4th INTERNATIONAL CONFERENCE
TRANSPORT SYSTEMS TELEMATICS TST'04

ZESZYTY NAUKOWE
POLITECHNIKI ŚLĄSKIEJ 2004
TRANSPORT z.55, nr kol. 1657

telematics, telecommunication, transport, sea transport, safety, effectiveness, reliability, information flow, information overflow, modelling, CASE

Wojciech WAWRZYŃSKI[1]
Przemysław DZIULA[2]

INFORMATION FLOW MODELLING WITHIN THE TRANSPORT TELEMATICS' SYSTEM

The thesis describes methods, capable of modelling of information flow within the Transport Telematics' System. Increased information amount (*the information overflow*) within the borders of a transport system, can cause higher safety and effectiveness level of this system. The thesis introduces also an example of realisation of the logical model of system, which task is to increase safety and effectiveness of the Sea Transport System. The base of the project was more efficient usage, of already existing sea transport system's telecommunication infrastructure.

MODELOWANIE PRZEPŁYWU INFORMACJI W SYSTEMIE TELEMATYKI TRANSPORTU

Referat przedstawia metody umożliwiające modelowanie przepływów zasobów informacyjnych w Systemie Telematyki Transportu. Zwiększona ilość informacji (*nadmiar informacyjny*) w systemie transportowym, może skutkować wzrostem poziomu bezpieczeństwa i efektywności tego systemu. Pokazano również przykładową realizację modelu logicznego systemu informacyjnego, mającego za zadanie zwiększenie bezpieczeństwa i efektywności Morskiego Systemu Transportowego. Jako podstawę przyjęto bardziej racjonalne wykorzystanie istniejącej już infrastruktury teleinformatycznej transportu morskiego.

1. INTRODUCTION

The transport is one of industry's sectors, where the significant increase of telematics' usage can be observed. The most popular solutions are GPS satellite system receivers, and applications for transport means' monitoring and management, basing on this system.

Fig.1 is showing simplified scheme of typical transport means' monitoring and management system, using elements of transport telematics' system [6]. These elements are: positioning systems' receivers installed and working on transport means, telecommunication

[1] Faculty of Transport, Warsaw University of Technology, Koszykowa 75, 00-662 Warsaw, Poland
wwa@it.pw.edu.pl
[2] Faculty of Navigation, Gdynia Maritime University, Al. Zjednoczenia 3, 81-345 Gdynia, Poland
pdz@am.gdynia.pl

systems capable of data transmission, and applications for monitoring and management of transport means, based on digital chart systems.

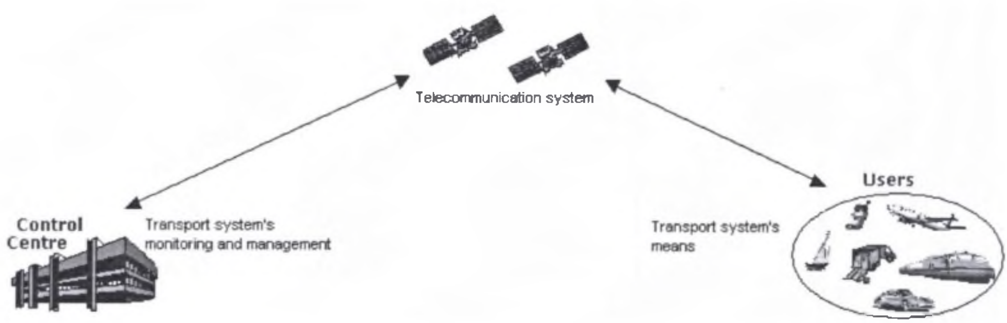

Fig.1. The simplified scheme of transport monitoring and management system

Pointed above elements of transport system are also constantly improved. Systems EGNOS, WAAS, MSAS, supporting GPS system, are already functioning. The start of European Satellite Navigation System – GALILEO, is scheduled for 2008 [3]. This system is going to show quite new quality and possibilities, in comparison to existing GPS and GLONASS systems.

Among „earth-based" telecommunication systems, the UMTS technology is slowly appearing. This technology will allow to achieve much more efficient data transfer, than GSM commonly used now. We observe also significant increase of possibilities of "satellite-based" telecommunication systems. Fig.2 presents possibilities of successive standards of INMARSAT, the most popular telecommunication system within sea and air transport.

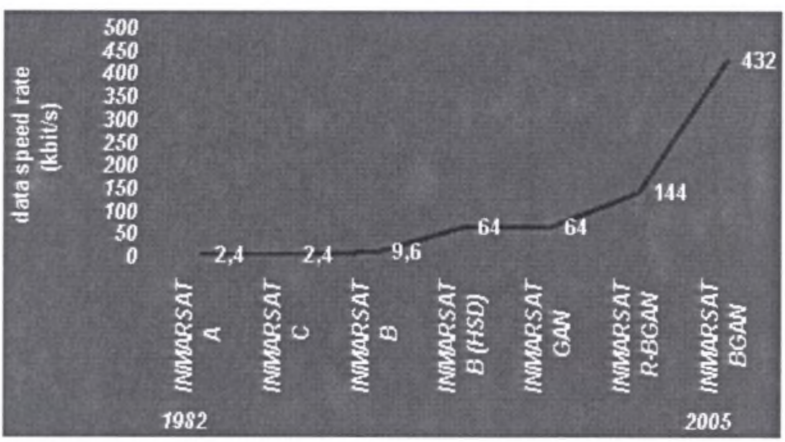

Fig.2. Possibilities of successive INMARSAT standards

Advanced digital charts' systems, being the base for transport means' monitoring and management systems, are also developed. There is an increasing coverage of areas covered with electronic data base. The possibilities of systems working with this data base also are still being improved.

2. INFORMATION OVERFLOW

Described aspects of telematics' usage evolution within transport systems, cause fact of existing of increased information amount in these systems. This amount can be specified as ***information overflow***. The information overflow is one kind of an ***overflow***, which, in general, is used for securing proper level of safety of a system. Information overflow is defined as ***existing of exceeded information amount within the system, concerning essential elements and events*** [5]. Illustration of information overflow existing within the system, has been illustrated on the Fig.3.

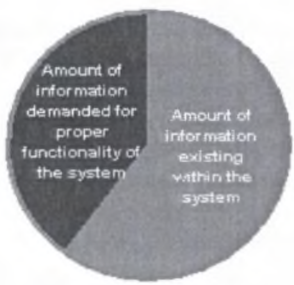

Fig.3. The illustration of information overflow

It is possible to prove, that increased amount of information within a system, is resulting increased safety of this system [7]. However, phrase *information overflow*, can have also negative meaning. Overflow, meaning *too much information*, can cause disturbances in its processing, consequently – disturbances in proper functionality of the system.

It is then highly recommended to *put* existing increased amount of information *in the right order*. One of possible ways for *putting* information overflow *in the right order* is to use an ***information flow modelling***. Further sections of this thesis describe new modelling techniques and tools – supported by ***Software Engineering***.

3. INFORMATION FLOW MODELLING - TECHNIQUES AND TOOLS

In the middle of sixties of the 20th century, new field in the computers' related technology – software engineering – appeared [4]. The reason was a computer hardware and programming tools' evolution, capable of advanced systems' projecting and producing.

One of the most important stages of software engineering (which, as a complex process, can be described like in Fig.4), is ***modelling***, named also the ***Analysis***.

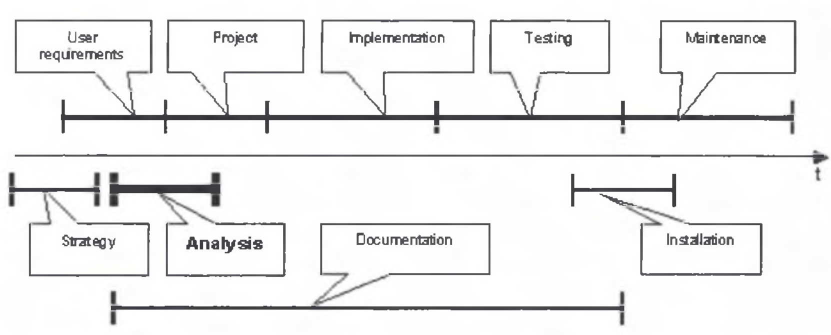

Fig.4. Successive stages of Software Engineering as a process, the analysis additionally marked

The main purpose of the modelling is to describe the rules of system's functioning – to build the logical model illustrating realisation of requirements set at the beginning. The *analysis* stage is covering partly *user requirements* and *project* stages. User requirements stage's target is to form intended functionality of a system, intended result of the project stage is software layout – meaning – the way of implementation. The modelling is then including part of tasks covered by user requirements stage, also, the modelling result is the base to start project of the system.

The achievements of software engineering in field of analysis, can successfully be used for information flow modelling [2]. It supports many interesting, not fully formalised techniques and tools, capable of interesting illustration of processed problems. Additionally, software engineering is basing on clear, giving an impression of reality, graphic diagrams.

3.1. CASE – COMPUTER AIDED SOFTWARE ENGINEERING

From the beginning of eighties of the past century, new sector in computer related technology is connected to software engineering – CASE (*Computer Aided Software Engineering*). CASE is a complex of tools capable of successive software engineering stages realisation, and error detection. These tools are mainly used for making of graphic diagrams, describing functions realised by projected system.

The most important task of CASE tools at modelling stage, is supporting of graphic model representation edition process. CASE graphic editors are specialised for creating of, and navigation through graphic diagrams, and ensuring of illustrated information co-existence. These tools are capable of realisation of whole system building process, starting with user requirements, through modelling and system projecting, ending at implementation.

3.2. STRUCTURED ANALYSIS

The modelling methods can be divided into two main kinds: ***structured***, and ***object–oriented*** [4]. Structured methods are being developed for forty years already, together with developing of software engineering. They are basing on selecting two main components of a system: *non-active* (data processed by system), and *active* (functions performed by system). Structured methods are designated for circumstances, when there is significant difference between structures of non-active and active components within the system, i.e. system performing simple operations on complicated data, or complicated operations on simple data.

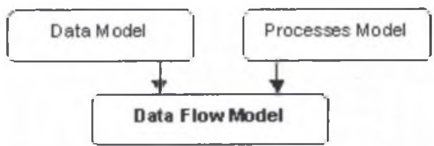

Fig.5. Main stages of structured model building process

Structured model building process consists of two main stages: ***data model*** composition, and ***processes model*** building (see Fig.5). Data model is the description of an information stored and processed by system. Processes model describes functionality performed by system. Two above mentioned models are afterwards (with the use of CASE tolls) integrated. Integration result is ***Data Flow Model***. The integration of data and processes models is complicated, when system is going to perform complicated functions on complicated data, therefore, for such systems, object-oriented methods are recommended.

3.3. OBJECT-ORIENTED ANALYSIS

Object-oriented methods appeared around twenty years ago. Fundamental difference from structured methods is permission to use of system's elements being capable of both storing and processing of data [4]. These methods are more useful, when projected system is going to perform complicated operations on complicated data.

Object-oriented modelling is not separating data (non-active components), and processes (active components). However, following model elements are specified:

- ***objects*** – system components being able to be precisely selected – having their own unique identity,
- ***classes*** – templates of object's groups – described by ***fields*** (attributes), and ***services*** (operations being able to be processed within class fields),
- ***class and objects associations*** – mutual interactions between different classes' objects, and different objects' classes,
- ***interactions*** – scenarios of ***messages*** flow between system's objects, and external systems,
- ***state transition*** – system elements able to present the dynamic behaviour of whole system, classes groups, or individual classes having complicated dynamic structure.

Object-oriented model building process consists of following stages: ***Classes Model*** building, and ***State Transition Model*** composition. Classes model is including: objects and classes identification, classes' attributes identification and definition, plus objects and classes' associations identification. State transition model covers messages and services identification and definition.

Object-oriented model building process is not linear, as it was in case of structured models. Particular stages can be interactively made (see Fig.6). The analyser can start with any of stages illustrated in Fig.6, depending on his own consideration.

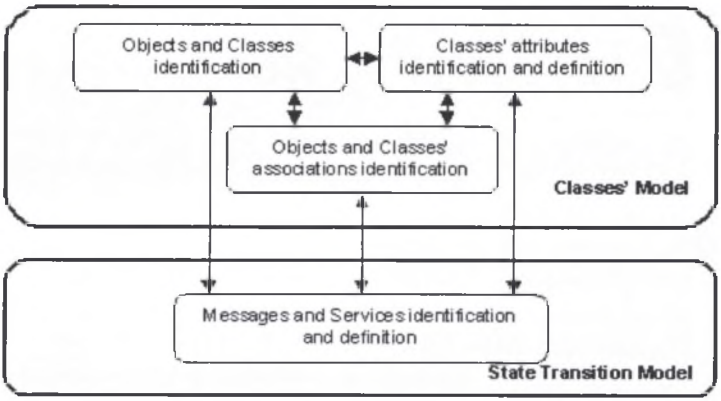

Fig.6. Stages of object-oriented model building process

4. LOGICAL MODEL OF INFORMATION FLOW SYSTEM FOR THE SEA TRANSPORT SYSTEM

Following part of the thesis is introducing information system model, proposed in [2], as a solution capable of increasing the safety and effectiveness of sea transport. The model is showing a concept of enhancing currently functioning, within the sea transport, information exchange system, able to use information overflow existing in the system. Model is showing new data flows and their sources. Proposed solution is able to increase the safety and effectiveness of sea transport, basing on more efficient use of existing already sea transport telecommunication infrastructure.

The model is made by using of structured modelling methods. Structured analysis has been considered as more useful for system's data flow modelling. Structured model lets for detailed presentation of data, on which the system's operation is based. Achieving of this target is more difficult by the use of object-oriented methods.

The model is illustrating the performance of system (named as ***S&E System***), realising three base processes (see Fig.7):

1. ***Read data*** process: reading by the shore service, data from systems and devices functioning on board of ships.
2. ***Determine status*** process: determining by the shore service of current condition of ship (safety, emergency or distress).

3. ***Generate instructions*** process: issuing of instructions for the ship's crew – designated (if fulfilled) for increasing ship's safety and/ or effectiveness.

The S&E System is controlled by ***Fleet Monitoring System***, by forming and sending of **steering instructions**. S&E System can work under two following modes:

- Determining of current ship's condition, or
- Supporting of actions undertaken for "reflecting" the emergency, if appeared, or supporting of activity designated for maximizing of effectiveness of ship's exploitation.

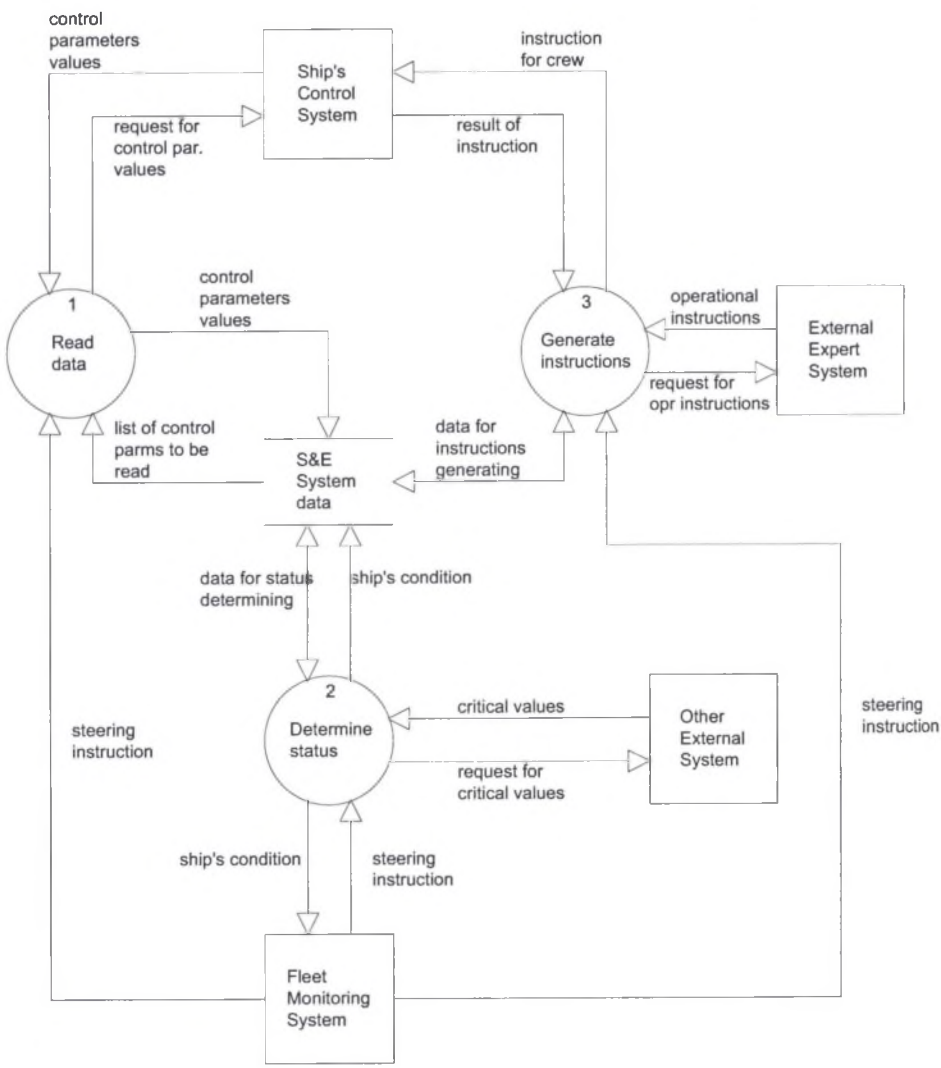

Fig.7. Data flow diagram of S&E system; symbols: square – external system, circle – process, arrow – data flow, two parallel lines – data store

Information on current task (mode), to be realised by the system, is carried by the ***steering instruction***. For the purpose of determining the current condition of ship, process ***Read data*** is reading from ship set of control parameters' values. Basing on this data, ***Determine status*** process is determining current condition of ship. Information on current ship's condition is then handled to ***Fleet Monitoring System***.

For the purpose of the second of above mentioned S&E System's modes, ***Read data*** process is to maximize the collection of information on ship's situation. This is to be done by reading from ship all possible data concerned with actual emergency, or exploitation task realised by ship. By the use of this data, and ***External Expert System***, ***Generate instructions*** process is issuing instructions for the ship's crew. Fulfilling of the instructions, depending on current ship's condition, is to effect with increased safety, or effectiveness of her exploitation.

5. CONCLUSIONS

It is difficult to find articles, treating on transport system's information flow modelling subject, among publications describing transport system's modelling. Then, information flow modelling, can be pointed as new direction within transport system's modelling sector. Undertaking of this subject is especially important because of constantly increasing amount of information within transport systems. For data flow modelling CASE tools are highly recommended, as they support good graphic techniques and tools. The recommendation on need of CASE tools usage, in nowadays jobs treating on transport systems, can be found i.e. in [1].

There is a model of sea transport information flow system introduced in the thesis. This model is capable of being the base for fully working system. The model can be also proposed for other transport systems: rail, road and air. Existing of increased amount of information, we face nowadays, is common feature of all mentioned transport systems.

BIBLIOGRAPHY

[1] AMBROZIAK T., Współczesne spojrzenie na teorię systemów transportowych, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2002.
[2] DZIULA P., Modele wymiany informacji pomiędzy statkami a służbami lądowymi umożliwiające zwiększenie bezpieczeństwa i efektywności żeglugi, Rozprawa doktorska, Warszawa 2003.
[3] European Satellite Navigation System GALILEO: http://europa.eu.int/comm/dgs/energy_transport/galileo/intro/index_en.htm
[4] JASZKIEWICZ A. Inżynieria oprogramowania, Helion, Gliwice 1997.
[5] JAŹWIŃSKI J. WAŻYŃSKA-FIOK K., Bezpieczeństwo systemów, PWN, Warszawa 1993.
[6] WAWRZYŃSKI W., Telematics transport system, International Scientific Conference "The Transport of the 21st century", Warsaw 2004.
[7] WAWRZYŃSKI W. DZIULA P., Rola nadmiaru informacyjnego w poprawie bezpieczeństwa statku, XXXII Zimowa Szkoła Niezawodności, Szczyrk 2004.

Reviewer: Ph. D. Jerzy Mikulski