V2X Technology-Based Electronic Devices for Intelligent Transportation Systems Tasks

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Abstract. The work describes the task of modern intelligent information systems devices developing. The prospects of using V2X technology for the segment of civil and special purpose vehicles, as well as its applicability for solving of road safety problems, have been evaluated. An experimental model of an on-board electronic device designed for organizing dynamic communication of transport network participants under unstable cellular coverage is shown. The transfer of information between vehicles with low or no signal is carried out via the V2X network, the nodes of which are vehicles located within a radius of up to 2 km. Areas and scenarios of the possible application of development are considered, the most promising functions are described.

1. Introduction

Intelligent transport system is a system uses modern technologies for modeling of traffic flows, which provides customers with greater informativity and road security, as well as a realisation of safety algorithms for traffic participants interaction compared to traditional transport systems [1-3]. In recent years, the emphasis in ITS has turned specifically towards the new generation – cooperative intelligent transport systems [4-6], which means mutual interaction between vehicles, infrastructure objects. Cooperative systems imply the use of large amounts of data describing the characteristics of vehicles and their behavior in road conditions, guaranteeing the reliability of the information being processed.

Despite the high prospects for the development of the direction, there are no fully implemented projects on the construction of a telecommunication network available for free use by participants in the transport infrastructure on the market. The reasons for this phenomenon vary widely, ranging from the fragmentation of technological design methods [7-9], which complicates the process of integrating vehicles / devices of urban infrastructure into a single network, to problems of a legal nature that require administrative approval for approbation of test technical solutions [10-12]. Both types of problems require for their solution the conclusion of centralized agreements between the interested parties in order to jointly promote technologies of intelligent transport systems.

Taking into account modern trends, a digital electronic device has been developed, designed to provide communication services by organizing a dynamic information network between participants in traffic. The developed system does not require third-party infrastructure facilities to function, which facilitates the implementation process.
2. On-board communication device
The developed device is installed on personal and public civil transport, as well as special purpose vehicles (figure 1) [13].

![On-board communication device](image)

**Figure 1.** On-board communication device.

Exchange of information between the vehicle in low level, and no signal conditions is performed by transmitting it by V2X-network via the vehicles (equipped with developed communication devices), which are within a radius of 2 km (nearest vehicle is used as a signal repeater). The developed solution is based on a principle of Vehicle Ad-hoc Networks, which specialized for “machine-to-machine” data transmission [14-16]. Vehicle Ad-hoc Networks is a special case of Mesh-networks. A mesh-network is a distributed, peer-to-peer network where each node has the same authority as everyone else. Another types of mesh-networks are MANET - a network of mobile devices [17] and FANET - a network of unmanned aerial vehicles [18].

The system operates on the basis of developed software. Embedded software is an integral part of the on-board device and is distributed in a pre-installed form or as a binary image of non-volatile memory, which includes all the necessary system and application software, in particular operating system. The control software is responsible for starting and initializing the operating system service, within the framework of which the device software modules operate that control its hardware components – DSRC modem, LTE modem, GPS / GLONASS receivers, accelerometer and gyroscope, Bluetooth and WiFi network interfaces; and is intended to implement the target functions of the onboard DSRC device of the smart car network:

- Broadcast urgent alerts: about emergencies, about worsening weather conditions, about the road situation, mass events, etc.
- Emergency alarms to specialized services transmission (figure 2): requesting medical assistance, requesting technical assistance, reporting of accidents (cooperation with navigation satellite systems), etc.
- Traffic situation control in order to collect statistical data, quickly detect traffic jams, inform drivers and traffic control services.
- Collision avoidance between vehicles, including autonomous vehicles, by directly exchanging data with environmental sensors.
- Telemetry information transfer from vehicles to data collection centers.
The main commercial result of the development is to provide customers outside the coverage area of base stations of conventional mobile networks with an operational communication service built by organizing a communication network between serial vehicles (figure 3).

3. Conclusion
The development of an operational communication service for transport systems is an urgent research task in the context of improving road safety. The sphere of implementation of the development is private civil and special transport, including the promising segment of autonomous (unmanned) vehicles, where the need for such communication means is extremely acute [19-23].
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