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Architecture of Automated Navigation System of Passenger Transportation at Winter Olympic Games

¹Andrey Ostroukh, ²Andrey Ismailov, ²Anna Lvova and ³Andrey Nikolaev

¹Department of Automated Control Systems, State Technical University, MADI, Russia

²JSC of NPP Transnavigatsiya, Russia

³Faculty of Control Management Systems, State Technical University, MADI, Russia

Corresponding Author: Andrey Ostroukh, Department of Automated Control Systems, State Technical University, MADI, Russia

ABSTRACT

The study analyzes the structure of automated navigation systems of passenger transportation. The study looks at the automated navigation systems for passenger transportation and devises a set of requirements to the Automated Control System of Logistics Transportation Centre (ACS LTS) within Passenger Transportation Subsystem (PTS). The study suggests the architecture of the subsystem of planning custom-fitted transportation of customer groups during the 22nd winter olympic games.

Key words: Automated control systems, process simulation and information processing systems, control methods and means in transportation, modelling, passenger transportation

INTRODUCTION

The Custom-Fitted Transportation Subsystem (CFTS) can be referred to the passenger transportation subsystem in Custom-Fitted Transportation Subdivision (CFTS Custom-fitted transportation software) which exists within Passenger Transportation Subsystem (PTS). In its turn the subsystem of passenger transportation is the part of integrated automated control system of passenger transportation of Logistics Transportation Centre (ACS LTC) which by the type of activity can be referred to data acquisition, processing and display systems (ANO, 2014).

We have applied intermodal logistics approach, i.e., using several types of transportation vehicles simultaneously to transport guests and participants of the Olympics (Boreyko, 2011).

The general concept of intermodal logistics is based on the fact that spectators, staff and participants of the games will arrive to the site by rail, air, water and automobile transport. Railroad, automobiles and funiculars will be used for travelling between the Olympic venues (PSLAOF, 2012; Sychev, 2012).

The Olympic games is a public event, therefore, transportation of accredited parties that are subdivided into customer groups, to Olympic facilities, is of special importance (ANO, 2014).

OVERVIEW OF INTERNATIONAL EXPERIENCE IN USING AUTOMATED NAVIGATION SYSTEMS FOR THE PASSENGER TRANSPORTATION SERVICES DURING THE OLYMPIC WINTER GAMES

The Olympic games are a momentous sporting event that is held every four years in different countries with different climatic conditions, infrastructure and national characteristics. The results of the previous games are an example for the future competitions: What errors can occur, what

Table 1: Comparative analysis of the transport service systems during the previous Olympic games

Parameters	1996 summer Olympic games in Atlanta, USA	1998 Olympic and Paralympic winter games in Nagano, Japan	2002 Olympic and Paralympic winter games in Salt Lake city, USA	2006 Olympic and Paralympic winter games in Turin, Italy	2010 Olympic and Paralympic winter games in Vancouver, Canada
No. of service levels	5	4	5	7	4
Use of the provided vehicles for personal purposes	No	No	Yes	Yes	No
Special transportation services during the Olympics Opening and Closing Ceremonies	No	No	Yes	Yes	Yes
Use of transport racks for the planning of transport services	No	Yes	Yes	Yes	Yes
Use of the "arrival/departure" service	No	No	Yes	Yes	Yes
24h transport service	No	No	No	Yes	Yes
Use of several SMVF	No	No	No	No	Yes
Use of several carriers	No	No	Yes	Yes	Yes
Pre-booking of vehicles using software	Yes (on the previous day)	Yes (on the previous day)	Yes	Yes	Yes
Vehicle reservation using software	No	No (via LTC)	No (via LTC)	Yes	Yes
Use of agreed routes for ordered transport operations	No	No	Yes	Yes	Yes
Use of GSM system	No	Yes	Yes	Yes	Yes
Single AMS for transport service	No	No	No	No	No
Percentage of completed planned transport operations	~65	~60	~70	~73	~82

requirements must be met for the successful Olympics, etc. Each of the next Olympic games were organized taking into account the already proven technology. For example, the requirements for the transport service modify from year to year, becoming more rational and focused on the needs of clients.

Table 1 provides a comparative analysis of the transport service systems during the previous Olympic games (LA84 Foundation, 2010a-c; Salt Lake, 2002, 2004, 2006a-c; The Shinano Mainichi Shimbun Inc., 1998, 1999a, b; Russian Gazette, 2007; PSLAOF, 2012; Sychev, 2012; Coutrouba, 2009; ACOG, 1997a-c).

The conclusion on the need for the creation of the transport planning subsystem as part of the automated navigation system for the passenger transport services can be made on the basis of the experience in using the transport service systems during the previous Olympic games. The created subsystem must take into account all of the above parameters for organizing transport services. The subsystem must also comply with the OCOG requirements to the organization of transport services during the Olympic games in 2014 in Sochi.

TYPES OF TRANSPORT SYSTEMS USED FOR THE TRANSPORTATION OF GUESTS AND PARTICIPANTS OF THE OLYMPIC GAMES ON THE BASIS OF THE SERVICE LEVEL AGREEMENT

To provide high-quality transport services for the accredited persons at the time of preparation and during the Olympic games, the international standards for the quality of transport services are used Service Level Agreement (SLA).

In general, the term SLA or service level agreement means a formal agreement between the service client and its supplier, containing the description of services, rights and obligations of the parties and most importantly, the agreed service quality level. As for passenger transportation, the Agreement is called the transport system (ACOG, 1997b).

Guests and participants of the Olympic games are divided into the following groups:

- Athletes and team managers
- International federations
- Marketing partners
- Technical service representatives
- Mass media
- Staff
- Spectators and locals

The guests and participants of the Olympic games are also divided according to their accreditation. To divide a wide range of accredited guests and participants of the Olympics into client groups, the IOC has introduced the term “Olympic family”. IOC divided the Olympic family into six client groups (Gallier, 2011):

- NOC, athletes and team officials
- Staff
- Media representatives
- International federations
- IOC
- Marketing partners

Transport services are provided and delivered according to the general structure of the client priorities (Fig. 1).

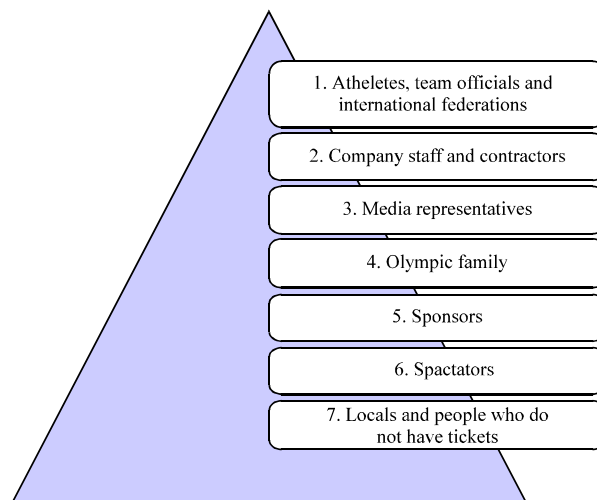


Fig. 1: Hierarchy of groups of guests and participants at the Olympic games

Each client group corresponds to a certain service system. It is responsible for the relationship between clients and the transport department. A total of 7 types of transport service systems shall be provided during the Olympics:

- T1 = Transport system to provide services for the Olympic family using the provided privileged passenger vehicles
- T2 = Transport system to provide services for the Olympic family using the provided cars
- T3 = Transport system to provide services for accredited persons according to prior reservation/ call (request) of cars or by buses as scheduled
- TA = Transport system to provide services for athletes and team officials
- TF = Transport system to provide services for representatives of international federations of sports represented at the Olympic games
- TM = Transport system to provide services for media representatives accredited at the Olympic games
- MP = Transport system to provide services for marketing partners of the Olympic games

The regions provided about 200 buses equipped with PTMS-controlled navigation and communication equipment for the Transportation of Athletes (TA) and media representatives (TM) during the test events.

And about 100-120 passenger vehicles equipped with navigation and communication equipment, created on the basis of the car navigator Shturmann Link 500, were provided for transporting the participants of the test events for T1, T2 and T3 systems. This equipment provides navigation service for the vehicle drivers while driving on the selected route and at the same time the operation under the control of the PTMS dispatch system, including messaging and communication between the driver and the system dispatcher.

Transportation of spectators at the time of preparation and during the Olympic games is provided by the city passenger transport of MUE "Sochiavtotrans" working on existing routes under the control of the city dispatching management system.

According to the T1 system, the provided vehicle must be given to OCOG for each of the following persons: IOC members, including honorary members, IOC directorate, IOC senior staff and other persons specified by the IOC executive board, members of the International Sports Federations (presidents and general secretaries) and representatives of the National Olympic Committees (presidents and general secretaries).

T2 accreditation provides the ability to use the provided car with a driver that is shared between two or more clients.

Cars are used for T1, T2, TA, TF and TM services. In addition, buses are used for T3, MP, TA, TM systems.

T3 services are available to representatives of the Olympic family at the request or under prior reservation and delivered in accordance with the IOC routes.

TA system is used to transport groups of athletes between sports venues during competitions; the route is based on the approved calendar of the Olympic games and accommodations of sports delegations.

To transport TF system client groups, the transport service plan for each international federation shall be pre-developed and agreed with OCOG. Each sports federation gets several vehicles, including vehicles for technical delegates (with T2 accreditation) in accordance with the IOC specification, as agreed between OCOG and international sports federations.

Table 2: Comparison of main characteristics of transport systems

Parameters	T1	T2	T3	TA	TF	TM	MP
Provided vehicles	Yes	Yes	No	Yes	Yes	No	No
Sharing vehicles	No	Yes	No	No	No	Yes	No
Provided drivers	Yes	Yes	No	No	No	No	No
Provided assistants	Yes	Yes	No	No	No	No	No
Personal transport	No	No	No	No	No	No	No
Driving by yourself	Yes	Yes	No	No	No	No	No
Vehicles upon request	Yes	Yes	Yes	No	No	No	No
Vehicles by order	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Waiting for clients	Yes	Yes	No	No	No	No	No
Types of provided vehicles	Cars and minivans	Cars and minivans	Cars, minivans and buses	Buses with cargo sections, minibuses and cars	Buses, minibuses and cars	Buses and cars	Buses
24 h service	Yes	Yes	Yes	No	No	No	No
Access to all Olympic venues	Yes	Yes	No	No	No	No	No
Vehicle parking near the hotel	Yes	Yes	No	No	No	No	No
Arrival and departure transfer	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vehicles at IOC events	Yes	Yes	No	No	No	No	No
24 h T3 service	Yes	Yes	Yes	Yes	Yes	No	No

The transportation process for MP and TM systems is also organized according to the plans agreed with OCOG. Transportation services are provided between the accommodation and the venue, as well as between the venues in accordance with the personally agreed program.

The comparison of main characteristics of transport systems is given in Table 2.

TASKS PERFORMED BY THE SUBSYSTEM OF AUTOMATED NAVIGATION OF PASSENGER TRANSPORTATION SYSTEM

There are several basic tasks that should be performed by the custom-fitted transportation subsystem:

- Automated urgent planning of custom-fitted transportation of accredited parties before and during the 22nd Olympic games and the 11th Paralympic games-2014
- Ensuring information exchange and coordination between the subdivisions of the transportation system when performing orders and reserving vehicles
- Ensuring truthfulness of acquired, processed and stored information used by the Transport Directorate of the Olympic games and providing uninterrupted transportation of passengers before and during the 22nd Olympic games and the 11th Paralympic games-2014

The planning subsystem is meant to eliminate manual entry of information during the exchange between related information systems.

GENERAL REQUIREMENTS TO CUSTOM-FITTED TRANSPORTATION SUBSYSTEM OF CUSTOMER GROUPS BEFORE AND DURING THE OLYMPIC GAMES

The subsystem of planning is meant to automate, plan, control and coordinate the Olympic passenger transport. The system of custom-fitted transportation must be able to perform the following (ANO, 2014; Boreyko, 2011; Fowler, 2003; Frantzeskakis and Frantzeskakis, 2006;

Edwards, 2012; Lvova *et al.*, 2012; Gallier, 2011; Ostroukh and Kuftinova, 2012; Ostroukh *et al.*, 2012; Polgun and Lvova, 2013; TDOG, 2012; OPTT, 2010; Vlasov *et al.*, 2003, 2006; Yefimenko and Bogumil, 2012a-c).

Automated planning of transportation including urgent alteration of the tasks: In this case planning of custom-fitted transportation is performed through crating transportation assignments which are then transferred to the drivers in the form of way-bills.

The subsystem of urgent planning should allow alterations in the way-bill depending on the current situation. Therefore, while letting off transportation vehicles to the route during the operational day traffic operators of special-purpose motor vehicle fleet can make alterations in the way-bill which means the data has to be altered in the dispatching system as well. New assignments can be created and distributed at any moment while existing assignments can be altered during the operational day:

- Immediate adjustment of processes when providing transportation service to customer groups at the Games in case the current situation changes (changes in the competition schedule, urgent transportation orders to certain customer groups)

Passenger transportation subsystem should timely react to sudden changes in the situation which may occur as the result of the change in the schedule of the Games events or because of new transportation orders from certain customer groups.

Automated generation of current data about the transportation process: Automated generation of current data about the transportation process helps the specialists of the Organizing Committee of the Olympic Games Sochi-2014 and the Transport Directorate of the Olympic games to obtain the information about the vehicles which do not follow a particular route at any moment during the operational day in the following categories:

- All the routes of the Olympics transportation vehicles
- Certain routes or categories of routes
- Special-purpose motor vehicle fleet
- Transportation vehicles
- Customer groups

Then, specialists can use the collected data to create information references about the transportation process which include the information about schedules obtained from time-table programmes and the information about actual transportation process and its results obtained from the software of dispatching control.

Figure 2 shows information flows of transportation services provided to customer groups at the games.

Therefore, the main task of the specialist of passenger transportation subsystem is to create and edit scheduled assignments or work with templates of urgent assignments and group them according to the special-purpose motor vehicle parks and types of assignments. The templates of urgent assignments can be edited and used at any moment. The assignment can be printed both

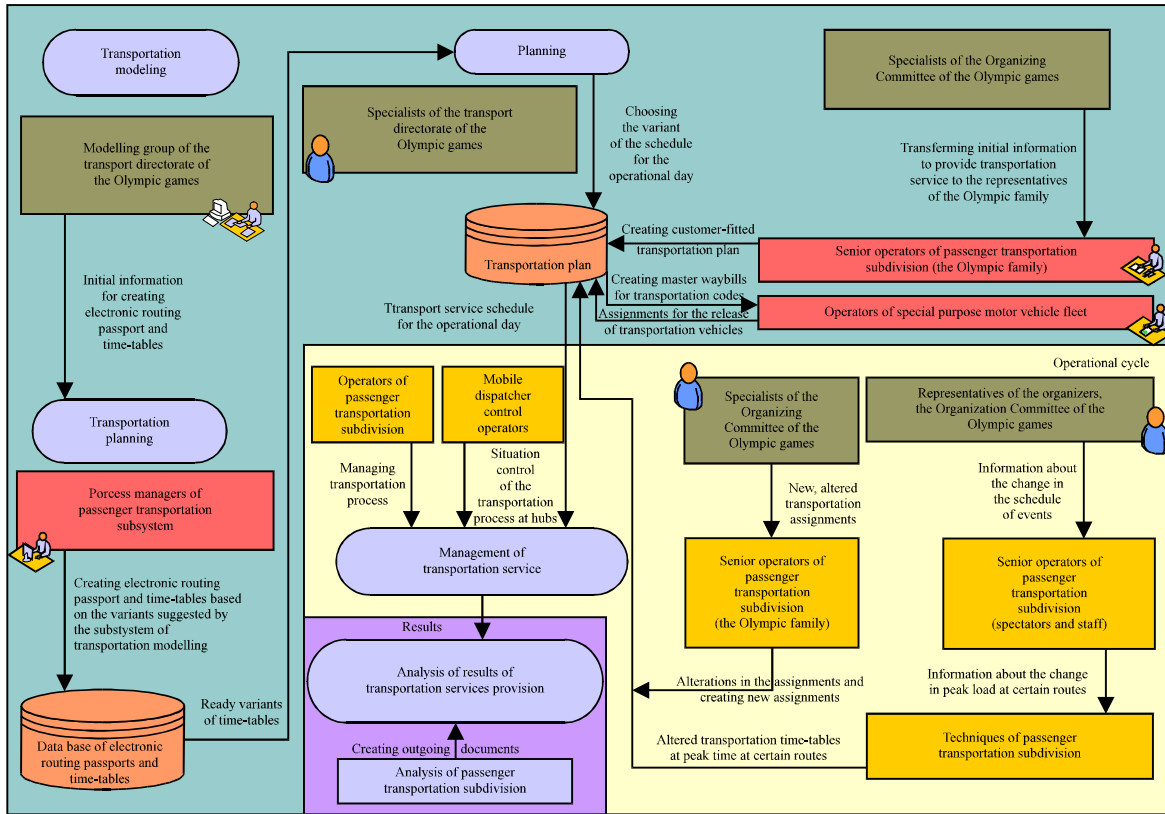


Fig. 2: Information flows during the transportation of customer groups

by the operator of special-purpose motor vehicle fleet (as the driver's way-bill) as well as the specialist of the passenger transportation subsystem, who creates the assignment for transportation service provided to certain customer groups (Lvova *et al.*, 2012).

Automated urgent planning of transportation service must ensure the planning of custom-fitted transportation services.

For processing of transportation orders from certain customer groups operators of special-purpose motor vehicle fleet create assignments and design job orders.

There must be an opportunity to alter the assignments during the operational day and the opportunity to execute new tasks at any time.

SERVICE PROVISION AND CHARACTERISTICS OF VARIOUS TYPES OF TRANSPORTATION SYSTEMS

Transportation services and their level are provided according to the type of the chosen transportation system. Thus, for every type of the transportation system there are sets of rules which must be observed when way-bills are created (Fowler, 2003; Gallier, 2011).

Service provision in transportation systems T1, T2: In the passenger transportation subsystem automated dispatcher control technology of transportation systems T1 and T2 is used to control automobile fleet assigned to certain persons or groups of customers who are entitled to the transportation services within these systems. Vehicles assigned to the customers and the

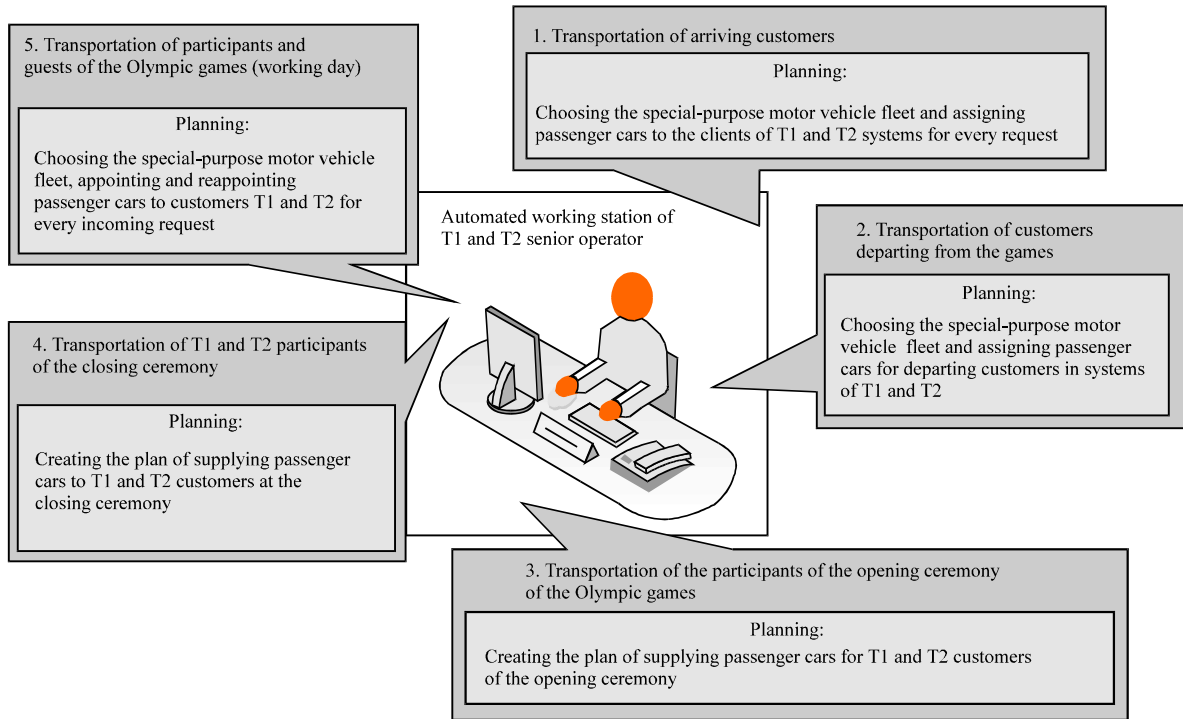


Fig. 3: Business processes of transportation service provision to customer groups T1 and T2 at the Olympic games

planning of transportation process are similar in systems T1 and T2. The service of T1 and T2 is provided to the customer entitled to it after they turn to the transportation centre. After the customer requests a vehicle, senior operator of the passenger transportation subsystem assigns it to the customer according to systems T1 and T2. According to the rules of the International Olympic Committee requests for provision of T1 and T2 transportation services may only contain the information about the collection point without specifying destination point (Fig. 3).

Service provision in transportation system T3: The decision on the provision of transportation service to the members of the Olympic family is implemented in compliance with the requirements of transportation system T3 and the main provisions of the International Olympic Committee:

- Services of T3 system are provided only to entitled accredited customers
- Services of T3 system are provided only within the routes approved by the International Olympic Committee. The T3 system will connect directly hotels of the International Olympic Committee, competition venues, the Olympic village, the Central Media Centre and the International Broadcast Centre, the awards square, Sochi airport, official functional subdivisions and other agreed sites in the specified geographic area
- Transportation service is provided either by request or via 24 h booking service

When creating and implementing requests for transportation services from accredited customers, senior operator of transportation system T3 interacts with transportation centers' specialists at the Olympic sites.

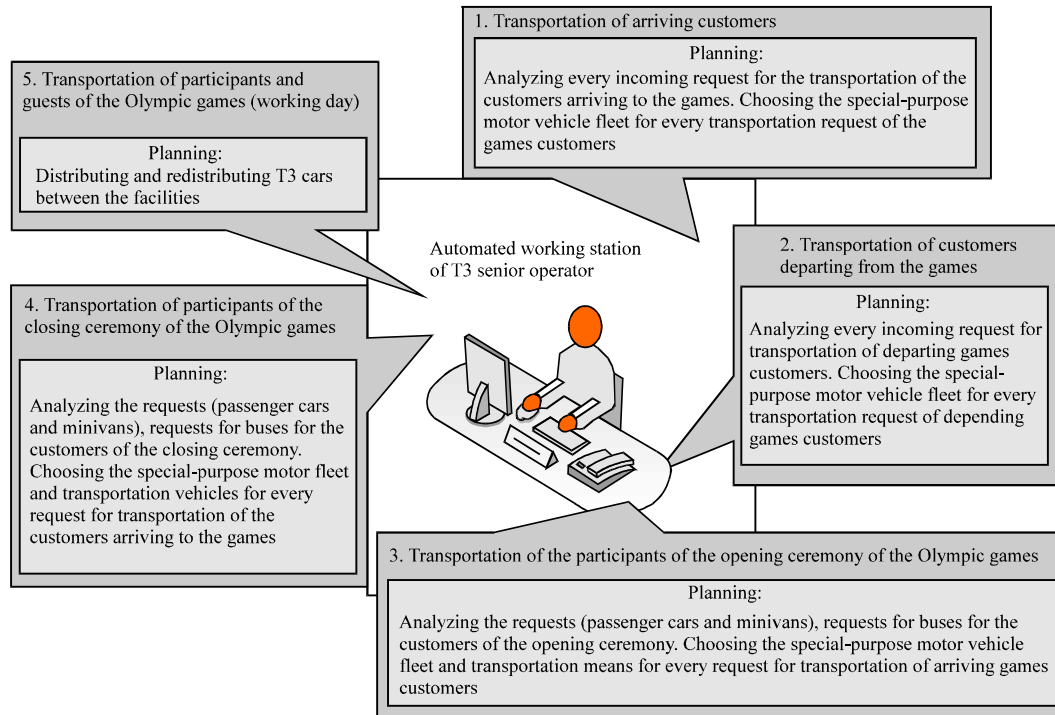


Fig. 4: Business processes of providing transportation services to T3 customer group at the Olympic games

T3 technology is a basic technology used in transportation. The assignment must contain the information about at least two main points-‘collection point’ and ‘destination point’.

Therefore, specialists of transportation centres at the sites provide transportation service to T3 group by creating assignments immediately after the customer group representative turns to the centre (Fig. 4).

Service provision in transportation systems TA, TF: Vehicles for the athletes and the National Olympic Committee are of the highest priority during the planning and provision of transportation services in the system.

In TA system comfortable buses with a freight compartment for sports equipment are used. Mini-buses are also used for trips to all the training and competition sites, between the Olympic villages of the mountain cluster and the sea-side cluster. The requests formed by the specialists of transportation centres of the Olympic villages of the Organizing Committee of the Olympic games should contain information about bus types.

Management of the transportation of the athletes in TA system is performed according to the approved time-table of the Olympic games and places where sports delegations are accommodated. According to the transportation schedules, plans for the transportation of the athletes of every special-purpose motor vehicle park assigned to it will be devised and agreed with the Organizing Committee of the Olympic games Sochi-2014. During the games operators of special-purpose motor vehicle park create assignments based on agreed transportation schedules to let off vehicles of TA system for every operational day.

Management of TF system is based on the provision according to which official persons and personnel of international sports federations will be transported by the vehicles fleet assigned to every federation which will include vehicles for technical delegates with T2 accreditation.

During the preparation process within TF system schedules for the transportation of official delegates and staff of every international sports federation to the events of the games which are of primary importance for them will be prepared and agreed with the Organizing Committee of the Olympic Games Sochi-2014. The schedules can be specified during their preparation and signing of service agreements between each international sports federation and the Organizing Committee of the Olympic Games Sochi-2014.

Thus, there is no difference in the service between TA and TF systems in terms of assigned transportation vehicles during the planning of the task. Another characteristic is that only collection points and destination points may be provided in the request (Fig. 5).

Service provision in systems MP and TM: The MP and TM transportation services are provided to marketing partners and representatives of the mass media before and during the games.

Computer software should automate the process of transportation of marketing partners and the mass media representatives and the same principles and patterns as those used when providing the services to marketing partners and the representatives of the mass media of the International Olympic Committee should be applied.

This means transportation of the marketing partners and the mass media representatives will be direct and detached between the place of accommodation and the venue and between the venues

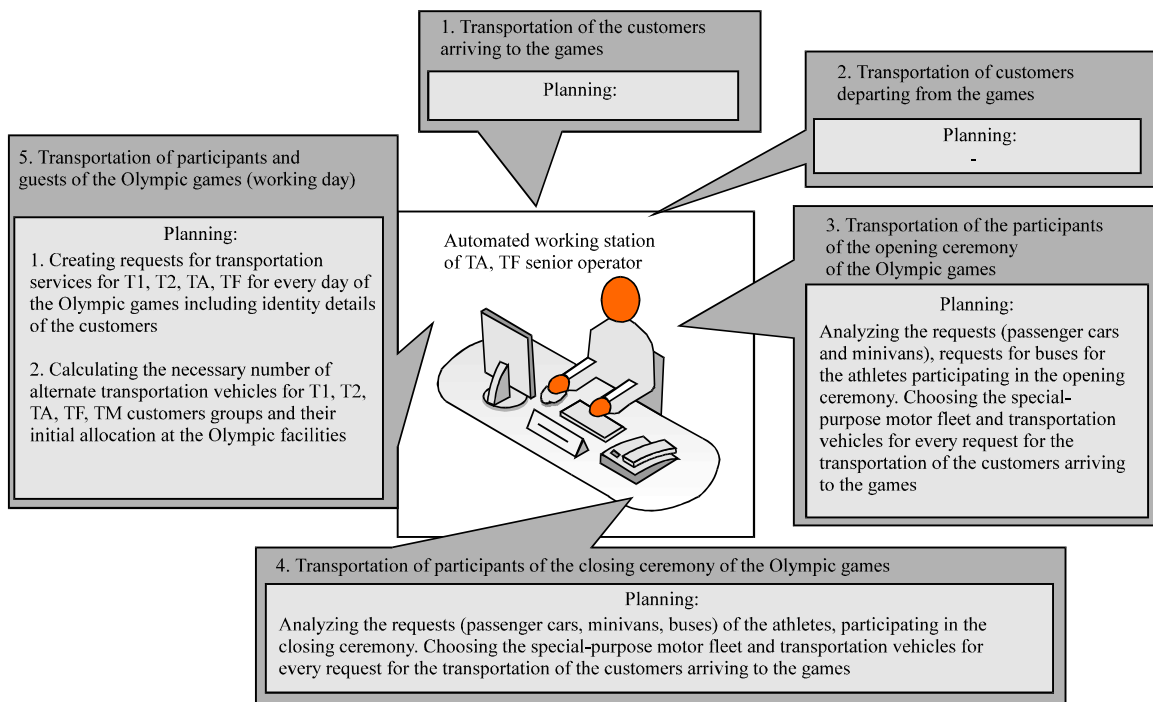


Fig. 5: Business processes of providing transportation services to customer groups TA and TF at the Olympic games

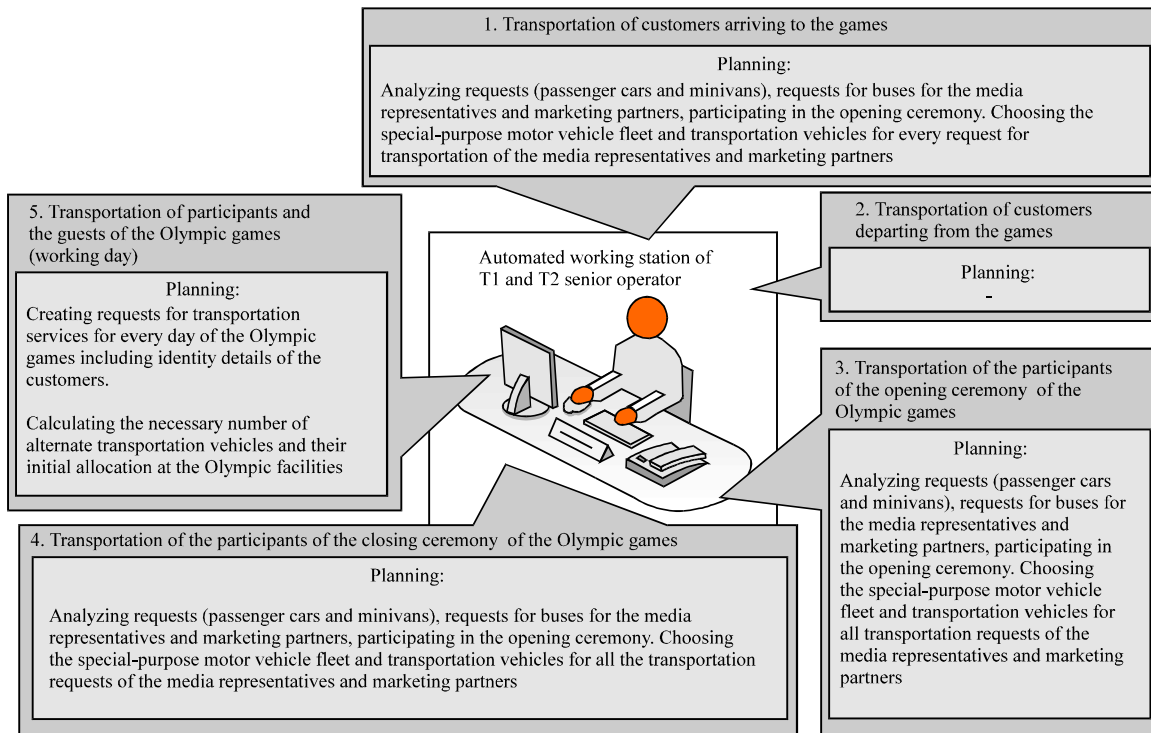


Fig. 6: Business processes of transportation services provision to customer groups TM and MP at the Olympic games

according to the programme which is personally agreed upon with every customer; arrival and departure time of special-purpose motor vehicles can also be specified.

According to TM requirements in case the customer chooses this system the amount of luggage is recorded (Fig. 6).

CONCLUSION

We have conducted the analysis of approaches to customer-fitted transportation process and have studied basic principles of transportation services provision which should be considered when creating automated navigation system of the transportation service.

The problems solved by the given subsystems were analyzed; the requirements for their architecture were formulated. Also, a detailed analysis of the planning subsystem design was performed. The task parameters and a number of restrictions and prohibitions related to its creation were specified.

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