Archives of
Transport System
Telematics

Volume 5
Issue 3
September 2012

# Standards of data transmission protocols for the traffic management system

**S. SURMA[a], J. MIKULSKI[a]**
[a] FACULTY OF TRANSPORT, Silesian University of Technology, Krasinskiego 8, 40–019 Katowice, Poland
EMAIL: szymon.surma@polsl.pl

**ABSTRACT**
Article is a summary of works, the purpose of which was to determine the standardized data protocols for the National Traffic Management System

**KEYWORDS: ITS, Traffic Management System DATEX II**

## 1. Introduction

In 2012, work started on the creation of National Traffic Management System. Within the framework of cooperation between the government and non–government sector, ITS specifications were developed to be the basis for the development of National Traffic Management System. Article presents the results of the works, the task of which was to develop technical specifications for data transmission protocol standards for the traffic management system.

## 2. Scope of impact

Architecture of the traffic management systems is a layered one. An example of a simplified model of traffic management system architecture is presented in Fig. 1.

The range of substantive impact should be understood as the definition of system layers for which it was necessary to determine the data transmission protocols. The "depth" of interference with the roadside devices was analyzed, including the determination of means of communication between the sensors and the device controller. Two solutions were developed which differed in the range of definition of communication. Version A (Fig. 2) included the determination of transmission protocols between the roadside devices and the central computers. Version B (Fig.2) would also include the definitions of methods of communication with the actuating instrumentation such as sensors, motors, etc.

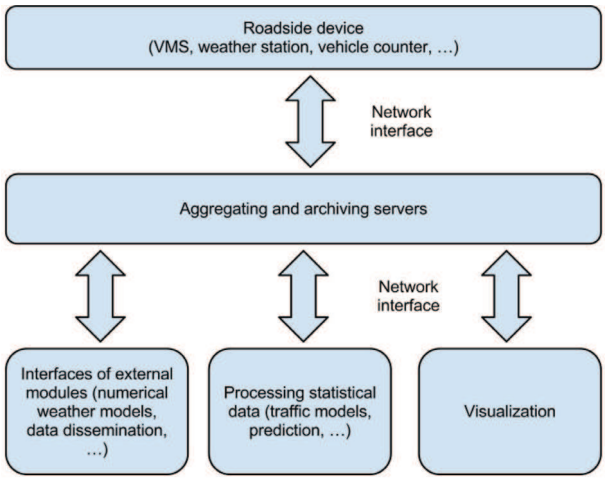


**Fig. 1. A simplified model of the traffic control system**

After analyzing the documentation of the producers of devices it was decided, that Version A will be selected for further work. For reasons of maintenance and servicing of the devices, the necessity was pointed out for the producers of devices to supply the user (the road management authority) with complete documentation of the

system, including the parameters of the individual components of the roadside devices, such as sensors and controllers, along with a description of the communication among them.

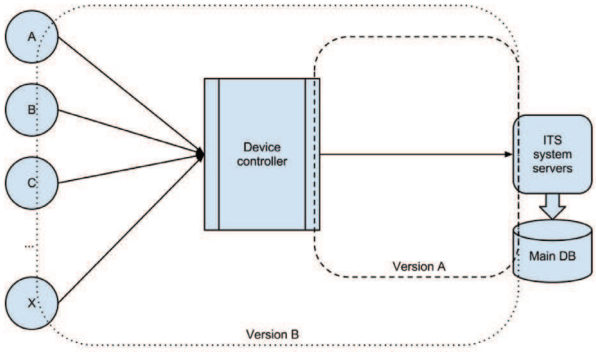


**Fig 2. Options of solutions were analyzed during the work**

# 3. Selection of a protocol for the application layer

After determining the extent of substantive impact, works were conducted on the selection of an optimal communication protocol. Due to equipping the roadside devices with controllers which, in addition to transmitting information from the sensors, are designed to aggregate information and its short–term archiving (in the case of loss of connection), it was stated that it is possible to use the existing protocol of the application layer of the OSI model instead of developing new authored (binary) protocol. After carrying out the tests of the existing protocols and their properties (DATEX II, TLS, NTCIP, UMTC, MTM), it was decided that DATEX II and TLS should be adopted for further consideration.

The main criteria for the selection of protocols were:

- openness,
  - possibility of obtaining documentation,
  - possibility of adopting to the needs of national specifications,
- free of charge / licensing,
  - use of the protocol should not be burdened with any charges,
  - license to use the protocol should not restrict its application,
- promise of continuity of standardization,
  - possibility of development,
  - continuous activity, adopting the documentation to the changing market conditions (keeping pace with technological development).

The conclusion was that:

- DATEX II protocol is consistent with the conditions above:
  - presently the work on DATEX II version has been completed,
  - the documentation provides for the possibility of introducing additional components without the need to inform the standardization authority,
  - use of the protocol is free of charge,
  - the documentation of the protocol is available free of charge on the web www.datex2.eu,
  - EasyWay – the project which includes DATEX II protocol is supported by the European Parliament,
- TLS protocol is in part consistent with the above conditions. Its principal disadvantages are:
- the cost of documentation,
  - design with backward compatibility with devices implemented in one country (Germany) in mind,
  - requirement of the existence of additional roadside infrastructure (workstations),
  - protocol encapsulation for transmission with the use of TCP/IP (TLSoIP) protocol.

# 4. DATEX II communication protocol

A suggested communication protocol for the transmission of data, on the basis of the analysis of documentation, as a protocol most adaptable in Polish conditions. This is a protocol described in UML language, with markup described in an XML structure. It contains a definition fpr most of the values acquired from roadside devices and allows for the control of roadside devices.

DATEX II allows the definition of extensions in accordance with CEN/TS 16157–1:2011. These extensions have different levels of interoperability and defined restrictions.

Three levels of extensions are defined:

- Level A of the DATEX II data model
  basic/base model. An extensive base data model (called "level A") is suitable for most scenarios of data exchange. This model already has a huge amount of options from which users can select individual items when compiling the data for "publication". It is a minimal set for all DATEX II systems which must be met in order to ensure interoperability. Implementations should fully support level A.
- Level B of the DATEX II model.
  extended base model – in the situation when in the concept of data required for the particular uses is missing from the Data Dictionary, for example when the data makes sense only in a national context. In this case users have to provide an extension to the model B (called "level B") which provides the missing concepts. Users can apply a limited set of well–defined UML mechanisms for these extensions at the level B, which then still maintain the technical interoperability with the standard DATEX II systems (level A). This means that the customer supporting only level A is able to receive and decipher the information sent by the service provider using an extended level B, but he will not be able to decipher the part of the "publication" covered by the extension.
- Level C of the DATEX II data model
  Use of the concept DATEX II in various content – models and implementations of level C are considered to be inconsistent with DATEX II model, level A/B. However, they are consistent with all other DATEX II specifications (common rules for modeling and common exchange protocols). Of course, C level systems are not compatible with level A and should not be used for the EasyWay exchange.

The application in National Traffic Management System will have all three levels of the model described in the Datex II protocol documentation. The application of this protocol will allow making uniform the exchange of information on all levels of the control system and for standardizing the manner in which information is transferred in the system. Standardizing the description of the variables is supposed to lead to full independence of the devices, ie. Each one based on the documentation of the protocol will be able to adapt the device to cooperate with the National Traffic Management System.

# 5. Aggregation, preliminary data processing and data transmission rules

Roadside devices, in accordance with the concept of National Traffic Management System, have to transmit data in two modes:

- on demand
- at intervals

Both modes can operate simultaneously, with the mode "on demand" initiated by an external application (e.g. by Road Transport Inspection officers). The „at intervals" mode will be active continuously and the data aggregated during the intervals will be sent to the central servers.

Regardless of the mode of operation used, the aggregation of data was analyzed from the perspective of the amount of generated data, as illustrated in the following figures. Due to the fact, that the number of generated data is usually larger than the throughput of the communication link (for example, sending information about each registered vehicle by a vehicle counter), two solutions were analyzed:

1. each component of the infrastructure has its own aggregating server (Fig. 3),
2. all infrastructure components at a given point are connected to one aggregating server (Fig. 4).

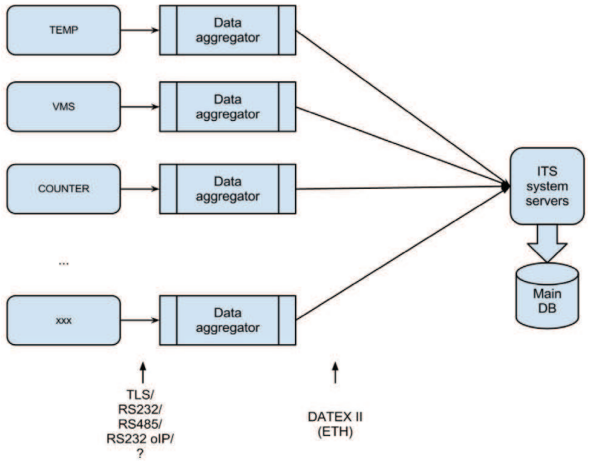


**Fig.3. The model for transmitting information and protocols used in roadside devices ITS – the model with separate aggregators for each device**

The prerequisite for the second solution would be for all cooperating devices to be supplied by one producer and to own separate interfaces for individual components (e.g. different IP addresses or ports numbers for meteorological stations, VMS and scales), i.e. the virtualization of devices cooperating with an aggregator from the perspective of the traffic control system. The main argument for this solution would be the reduction of costs of a single roadside device through the use of less expensive hardware solutions with lower parameters.

However, due to the increase, in this case, of the maintenance complexity of the roadside part of the National Traffic Management System, this solution was assumed to be unfavorable.

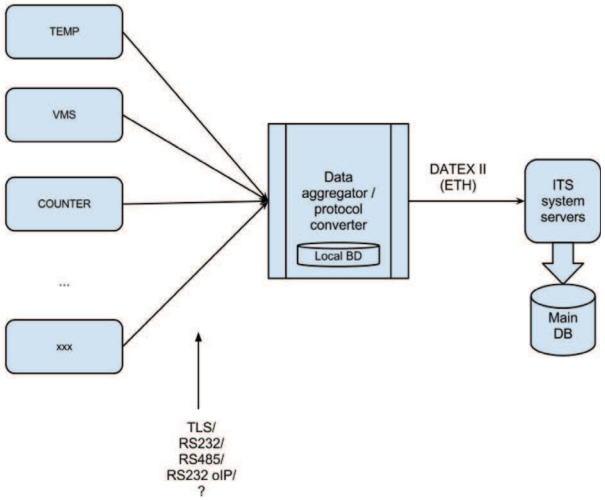


**Fig.4. The model for transmitting information and protocols used in roadside devices ITS – a model with single aggregator for several devices**

# 6. The issue of information transmission – the choice of transport protocol

TCP/IP model describes the layered structure of data transmission between applications, with the use of computer network, and is divided into four layers: application, transport, Internet and network access. DATEX II protocol is contained in the application layer.

The data in the protocol DATEX II, according to the documentation, are sent with the use of http protocol in the push/pull mode, i.e. sent in intervals or on demand. On the other hand, http protocol uses, in the transport layer of the assumed model, the TCP (Transmission Control Protocol).

The above solution is based on http and TCP protocols and allows transfer of data both formatted with DATEX II protocol and any other binary and text files. Due to the widespread implementation in the devices operating in ITS systems, it was decided to allow the use of FTP protocol (File Transfer Protocol) to transmit binary files, such as images.

# 7. The diagnostics of roadside devices in National Traffic Management System – SNMP protocol

In accordance with the decisions made, the diagnostics will be carried out based on SNMP protocol. It is possible to simultaneously carry out the diagnostics based on DATEX II protocol, however, it will not allow such a broad spectrum of diagnostics of the particular components of the system as SNMP protocol allows. Hence it was decided to stipulate two separate levels of diagnostics – for system operators and for maintenance staff / system administrators:

- The diagnostics for system operators:
  - for information purposes – for a system operator, the data should be generalized and, most often, reduced to the information "good" – "fail". For this purpose, DATEX II protocol can be used together with the extensions B and C. The complete documentation of information made available or transferred by a given device shall be included in the technical documentation of the device.
- The diagnostics for maintenance staff/system administrators.
  - for maintenance or administrative purposes a higher level of information detail is required, which cannot be obtained with the use of DATEX II protocol. For this purpose it is suggested to use SNMPv3 protocol.

The definition of the information about components of roadside devices and information which can be obtained from them should be described in the MIB's (Management Information Base) of each device, ie. the set of information possible to read or change with the use of SNMP protocol. The data block of basic information ( e.g. device ID, device name, device location, time of launch, etc.) should be specified when creating the specification of the system diagnostics. The data block of information possible to obtain from devices, allowing for a wider diagnostics, should be described in the documentation of the device.

# 8. Conclusion

DATEX II protocol, as a communication protocol, was chosen as an intermediate solution between the existing protocols and the creation of new authored communication protocol. It is necessary to carry out further work in order to determine the content of B and C extension of DATEX II protocol, so that it can be used to transfer data from the currently used and from introduced devices.

The creation of an entirely new protocol would require a lot of time and human resources. An adaptation of the chosen protocol will allow its quick implementation. It should be emphasized that the implementation of the DATEX II protocol will take place on Polish territory, where the current ITS infrastructure is very poor and the individual centers are just beginning to implement ITS solutions of insular character. Such single implementations have unfortunately one feature in common – if they are not manufactured by one company, they will not cooperate with each other and thus they will not work with the National Traffic Management System.

National Traffic Management System will be the standardizing link, if not for the whole ITS systems, then for their interfaces, which will ultimately lead to the improvement of functioning of Polish road system and thus to the reduction of unit costs of transportation.

# Bibliography

[1] DATEX II project site http://www.DATEX II.eu/ (acces date 02–07–2012)