THE CONCEPT OF MONITORING A TELETRANSMISSION TRACK OF THE HIGHWAY EMERGENCY RESPONSE SYSTEM

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Summary
Intelligent transport systems usually operate in diversified working conditions. As elements participating in the transport process, they should keep their usability. That is why the elaborations in the scope of ensuring proper values and indices of reliability and operation are so important. The article presents issues regarding monitoring of the fibre optic cable teletransmission track of the highway emergency response system. The overriding goal is to aim for maintaining a usability state for that transmission medium.

Keywords: transport telematics, fibre optic cables, highway emergency response system

KONCEPCJA MONITOROWANIA TORU TELETRANSMISYJNEGO ALARMOWEJ ŁĄCZNOŚCI AUTOSTRADOWEJ

Streszczenie
Inteligentne systemy transportowe pracują najczęściej w zróżnicowanych warunkach eksploatacyjnych. Jako elementy biorące udział w procesie transportowym powinny zachować stan zdatności. Dlatego też tak istotne są opracowania z zakresu zapewnienia odpowiednich wartości wskaźników niezawodnościowo- eksploatacyjnych. W artykule ukazano zagadnienia dotyczące monitorowania światłowodowego toru teletransmisyjnego alarmowej łączności autostradowej. Nadrzędnym celem jest dążenie do zapewnienia stanu zdatności temu medium transmisyjnemu.

Słowa kluczowe: telematyka transportu, światłowody, system autostradowej łączności alarmowej

1. INTRODUCTION

The term "Telematics" comes from the French language (Fr. télématique) and it started to be used at the beginning of 70's of the twentieth century. It was coined using two French words: telecommunications (Fr. télécommunications) and information technology (Fr. informatique). This term started to be used in English at the end of 70's of the twentieth century. At the beginning, it was not commonly used. Only when the EU programmes aimed at developing telematics in different areas were started, the term became more popular. Today, the term "Telematics" is used to describe sciences integrating the telecommunications and IT solutions. Such solutions are applied everywhere where this combination can bring benefits, compared to isolated solutions. One of the areas, in which the term is used, is transport [21].

The transport telematics uses advanced electronic devices as well as telecommunications and IT systems in transport. It enables to implement modern services in transport, most of which could not be offered to travellers and carriers.

If we apply the specialised IT applications that make use of data from the transport telematics systems, it will make it possible to create Intelligent Transport Systems (ITS). They are currently one of the most complex systems in transport. Their effectiveness depends on the amount of information received from the measuring devices [17, 19] and algorithms used in computer programmes. These systems should be characterised by scalability of extension, so that they can be gradually modernised and supplemented. Only then, their complete use in terms of the implementation of constantly newer technologies will be possible. The primary goal of the ITS operation should be to ensure such interoperability of all subsystems to achieve the following benefits [18]:

- the increase of transport safety [13],
- the increase of efficient use of infrastructure [20],
- the improvement of economic indicators related to transport [4],
- the increase of reliability of transport,
- the increase of the degree of ecological environment protection,
- the improvement of travel comfort.

Intelligent transport systems most commonly operate in diversified maintenance conditions [3]. As elements participating in the transport process, they should keep the state of usability. Therefore, the elaborations in the scope of ensuring proper values and indices of reliability and operation [1, 2, 5] are so important. To this end, the simulations in the scope of reliability [8] and maintenance [9, 16] of the intelligent transport systems (also taking into account the impact of electromagnetic interference [14]) are conducted. It enables to develop new concepts, the aim of which is to ensure appropriate values of the indices of reliability and operation (e.g. availability rate). The article presents issues regarding monitoring of the fibre optic cable teletransmission track of the highway emergency response system. The overriding goal is to aim for maintaining a usability state for that transmission medium.

2. HIGHWAY EMERGENCY RESPONSE SYSTEM

One of the transport telematic systems that is used for highways is the highway emergency response system. It is used to transmit information (most commonly emergency ones, e.g. accidents, collisions, etc.) from users in one section of the highway to the highway section surveillance station [10, 11].

The highway emergency response system includes, among others, emergency roadside telephones. They make possible the communication between them and the surveillance centre of a given section of the highway. Depending on the type of the emergency roadside telephone, it is possible to establish the bidirectional communication (signalling the report and acoustic listening) or unidirectional communication (only signalling the report with an emergency button). The user of the system (e.g. driver), by pressing the emergency button in the highway emergency roadside telephone, contributes to the transmission of information to the surveillance centre. The sent message contains an identification number of the emergency roadside telephone. Thanks to that, the operator knows the location of the emergency roadside telephone and also has knowledge of the area on the spot of the incident. It allows to efficiently inform relevant services and take reasonable steps in order to help the person, who reports the incident. At the same time, the operator can remotely activate a flashing light installed on emergency roadside telephones. In case of the bidirectional communication, he/she connects with the emergency roadside telephone, from which the emergency call is done as well as a conversation with the user, in order to determine the details of the event and the scope of assistance to be granted, is conducted.

One of the highway emergency response systems is the STOER system (Fr. Systeme de Transmission Optique pour Equippements de la Route). It is a solution of emergency communication where a fibre optic cable is used for transmitting information between network nodes. It is laid in the ground, along the highway. Using fibre optic transmission ensures resistance against environmental electromagnetic interferences and high bitrate. The overall architecture of the highway emergency response system was shown in Fig. 1.

The fibre optic highway emergency response system consists of the following subsystems:

- The Surveillance Centre (CCS) – it manages the reports received from users, and also allows to take reasonable steps adequate to the occurred road situation (e.g. notifying the ambulance service, fire department),
- the optoelectronic interface device – it enables the bidirectional transmission via the applied fibre optic cable,
- systems of passive optical couplers – they are connected with the fibre optic cable designed for the fibre optic emergency response system. They make it possible to connect all emergency roadside telephones on the same branch using one fibre for the branch,
- the electro-optical interface (a field optical box FOB (Field Optical Box)) – it is assigned to each pair of the emergency roadside telephones and connected with the main emergency roadside telephone. The connections between FOB and the main emergency roadside telephone are conducted using a short multi-couple cable. It facilitates the maintenance intervention in case of the damage to the emergency roadside telephone, e.g. by the vehicle striking.

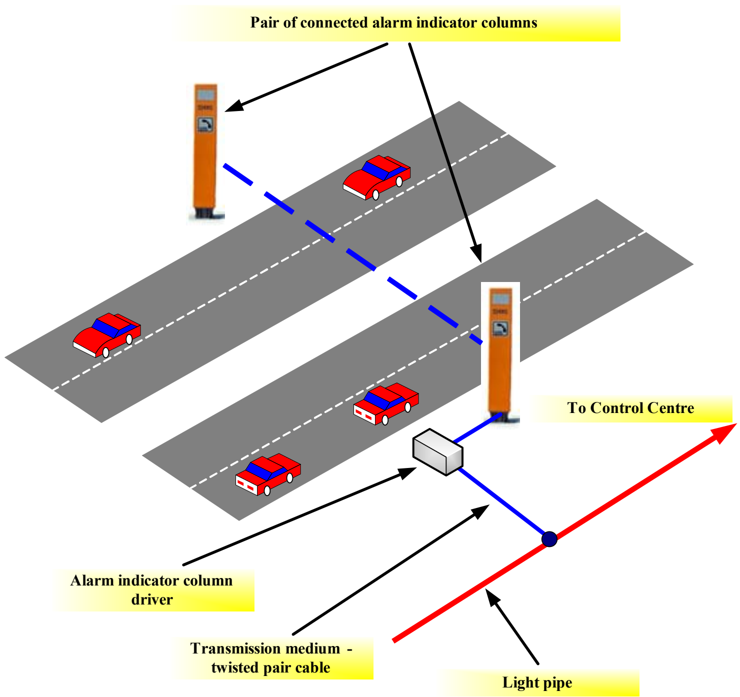

Fig. 1. Architecture of the highway emergency response system

Emergency roadside telephones (major and minor) are located along the highway on both its sides. They create branches from the surveillance centre. The main emergency roadside telephones consist of the electronic system (audio-frequency amplifier, link input, acoustic system with a microprocessor, modem and interface), microphone, loudspeaker, emergency button.

3. MONITORING A FIBRE OPTIC TELETRANSMISSION TRACK OF THE HIGHWAY EMERGENCY RESPONSE SYSTEM

The management of the ICT network can be defined as creating the conditions, in which the network elements can provide services to its users. The increase in the complexity of the managed networks, their heterogeneity, as well as the increasing customer expectations with regard to the diversity of the provided network services result in the necessity to automate the process of managing the network and services. At the same time, it is important to strive for the integration of the management systems, both belonging to various operators and those managing different subnets or services within the network of one operator. The subject matter of maintenance of the network can be considered in two ways. According to the first way, the network should not be monitored, and the response to emerging irregularities should appear right away. The second way is monitoring the network. This approach involves the continuous monitoring the network and ensuring that the network elements function correctly. If the operator has appropriate resources, then the continuous monitoring is a more favourable solution, which allows you to counteract adverse events.

In the ITC networks using the fibre optic media, the damage of the fibre optic cable is the most common one. The damage of the regenerator is also possible, but it is treated on an equal footing with the damage of the fibre optics. This is because a given section is functionally in the state of unfitness.

From the point of view of ensuring proper values of the indices of reliability and operation, monitoring the state of the network is essential [12]. Then, the swift detection of errors and occurred damage will be possible. Therefore, it is preferable to use the continuous monitoring of the ICT network. In case of using fibre optic cables, the system of automatic control of the optic fibres can be applied. In the event of the detection of the state of unfitness (partial or complete), the relevant services can take actions to restore the state of usability. The automatic control systems of the optic fibres the most often allow to the accurate determination of the damage location. In combination with the terrain map, in which the routes of cables are included, services immediately receive detailed information as to the damage location of the cable. The situation is similar in case of deterioration of transmission parameters (e.g. increasing the attenuation of welded joints).

The automatic control systems of optic fibres mostly function independently of the teletransmission devices, which also indicate various kinds of states of unfitness. The operation of these systems means cyclical taking the reflectometric measurements with the frequency adjusted depending on the road validity. The wavelength (e.g. 1625 and/or 1310/1550 nm) also depends on the applied optic fibre cables. The system can measure both "dark" and working fibres. Attenuation curves are periodically read and compared with the previous ones. In the event of changes exceeding the accepted limit values, the state of unfitness in the surveillance centre is indicated. Fig. 2 shows a general scheme of the automatic control of optic fibres used in the highway emergency response system.

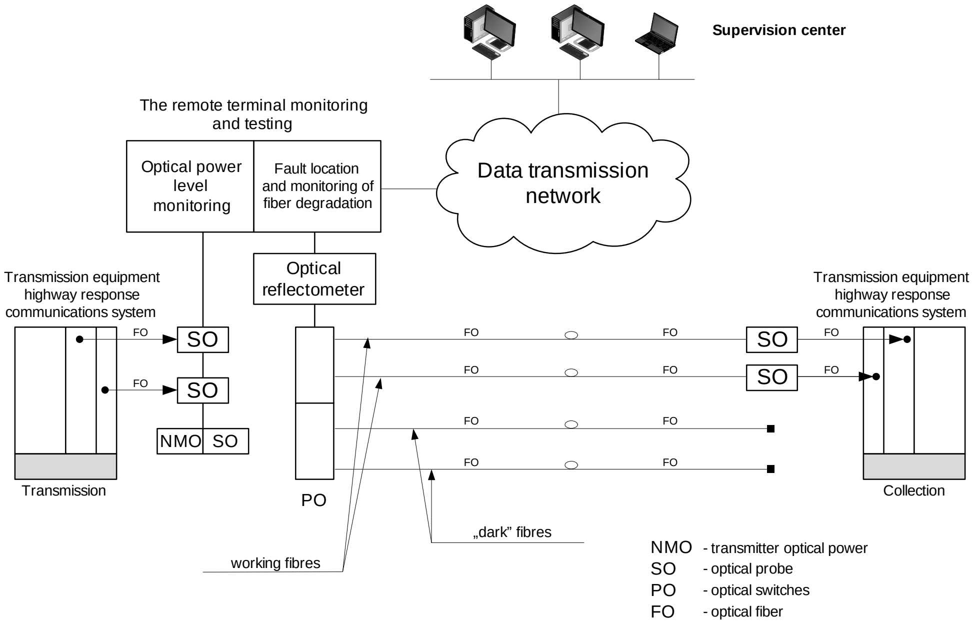

Fig. 2. Scheme of the automatic control of optic fibres

The OTDR measurement technique (Eng. Optical Time Domain Reflectometer) can be applied in the reflectometric measurements of the optic fibres [7, 15]. It allows to determine the attenuation of the fibre optic track, which makes it possible to assess the quality of the tested fibre optic line. Thanks to that, it is possible to assess the attenuation of individual sections of the line, the attenuation brought by separated and welded joints, or to locate the damage. The sample reflectometric measurement result of the optotelecommunication line was presented in Fig. 3. It shows, among others, the length and attenuation of the tested fibre optic line as well as the attenuation of passive elements included in the optotelecommunication system.

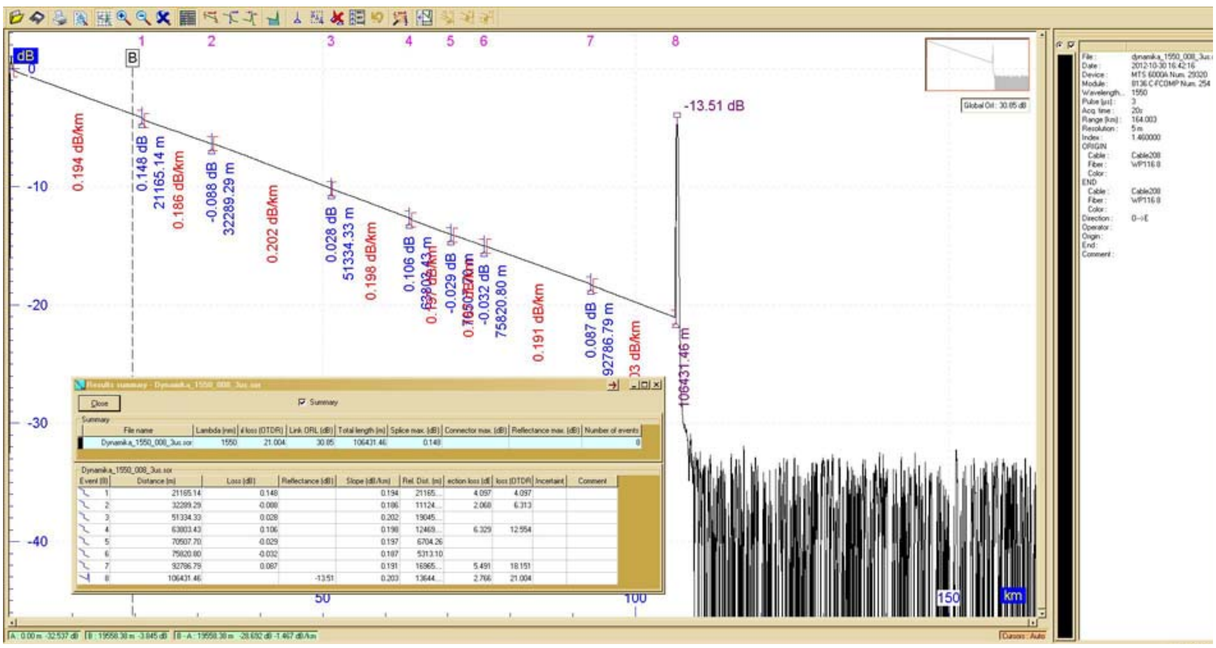

Fig. 3. Reflectometric measurement of the tested fibre optic track [15]

The presented concept referred to monitoring the fibre optic teletransmission track of the highway emergency response system. However, it is crucial to remember about the other subsystems, which also affect the availability rate of the whole system.

4. CONCLUSIONS

The article presents the issues related to the highway emergency response systems. Their construction as well as transmission media were shown. The special attention was paid to the issues connected with providing appropriate indices of reliability and operation of the applied transmission medium, such as the fibre optic cable. Therefore, the concept of monitoring this transmission track through the continuous control was presented. Such a solution enables the earlier detection of partial incapacity caused by e.g. increased attenuation of a welded joint. Archiving of attenuation curves of particular optic fibres and their analysis make it possible to increase the readiness level of that transmission medium. The complete information on the nature of interferences and their location makes it easier to take decisions with regard to the activities which are going to be performed by the service teams. Additionally, the transmitted information and data are also protected through the constant control of power of the transmitted optic signal.

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