

ASOP Symbol Transport. Brief technical description

Introduction

The automated fare collection system (ASOP) "Symbol Transport" (hereinafter referred to as the System) is designed to organize and record public transport fares, introduce modern payment methods, collect and analyze passenger traffic data.

The purpose of this document is to provide an overview of the functions and specifications of the Symbol Transport ASOP. At the same time, the specific configuration of the "Symbol Transport" System and the corresponding prices are set out in the Commercial Offer.

Terms, definitions and abbreviations

ethernet	A family of packet data technologies for computer networks
FTP	File Transfer Protocol - file transfer protocol
GPRS	General Packet Radio Service - standard for data transmission in cellular networks
GPS	Global Positioning System (global positioning system) - satellite navigation system
GSM	Global System for Mobile Communications - digital cellular standard
NFC	Near Field Communication (near field communication) - a short-range wireless high-frequency communication technology that allows the exchange of data between devices located at a distance of up to 10 centimeters
WiFi	A family of standards for the transmission of digital data streams over radio channels
HTTPS	HyperText Transfer Protocol Secure is an extension of the HTTP (HyperText Transfer Protocol) that supports encryption. The HTTP protocol is now ubiquitous on the Internet.
MAC	Message Authentication Code (message authentication code). Means of providing imitation protection (protection of an encryption communication system or other cryptosystem from the imposition of false data) in message authentication protocols with mutually trusting participants
SOAP	Simple Object Access Protocol (simple object access protocol), used to exchange arbitrary messages in XML format
SSL	Secure Sockets Layer (secure sockets layer) - a cryptographic protocol that ensures communication security
USB	Universal Serial Bus (universal serial bus) - serial data interface for medium-speed and low-speed peripherals
IBIS	Input / Output Buffer Information Specification - a specification that describes the behavioral models of input and output buffers of microcircuits, microcircuit packages, as well as all kinds of connectors

WAV	Container file format for storing a recording of a digitized audio stream, usually in uncompressed form
MP3	File format for storing compressed audio information
MassPay	Mass payment service designed to quickly make a large number of payments in batch mode
MIFARE	Trademark of a family of contactless smart cards
Visa payWave	International payment system standard compliant contactless payment capability based on ISO/IEC 14443 standard and VISA technology. This method of making a payment is carried out by presenting the card to the payment terminal and allows you to make payments for amounts up to a certain amount (different in different countries) without confirmation with a signature or PIN code
workstation	Automated workplace
Beatmapping	A bit memory structure of a card representing in binary form a travel document of a public transport fare system
Tear-off ticket, check, receipt	Document confirming the fact of travel payment
Customization	Adapting an existing product to a specific consumer
ON	Software
Reader	Interface device for reading and writing information on smart cards
System	Symbol Transport system
UEC	Universal Electronic Card
ECL	Electronic control tape - a file containing operations carried out on terminal equipment with a loaded transport application

"Symbol Transport" - features and benefits

"Symbol Transport"- automated fare collection system suitable for most types public transport - metro, buses, trolleybuses, trams and minibuses. The system complies with the standards of work of transport enterprises - opening and closing shifts, release on the route, change of flight, travel zoning, centralized change of tariffs.

The System can use and account for both cash and non-cash forms of fare payment. Various payment methods are available for the non-cash form: contactless transport cards, bank cards with a transport application, Visa payWave bank cards, social cards (also based on contactless smart cards) and mobile payments (NFC).

The use of both portable and stationary terminals in the System allows you to equip any type of vehicle and implement any fare payment scheme (conductor or non-conductor).

The two-tier architecture of the System ensures rapid implementation as well as simple and inexpensive operation. Data between the terminals and the central server is transmitted in encrypted form via a GPRS communication channel, which ensures prompt exchange of information and low operating costs.

Use and accounting in the System of both cash and non-cash payments	<ul style="list-style-type: none"> • Complete information on the services provided by transport operators. • Coverage of 100% of passengers from the moment of implementation. • Convenience for passengers - a gradual transition to a cashless fare system, which is easier for the passenger compared to the abrupt cessation of accepting the usual cash payments
<p>A wide range of non-cash payment methods:</p> <ul style="list-style-type: none"> - Transport Card; - social card; - a bank card with a transport application; - mobile payments (NFC); - Visa payWave 	<ul style="list-style-type: none"> • The possibility for the passenger to independently choose the most preferred method of non-cash payment, which speeds up and simplifies the transition from cash to non-cash payments. • Reducing the number of cash payments and, consequently, the cost of collecting and processing cash
Implementation of non-cash payments based on contactless smart cards	<ul style="list-style-type: none"> • High security of cards and operations performed with them (replenishment of cards and fare payment). • No need for mechanical contact between the card and the terminal (unlike magnetic cards or coupons) reduces operating costs. • High speed of interaction between cards and terminals, which speeds up card validation
<p>Possibility of using various types of tariffs:</p> <ul style="list-style-type: none"> - a one-time trip (fixed cost or zonal - only for a conductor scheme); - travel card for a certain number of trips (with a limited period of validity); - travel card for a certain time without limiting the number of trips 	<ul style="list-style-type: none"> • Possibility to create the most convenient and progressive tariff system
Printing a check (tear-off ticket) confirming payment, regardless of the payment method	<ul style="list-style-type: none"> • The passenger always has a document (receipt) confirming the fact of payment for the fare. • Controllers do not need additional equipment to check fares
Automation and accounting of all ways of paying for travel, as well as reducing the share of cash payments	<ul style="list-style-type: none"> • Increasing the collection of revenue by an average of 10-30%. • Significant reduction in the number of abuses by both passengers and carrier personnel

The ability to connect various devices to the System, regardless of the manufacturer	<ul style="list-style-type: none"> You can implement any fare payment scheme: conductor or non-conductor
The transport card recharge network can be integrated with existing payment acceptance networks and/or ATMs	<ul style="list-style-type: none"> A significant reduction in the costs of creating a network of replenishment of transport cards. Convenient and familiar ways for passengers to top up
Compliance with the standards of the transport company: work according to schedules (release on routes, change of flights, etc.), opening and closing shifts	<ul style="list-style-type: none"> Easy integration of the System into the processes existing at the transport enterprise. The concepts and procedures familiar to the carrier's personnel are preserved - simplification of training
Efficient daily collection of passenger flow data with details by time, carrier, route and stop, as well as the creation of reports on the collected data	<ul style="list-style-type: none"> Opportunity to optimize the public transport schedule, which will allow more efficient use of the existing rolling stock. Subsidization (reimbursement of shortfalls in income) of transport enterprises based on real indicators. Analysis and optimization of the replenishment network
Two-tier architecture	<ul style="list-style-type: none"> Rapid implementation. Simple and inexpensive operation
Data transfer between terminals and central server via GPRS	<ul style="list-style-type: none"> Significantly simplifies and reduces the cost of the data exchange procedure, and hence the operation. Ability to remotely manage information in terminal equipment (tariffs, routes, etc.)
Turnkey solution, customization	<ul style="list-style-type: none"> Modification of the system individually according to the requirements of the Client. Rapid implementation (on average 3 months). Completely independent system

General scheme of work

The automated fare collection system is a set of software, software, hardware and equipment operating as part of the complex and united by common information flows. The system can be supplied in the minimum basic configuration, but can be supplemented with modules designed to receive and store information about sold tickets and social cards, as well as modules for interacting with External Systems (ticketing, information systems of managing organizations and transport companies), personalization of transport cards etc.

The process of servicing passengers in the System can be conditionally divided into several stages.

1.Obtaining (purchasing) a “transport card”, which is a means of paying for travel in public transport.

By transport card we mean any smart card of MIFARE Ultralight and MIFARE Classic 1K 4B UID standards (including in emulation mode) or CIPURSE on which a transport application is recorded. In reality, these can be special cards intended only for travel, social cards issued by executive authorities, bank cards with a transport application, or mobile devices that support NFC technology. Mandatory conditions are: the presence of a transport application on the map (as mentioned above), as well as the availability of funds to pay for the fare.

Transport cards are purchased through operators:

- at points of replenishment and issuance of cards equipped with cash terminals;
- at remote replenishment points equipped with special equipment.

Renewal and replenishment of previously purchased means of payment is carried out both at points of sale and through self-service devices: bank terminals and payment terminals that have the ability to work with contactless cards.

You can also pay for the fare using cash and Visa payWave bank cards.

The advantage of means of payment with a transport application is the presence of prepaid funds in their accounts, which is actually an advance for the transport company.

2. Fixing the fact of fare payment.

To fix the payment, transport terminals located in the interiors of vehicles are used. Terminals are divided into mobile, located at the conductors or drivers, and stationary, fixed on the handrails.

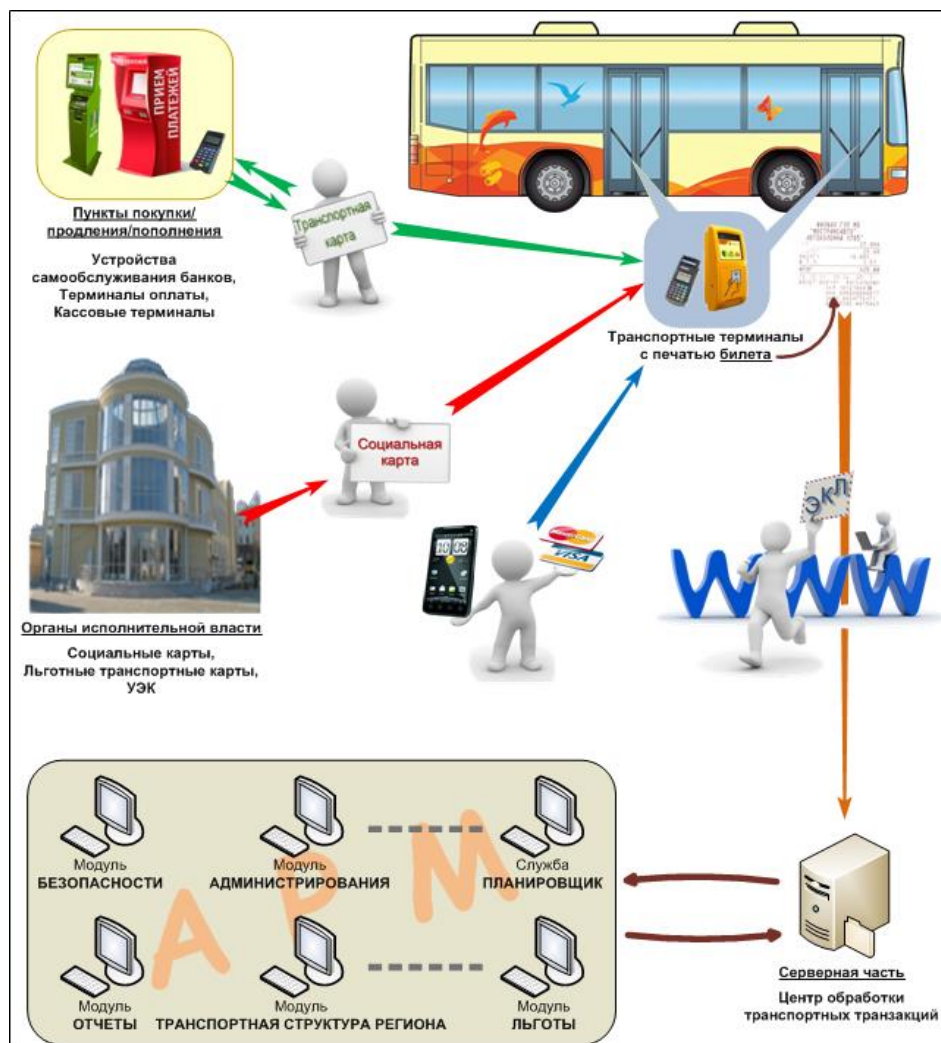
The fact of payment for the fare is confirmed by the seal of the tear-off ticket, which, if necessary, is presented to the controller.

It is also possible to pay in cash for the trip. In this case, the conductor registers a one-time trip with his card, confirming it with a seal of a tear-off ticket.

3. Data exchange with the server.

Before leaving for the route, a new shift opens at the terminals. During the shift, all operations with transport cards - transactions - are recorded in the terminal's memory. At the end of work, the shift is closed or partial unloading is set, which is triggered at a given frequency, and the terminal data is exchanged with the server that processes and stores travel data - terminal collection (the collection procedure is described in more detail below).

The service process is shown schematically in Fig. 1.



Rice. 1. Maintenance scheme

Composition of the System

The system can operate in a minimal (basic) configuration, or can be supplemented with other components, including modules for interaction with third-party systems.

The minimum basic configuration (the functional purpose of the components is given below, in section 4.1 "Components of the basic configuration") includes:

- terminal equipment;
- cash terminals - for the sale, replenishment and renewal of transport cards. Installed at points of sale / replenishment of transport cards;
- transport terminals - for registration of fares, with the function of printing a tear-off ticket. Installed directly in transport or issued to conductors;
- communication module for data exchange between: terminal devices and transaction processing server; between terminal devices and the terminal management system;
- center for processing transport and cash transactions (TSOTT);
- terminal management system;

Basic configuration expansion modules (the functionality of the modules is given below, in Section 4.2 "Connected Components") are:

- card personalization system;
- ticket server.

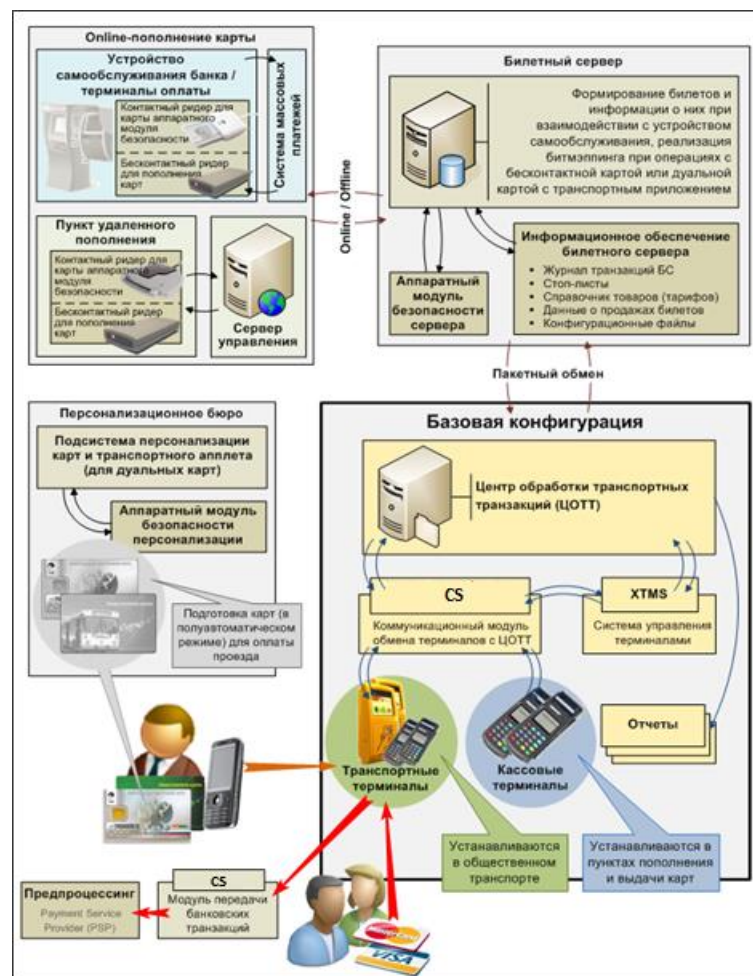
Interaction with external systems is provided according to the developed protocols in accordance with the rules of information interaction. External systems can be:

- mass payment systems of banks, self-service devices and payment terminals;
- ticket servers of third-party organizations-owners of cards (large transport networks, executive authorities and other organizations).

Interaction with external systems is carried out using the secure HTTPS protocol with SSL encryption. The transmission of requests is implemented on the basis of the web services mechanism using the SOAP protocol.

It is also possible to further expand the use of the System - cards with a transport application can also be used to pay for services. In this case, cards with an electronic wallet or a daily limit for the consumption of services (for example, payment for meals) are used. Terminals with special software - trading terminals - are installed in the places where services are provided.

The functional diagram of the System is shown in Fig. 2.



Rice. 2. Functional diagram of the System

Description of System components

Basic Configuration Components

Terminal equipment

The terminal equipment is intended for the sale, replenishment and renewal of transport cards, registration of passenger travel, as well as verification of fare payment using transport cards. The System uses both mobile and stationary terminals.

For the terminals to function, they must be loaded with special FarePlus software.

The software (SW) differs depending on the purpose of the terminal -**cash, transport or trade:**

- cash terminals - designed to carry out sales, replenishment and renewal of transport cards;
- transport terminals - designed for registration of travel using transport cards and ticket sales operations for cash. The fact of carrying out transactions is recorded by printing a paper ticket;
- trading terminals - are intended for performance of operations of payment for services.

Regardless of the type of terminal, **ON "FarePlus" performs the following functions:**

- local preparation and loading into the terminal of parameters received from the server and from the terminal management system;
- support for the operation of equipment, both with built-in and with an external reader of contactless smart cards;
- maintenance of tear-off ticket printing operations;
- records of all transactions in an electronic cash tape (transaction file) with subsequent unloading;
- joint work with TSOTT.

The System uses mobile terminals of the NEW 8210 model or fixed terminals of the model.

Transport Transaction Processing Center component

The Transport Transaction Processing Center (TCTT) component is an automated system designed for collecting, storing, analytical processing (in the form of reports) information on payment and registration of public transport passengers. Primary data on operations related to payment and registration of passenger fares (transaction files - electronic control tapes (ECL)) are received by the CCTT from terminal devices. The data is received in encrypted form, further data protection from unauthorized access is provided by system tools.

COTT provides the following functions:

- administration of software in order to differentiate user access rights, setting up the current configuration of the module;
- loading and processing files with source data;
- viewing information about errors in the System that occur when downloading files;
- viewing the transaction log stored in the database;
- viewing and updating information about transport, personal and service cards;
- generating reports using queries of any complexity written in SQL, viewing reports;
- viewing and adjusting benefits and their groups;
- management of the structure of transport enterprises;
- data exchange via FTP server;
- execution of tasks according to a given schedule.

The set of reports is intended to provide users of the System with information about passenger service, sales operations, replenishment and renewal of travel documents, the number of passengers transported along routes, balances on cards, transportation of passengers of preferential categories, etc.

Communication module CS

The communication module "CS" is designed to provide data exchange between terminal devices with a transport transaction processing center (COTT) and a terminal management system (XTMS).

The exchange is carried out over the https network in encrypted form.

In the process of exchanging with TsOTT, transactions for the sale and maintenance of transport cards are transmitted from the terminals, lists of stop-lists (prohibited transport cards and terminals) are transmitted and downloaded to the terminals.

Configuration files are transferred and loaded from the terminal management system, containing: tear-off ticket forms, tariff parameters of transport cards of different series, tariff changes and dates of their application, route zoning, etc.

In addition to the above data, service information is also exchanged during the interaction.

Terminal management system XTMS

Terminal Management System (XTMS) is a software module designed for operational management and control of FarePlus application software.

The module automates the process of preparing and transferring FarePlus software settings to terminals via communication channels using the RS-232 standard (COM port), GPRS modem or Ethernet adapter.

The module provides the following functions:

- preparation and loading of configuration parameters into terminal equipment;
- downloading software files to terminal equipment;
- differentiation of user access rights and ensuring the necessary level of information security.

Pluggable Components

Hardware-software complex for transport cards personalization

The personalization software and hardware complex is designed to prepare cards for their use to pay for travel in public transport.

The "Personalization of cards" component provides the following functions:

- entry of the ticket form (transport application) on the transport card;
- recording a ticket on a transport card;
- changing access keys to the MIFARE area from transport to work;
- writing an application to the CIPURSE file system

Additional for dual cards(using the personalization hardware security module (AMPB)) operations are performed:

- loading the transport applet into the card's memory;
- loading into the transport applet data for each transport application:
- application identification data;
- diversified access keys to the MIFARE area;
- diversification keys for encrypting/decrypting the bitmapping in the message and forming the MAC message (the keys are calculated using the AMPB);
- other data required for the operation of the transport applet.

Large quantities of transport cards can be produced and personalized by plastic card companies.

Ticket Server

The Ticket Server software package is designed to generate tickets (bitmapping) and information about them when interacting with a self-service device in the course of operations with cards containing a transport application.

The complex consists of two components:

- module for interaction with external systems;
- automated workstation (AWP) - the interface part of the complex, designed for processing bitmapping and data management.

The module for interaction with external systems is the server part of the software package.

The main functions of the interaction module:

- ensuring transactions with electronic travel documents on cards with a transport application: transactions for the purchase, renewal or replenishment of travel documents performed through self-service devices or a remote replenishment point;
- ensuring operations with electronic travel documents on mobile devices that support NFC technology;
- informing the Client-holder of the card with the transport application about the status of the electronic travel document available on his card.

The Ticket Server workstation contains modules that perform various functions. Access to module functions is determined by the type of user permission.

The main functions of AWP:

- differentiation of user access rights and ensuring the necessary level of information security;
- setting up a connection to the Ticket Server and third-party systems;
- viewing and editing information about the enterprise, viewing the list of agents and the structure of enterprises;
- loading configuration and files, editing the Ticket Server settings file.
- adding and editing HSM terminals and web services;
- viewing requests and events occurring during the operation of the Ticket Server, transactions carried out at terminals, information on tariffs and discounts, blocking lists of transport cards;
- unloading ECL;
- setting up and uploading reports;
- setting up scheduled tasks;
- editing templates for printed tear-off tickets.

Tariffs (tickets) used in the System

There are many "ticketing solutions" to satisfy almost any need of passengers. And almost all of them are supported by the System.

Single trip

Fixed single trip:

- gives the right to make one trip by public transport without transfers;
- regardless of the method of payment, the passenger receives a tear-off ticket confirming the fact of payment;
- can be paid with:
- cash (the driver or the conductor applies the appropriate service card to the terminal);

- e-wallet (can be recorded on a transport card, a bank card with a transport application or an NFC mobile phone);
- social card;
- Visa payWave bank card.

Zone single trip(implementation is available only upon payment to the conductor/driver):

- gives the right to make one trip by public transport without transfers from the initial to the final zone;
- the conductor/driver enters the start and end zones, after which payment is made;
- can be paid with:
 - cash (the driver or the conductor applies the appropriate service card to the terminal);
 - e-wallet (can be recorded on a transport card, a bank card with a transport application or an NFC mobile phone);
 - social card;
 - Visa payWave bank card.

Travel cards

Travel card for a certain number of trips with a limited time period:

- gives the right to make a certain number of trips without transfers in a limited period of time;
- each time when making a trip, the passenger is obliged to attach a payment instrument to the terminal (in this case, one trip will be debited) and receive a receipt confirming payment and the right to make a trip;
- can be written to:
 - transport map;
 - bank card with a transport application;
 - mobile phone NFC.

Travel card for a certain time without limiting the number of trips:

- gives the right to make an unlimited number of trips without transfers in a certain period of time;
- each time when making a trip, the passenger is obliged to attach a payment instrument to the terminal and receive a receipt confirming payment and the right to make a trip;
- can be written to:
 - transport map;
 - bank card with a transport application;
 - mobile phone NFC.

Reports

Information about all operations with tickets - sale, replenishment, renewal, return, fare payment - are transferred to the transport transaction processing center (TSOTT). Transactions of travel by bank cards and social cards of preferential categories of passengers are also transferred to the CCTT.

Thus, TsOTT has all the necessary information to analyze and generate reporting documents on the functioning of the System.

Next, all data from the COTT is synchronized to the HelpDesk module

HelpDesk software is designed to operate a call center (technical support), to provide technical assistance to public transport passengers using transport cards. As well as for setting up and sending reports according to the specified parameters.

Terminal reports

They contain summary data on operations performed at cash registers and trade terminals: sale, replenishment, extension and return of electronic travel documents; deposit and withdrawal of cash. The data in the reports is grouped by shifts.

Passenger transportation reports

The reports contain data on:

- the total number of passengers carried and passengers carried on specific routes. Reports include data on average vehicle load, number of transport cards served and tickets sold;
- transportation according to schedules for certain dates. The report also includes information on the number of transport cards served and tickets sold;
- hourly load per day and daily load per month.

Report on Administrators (cashiers) on revenue per shift.

Passenger flow analysis based on data on card balances and cash flow funds.

Failure Analysis, relying on suspicious transactions of writing off amounts that are not a multiple of the tariff, and on double write-offs.

Reports on the use of social cards detailed by type of benefit.

Other reports.

Generated reports can be printed and saved in PDF, XLS or TXT formats.

By agreement with the customer, it is possible to develop new forms of reports.

System Security

The security of the system consists of the security of the components, its components and the security of data exchange.

Cards

Transport cards come from secure production to points of sale ready for sale. They have the same protection as the cards in circulation and do not require additional preliminary operations on the part of employees of transport companies. Simultaneously with the cards, passports produced and marked for this system of cards come to the CCTT from a security-certified production facility - files in which the unique systematic numbers of the cards and their unique identification numbers are compared.

Terminals

Access to operations at terminals is possible only upon presentation of a special card, and different types of cards are provided for different operations:

- technician card - designed to identify a person who configures the terminal's operation parameters and registers employees who are allowed to work at this terminal;
- administrator card - designed for registration and further identification of a person performing various administrative and service functions;
- operator card - designed for registration and further identification of a person performing operations related to passenger service:
- confirmation of the opening of the shift;
- confirmation of the cash deposit operation;
- blocking/unblocking the terminal;
- opening / closing of the flight;
- sale / return of tickets.

Each operation on the terminal is accompanied by the formation of a transaction. All transactions are recorded in a transactional file - an electronic control tape (ECL) - which is signed and encrypted on the system keys and, at the end of the shift, is transferred to the TsOTT. In addition, each operation is accompanied by the printing of a tear-off ticket.

Hardware Security Module (HSM). AMB is a software application for a POS terminal and serves to securely generate and store key information (cryptographic keys), as well as to securely perform cryptographic operations. Depending on the object of installation, the AMB also performs the functions of diversifying and issuing working keys of the card when personalizing the transport application, encrypting / decrypting bitmapping processed by the ticket server, in transactions with a contactless or dual card containing a transport application.

AMB software is developed in different versions for installation:

- to terminals (for personalization centers and ticket server);
- to smart cards (for self-service devices and remote card replenishment points).

Security cards (microprocessor JAVA cards) are used to store key information.

Bank self-service devices, payment terminals

The devices are equipped with contact smart card readers, which permanently contain contact smart cards, which are hardware security modules.

COTT

Primary data on transactions related to payment and registration of passenger fares (electronic control tapes) are received by the CCTT from terminal devices in encrypted form; Further, the protection of database data from unauthorized access is provided by means of the Oracle DBMS, built into the Oracle security system and the access control system.

To detect unauthorized use of the system, there is a special analytical module. It allows you to detect violations, both on the part of passengers and staff.

Help Desk

All synchronized data with the COTT is written to the database from unauthorized access provided by Postgres tools, as well as an authorization module and differentiation of rights and roles.

Ticket Server

External requests to the ticket server are made using the HTTPS protocol with SSL encryption. The request transmission is implemented on the basis of the WEB services mechanism using the SOAP protocol.

Bitmapping/decryption operations processed by the Ticket Server in transactions with a contactless or dual card containing a transport application are performed by the Hardware Security Module.

In the database, all key information is stored in encrypted form and is disclosed immediately before use through the Hardware Security Module.

Personalization Center

Transport applet and transport application personalization operations take place on a specially equipped Personalization workstation. Access to it is carried out upon presentation of a special smart card and entering a PIN code. Diversified keys are formed on the SBA. The AMB is also used in the bitmapping preparation operation. The entire traffic exchange between personalization workstation and AMB is encrypted on the transport key.

As a result of personalization, card passports are generated, which are used to activate the circulation in the TsOTT.

Blacklists

The security system uses various blacklists:

- black list of transport cards;
- black list of bank cards;
- terminal blacklist.

They allow you to quickly block the use of compromised elements of the System.

Conclusion

Public transport is an important element of any modern city. On the one hand, it ensures the mobility of city residents and thus performs a social function. On the other hand, this is currently the only way to improve the traffic situation - as international experience shows, road construction does not solve the problem of traffic jams. To achieve these goals, well-developed public transport with a high level of service is needed. Which, of course, requires funding. Fare collection is an important source for public transport, and Symbol Transport ASOP can significantly increase its efficiency.

How does the System improve the collection of fares? Automation of the process makes it possible to reduce the number of abuses by both staff and passengers, to obtain accurate data on passenger traffic (including the number of trips made at reduced rates to compensate for shortfalls in income from the budget). Moreover, thanks to the introduction of non-cash payment methods (transport cards, bank cards, NFC mobile payments), the cost of processing and storing cash for the transport operator is reduced. Using the System makes it possible to introduce a flexible tariff policy, which significantly increases the convenience and attractiveness of public transport for passengers. The proposed solution allows transport companies to increase fare collection by 10-30%. Besides,

The two-level architecture of the System provides a short implementation period and inexpensive operation. And the possibility of using various technical devices - to implement any scheme for collecting fares (conductor or non-conductor).

We are confident that our System will improve the collection of fares for any transport company, which is confirmed by the successful experience of implementation and many years of operation at transport companies both in Russia and abroad. We are ready to provide all the necessary information and assistance in automating the collection of fares using the ASOP "Symbol Transport" in your region.



Let's improve public transport together!