В материалах работы предлагается методика, позволяющая производить проектирование сетей компьютеров навигационного наблюдения в Латвии

Как следствие применение GPS есть увеличение эффективности транспортных средств, улучшение логистики авто транспорта; осуществление управления авто транспортом, при строгом контроле над транспортными средствами и уменьшение неудавшихся доставок, что позволяет сократить цикл “заказ - доставки”. Реализация системы GPS обеспечивает существенные преимущества; однако, этот процесс сложен, так как есть различные факторы, которые должны быть учтены при проектировании. Дальнейший эффект больше всего определяется адекватным выбором системы и реализацией процесса выполнения. Если система выбрана правильно и процесс выполнения осуществлен удачно, работники организации могут к использовать время их работы эффективнее и делать работы за более сокращённое время. Система так же позволяет проводить оптимизации действий, которые могут быть использованы для дела различные важные кардинальных решения.