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AUTOMATION OF DATA TRANSFER OF DRIVING CONDITIONS ON ROADS

Data concerning weather and driving conditions on public roads have been collected and processed by the national road administration in Poland for many years. Data transfer methods and techniques used in the past are shortly presented. A newly implemented system of automatic data collection and transfer is described. Data is collected from Glazed Frost Warning Stations and transferred to Central Database and a database application then automatically launches various information procedures, e.g. generating and updating of a Web information bulletin.

AUTOMATYZCJA TRANSMISJI DANYCH O WARUNKACH NA DROGACH

Administracja drogowa w Polsce od wielu lat zbiera i przetwarza dane o warunkach na drogach. W artykule krótko omówiono dotychczasowe sposoby zbierania i przekazywania danych oraz omówiono wdrażany właśnie system, pozwalający na automatyzację tego procesu. System ten pobiera dane z automatycznych stacji drogowych, przesyła je do centralnej bazy danych i automatycznie uruchamia różne procedury informacyjne (m.in. generowanie informacyjnego serwisu internetowego).

1. INTRODUCTION

The public road management in Poland is carried out through a three-level administration structure. Although the number and the names of individual administration units were subject to various changes in the past, the organization scheme remains primarily invariant. As of now, General Directorate of National Roads and Motorways (Polish abbreviation: GDDKiA) is in charge of the national road network. The national road network administration is composed of 111 Road Base Units, 16 Regional Units (medium level administration) and the Central Directorate of GDDKiA (top level administration).

One of the road administration tasks is the acquisition of data concerning driving conditions, as well as making the resulting information available to the public. The information can be classified according to several criteria, such as weather conditions, the state of the pavement, traffic obstruction due to road works, road infrastructure failures,

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accidents etc. In Polish climate, where the winter season can last for as long as six months, the conditions on roads are subject to frequent variations. That is why fool-proof transfer of latest information on a regular basis is a very important issue.

In this paper, we present the evolution of the system of data acquisition and transfer within the road administration structure. Then we discuss suggested changes in the data acquisition system as well as a new system of data acquisition through automatic road stations that is being implemented.

2. EVOLUTION OF DATA ACQUISITION SYSTEM

Data transfer scheme was a natural consequence of the above-described organization structure of the road administration. Starting from basic level administration units, the information was sent to the central administration via the medium level administration units. The organization chart can be viewed as an oriented tree-type graph, where the data flow is directed "upward".

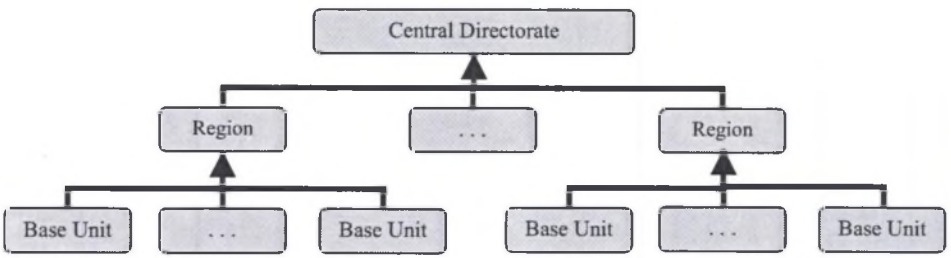

Fig.1. Scheme of data transfer

2.1. INFORMATION FLOW IN THE ABSENCE OF COMPUTERS

Computers were rarely seen in the road administration until late eighties. The basic medium for information transfer was a telephone. One to four phone reports were submitted every day, depending on how burdensome and variable the road conditions were. Partially aggregated on the medium administration level, the information was being passed on to the central administration. More than 600 people countrywide were kept busy a few times everyday, gathering and passing information over the phone, as well as processing it manually on each administration level.

2.2. THE WINTER SYSTEM – FIRST VERSION

The first version of the Winter microcomputer system was created in 1991. The system was primarily designed as a calculation-type support for processing a large amount of tabular data about winter conditions on national roads. Computer-mediated data transfer was not supported yet. The system was implemented in the central administration unit in December 1991.

2.3. SECOND VERSION – MEDIUM ADMINISTRATION LEVEL

During 1992, the second version of the system was created and implemented in the majority of medium-level road administration units well before the winter season 1992/93 began. The significant enhancement was the fact that the system was capable of automatic computer-mediated data transfer from the medium to the central level of administration.

2.4. WINTER 3 – FULL AUTOMATION OF DATA TRANSFER

The third version of the system was implemented in nearly 100% road administration units before the winter season 1993/94 began, thus eliminating the necessity of the telephone reporting. Typical problems could be seen in many parts of the country at that time, the telecommunication network being still obsolete. It took until the mid-nineties for the national telecommunication services to attain the level of reliability that would guarantee efficient modem-based data transfers.

Other systems with the automatic data transfer feature were being developed in that period. In 1995, the Traffic Restrictions system was first introduced, providing support for the acquisition of information concerning traffic disruptions due to road works and accidents. The systems were additionally equipped with a variety of reporting utilities, including graphical representations through graphs and maps. Not only could the resulting reports be generated in the printed form, but the systems were also capable of sending the data directly to remote faxes (for example, to editorial boards of newspapers and radio stations). See [1], [2], [4] for details.

2.5. DATA TRANSFER AND THE INTERNET TECHNOLOGY

In the second half of 1990s, Internet technologies became a natural substitute for the classical modem-to-modem data transfer. The systems described above were undergoing continual modernizations. A new data transfer system, PT2000, was introduced. The system was created so that even old versions of "cooperating" applications could be easily adapted to using its capabilities. The system is a typical service-oriented data transfer system that can use both e-mail (SMTP, POP3) and FTP protocols. Below, we list a few well-known advantages of the Internet technologies applied to road data processing systems:

1. Easier operation of data-transfer utilities on the user part.
2. Increased reliability of data transfer.
3. Maintenance-free procedures (e.g., an automatic update of a WWW information service) made possible in many processes..

The application of Internet in the road administration information systems has been presented in [3].

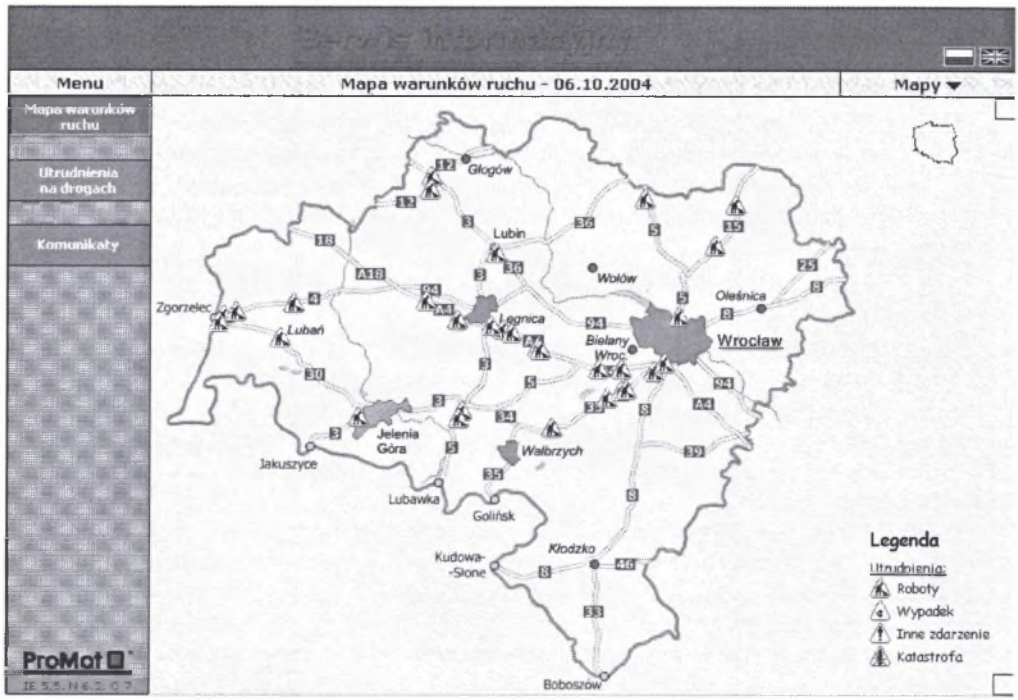

Fig.2. Web-based information service

2.6. DATA TRANSFER IN ROAD ADMINISTRATION – CURRENT STATE

Although the systems discussed here (Winter and Traffic Restrictions) were continually modified and extended during the period 2000 – 2004 (mainly by being equipped with new modules), the above-described Internet-based data transfer system turned out to be efficient and versatile enough to basically remain in its original form. The client application systems were equipped with automatic generators of WWW information services (Fig.2).

As evident as the advantages of the present solutions are, downsides can be identified as well. The main disadvantage of the data flow model is the fact that both the acquisition and the transfer of information are based on an outdated tree-like structure for decades. The reports are transmitted as rarely as 1 to 4 times a day (on weekdays), or not sent at all (on holidays). On the other hand, the road conditions are subject to rapid changes. As a result, the information that road users receive is often outdated (e.g. by up to 10 hours).

In the present system, more frequent data gathering and processing is, of course, possible, but at the price of a higher frequency in terms of manual reporting (i.e. more frequent entering of data to computers), which means a considerable increase of data acquisition costs. A new approach to the problem is presented in the following section.

3. DATA TRANSFER – PROPOSED MODIFICATONS

During every winter season, the road administration on all levels is bound to maintain what is called "winter duty shifts". It is the basic level administration units where the majority of those duties are assigned. In view of the organization of administrative work, the information about conditions on roads should reach those units as early as possible. In the present data transfer system, an employee on duty manually feeds a computer with data and sends the information immediately to the superior (medium level) unit. If the receiving unit "is not on duty" at the moment, the process of information distribution is halted. The resulting delay could run into tens of hours. Of course, the systems are capable of treating the medium administration level as totally transparent and continue to transmit the data to the central level. However, the medium level administration routinely disable that utility, wishing to avoid the responsibility related with passing on the information without visual inspection of its contents.

The following modification of the data transfer scheme could be a solution of the problem. Rather than traveling through the administration structure, the information could be entered directly to a central database. As before, the basic level administration units would be responsible for entering data to the system. The remaining units would have direct access to the database. Dedicated specialized procedures would be designed and implemented to generate reports. The figure below depicts the proposed model.

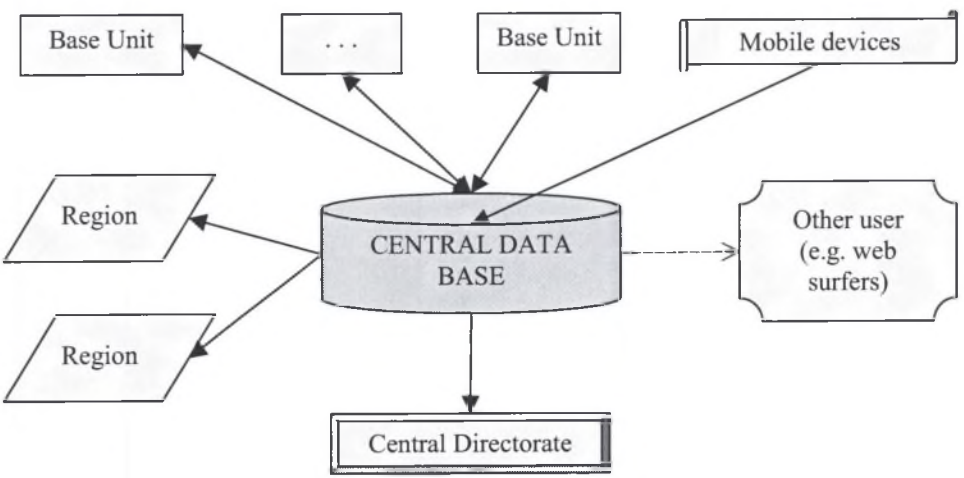

Fig.3. Suggested scheme of data transfer

4. DATA FEEDING THROUGH MOBILE DEVICES

Of many obvious advantages of the model suggested above we wish to list those that are strictly related to the way the information is transmitted.

1. A central server makes it possible to gather all the databases on one site. (as opposed to the system where tens of local databases have to be maintained).
2. Any device with Internet connectivity feature have access to the databases. (The access to databases no longer relies on any specific computer).
3. Data transmissions between individual levels of administration structure are no longer necessary. The same applies to data transmissions among respective application systems.
4. Mobile devices like notebook computers, palmtops, cell phones etc. can be easily connected to the road systems.
5. Information services can be generated on one server, and rely exclusively on one common set of data. The service thus rendered is always up-to-date. The danger that two mutually contradictive pieces of information can be generated by two different administrative units can thus be avoided.

Applications for entering data into mobile devices seem to be very helpful in feeding the central database with rapidly changing information. One of such applications is shown in the figure below. The application runs on Compaq iPAQ Pocket PC and supports gathering the information about traffic restrictions.

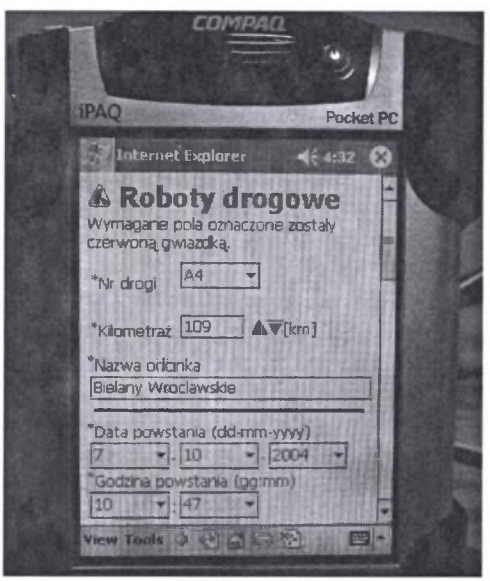

Fig.4. Data acquisition through a mobile device

5. DATA GATHERING BY AUTOMATIC ROAD STATIONS

A large number of automatic road station have been installed by the road administration over the past years. The stations take measurements of various weather and road parameters that are later partially utilized by the Winter system:

- Temperature
- Rainfalls and snowfalls
- Magnitude and direction of wind
- State of pavement

Some of the stations (e.g., ones serviced by TRAX Electronics, Cracow) are configured to gather and transmit data to computer servers as frequently as several times an hour. The Winter system has been modified so that the station-originated measurements can be utilized. The system was set to work on a trial basis in Poznan Regional Unit in the first quarter of 2004.

The stations turn out to provide efficient means for transmitting weather-related data. As soon as the measuring devices are checked and possibly replaced, the Winter system will no longer require manual data feeding. One major difficulty appears when it comes to the correct identification of the state of the pavement based on the station data. An algorithm for the recognition of the pavement state was improved and will be tested in the fourth quarter of 2004.

6. CONCLUSIONS

The analysis of the systems that have already been implemented, as well as the results of research work, the following final conclusions can be drawn:

1. All the databases of applications that support road management should reside on one central database server.
2. Data acquisition should be automated whenever possible.
3. The remaining data should be entered into systems as soon as it is available, e.g. by means of mobile devices operated by personnel working directly on roads.
4. Putting the above-listed postulates in effect would ensure that current and precise information about road conditions become available both to the road administration and to the road users.

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