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The Concept of Situation Centers for Smart Cities

Oksana Smirnova, Tatiana Popovich

(Oksana Smirnova, PhD, St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences (SPIIRAS), 39, 14 Linia VO, 199178, St. Petersburg, Russia, sov@oogis.ru)

(Tatiana Popovich, PhD student, St. Petersburg Institute for Informatics and Automation - Hi Tech Research and Development Office Ltd, 5, Galerny proezd, 199178, St. Petersburg, Russia, t.popovich@oogis.ru)

1 ABSTRACT

"Smart city" is a very popular trend for modern Europe. Nearly every large city aspires to become more technologically advanced in order to raise quality of life and security of its citizens.

Thus, various city departments and services, such as traffic services, police and fire departments, have constant need for receiving complete up-to-date heterogeneous information from various sources and for analyzing it in real-time scale.

The concept of situation centre for management and control of city life, described in this paper, is one of the ways of reaching that goal. Situation centre for monitoring and intelligent decision making support is intended for surveillance (observation) of objects of different nature and associated situations. Situation centre supports monitoring, prediction and modelling of development of various situation of local and global scale in real time operation mode with cartographic representation. In this paper we demonstrate the functionality of situation centre on the example of prototype installed in the Bonch-Bruevich Saint-Petersburg State University of Telecommunications.

2 INTRODUCTION

In recent years city management tasks have been characterized by high dynamic, complexity, multidimensionality and access to number of heterogeneous intersecting information sources. Moreover, the level of uncertainty in management decision making has risen greatly. It is primarily related to rapid development of modern digital and technological means of accessing data, growing number of heterogeneous data sources, and also to social factors, such as: "speed" of live in cities, constantly growing population size, improving quality of life and etc. Hence, at current moment, every city faces a problem of informational support and creation of city management structures – situation centers.

City's informational support implies aggregation of all information sources, their processing and analysis, provision of access to them on different management levels. Commonly, three levels of city management are distinguished:

- global level: provides centralized monitoring and management of city as a whole, and interaction with upper federal departments;
- local level: provides monitoring and management of specific city sector (district or region);
- object level: provides monitoring and management of specific city's entity (buildings and department units);

City's informational support ought to be executed sequentially: from information dissociation to centralized data and creation of unified information space, from unstructured resources to information portals, from custom engineering to standard application systems, and finally, from hard-copy paperwork to "electronic government".

Development and implementation of city management situation center will allow:

- to expand possibilities of strategic decision making;
- to improve efficiency of data representation;
- to improve productivity and quality of decision making;
- to increase city safety;
- to optimise communications and resources management.

Experience of developed countries shows that there are two major obstacles on the way of creating informationally supported city:

(1) Complexity of creation of large-scale information system. The more complex the system and its tasks, the more complex its architecture and engineering solutions become. Currently, there are no standard city level solutions.

(2) Low integration level of city information resources. Dissociation of data bases, various protocols and program solutions not only complicate data search and systematisation, but also increase the expanses of forming a unified city information space. Development of data representation model and of means of data aggregation is needed. Problem of data duplication in different city information systems is evident.

(3) Large amount of out-of-date systems. Process of development and integration of new systems is costly enough and is time-consuming.

(4) Number of properly-functioning systems that should be integrated into a unified city information system. System development, as a rule, is conducted with use of various technologies and standards. To provide opportunity of integration of existing systems, following issues should be solved:

- development of means of integration;
- provision of resources centralization;
- development of means of data aggregation.

(5) Absence of sufficient technical infrastructure. Currently, technical infrastructure is not fully formed. There exists a large number of various networks that differ from each other in their characteristics, scale and purpose. Those networks usually duplicate each other in many ways.

(6) Complexity of creation of a unified data access portal. Unified portal integrates whole range of services, provided by city's authorities, and allows access to them at any point in time. Aggregation of city's authorities resources has several of advantages:

- allows to provide objective and complete information to citizens, concerning social services and support;
- supports "transparent", constant and operational interaction of government agents with economic entities, along with sufficient economy of time and budget resources;
- provides optimization of government agents interaction among themselves.

(7) Absence of systematised list of city's business processes. In a city, as well as in any organisation, there exists a large variety of processes, that can be easily formalized and adjusted to fit existing concepts. Only with clear description of business processes it is possible to build information system on city level.

(8) Absence of worked out data processing and decision making support mechanisms on different levels of city management. Specifics of data processing lie in necessity of simultaneous analysis of large amounts of heterogeneous information. At that, processing should be executed in real-time mode in order to provide actual informations to users.

The issues of creating city information system stated above at large extent can be solved with integration of unified situation center for city management. Such centers will allow to execute comparison of data, acquired from various divisions and departments, in real time scale, detect dangerous and emergency situation in city life, and to operatively make effective management decisions.

3 GLOBAL EXPERIENCE OF SITUATION CENTER ORGANISATION

Concept of situation center creation in Siemens Company departments in Belgium and Luxembourg involves combining neurophysiology and ergonomics approaches with modern administration principles and information technologies (Cockpit).

Key advantages of this concept lie in expansion of opportunities for strategic decisions, rising of their quality, communication management and rising of management team productivity.

Concept of French Tableau de Bord (Daum, 2005) has been actively applied for many years in France for creation of situation centers. Information structure and representation are usually based on perception peculiarities of human brain. Walls in situation center room are usually without windows, and painted in four

different colours (black, blue, red and white), that are associated with four basic steps of decision making process.

On each wall, data is displayed on six screens, along with aggregated geographical and detailed information, which represent six most actual questions.

The choice of six alternatives is determined by perception peculiarities of human brain as well, which is capable of processing no more than seven blocks of information under one decision making problem.

The Boeing Company (Boeing) has implemented the situation center concept for a department, responsible for maintenance and exploitation of aircrafts. In this context, situation center helps to improve interaction between different functional teams in given department. As a result of implementation of this project, the Company has saved about 3,5 million dollars per year and has significantly improver department productivity.

Currently, management situation centers efficiently operate in cities like New York and Miami. Situation centers allow to promptly coordinate functioning of various city services like police, medical, fire departments and others. This project is executed by IBM company. Instruments for integration and visualization of data were created on cartographic base as well. This instrument is called Crime Data Warehousing. Before, data used to be collected from bottom to top, which could take months. Data was in different formats, cluttered with errors and inconsistencies, and it had to be added manually.

4 SITUATION CENTER CONCEPT

Situation center, from technical point of view, represents hardware and software complex, equipped with communication and interactive data representation means, intended for monitoring, forecasting and modelling of development of various situations and objects in real-time scale. From the point of view of city management, situation center is an element of operative decision making system on strategic management level with application of earlier acquired data bases and expert technologies.

Situation centers allow to perform effective informational and organisational decision making and to train personal that takes part in city management.

Among strategic city management tasks, situation center solves the following:

- social and economic factors dynamic forecasting
- analysis of balance and accessibility of different city resources (electricity, water, gas and etc.);
- estimation and planning of city infrastructure state and its development;
- citizens' safety estimation;
- social tension analysis;
- provision and optimal resource allocation.

Situation center functioning is based on the following basic principles:

(1) various situation monitoring in real time scale, process modelling, situation scenario developing;

(2) situation visualisation and analysis;

(3) operative decision making with application of expert data bases, modern information technologies and means of data representation;

Modern situation centers for city management solve the following tasks:

(1) information support of city's government;

(2) support of collective decision making in various situations;

(3) reduction of time and financial expanses, related to data duplication, inconsistency, acquisition and processing;

(4) integration of heterogeneous information systems in unified information space.

Situation center main operating modes are the following:

- routine management and monitoring mode;

- operative decision making mode;

- management in crisis situation mode;

- modelling and forecasting mode.

5 CITY'S SITUATION CENTER STRUCTURE

Behind the structure of situation center lies informational (or situational) city management model. Informational (or situational) city model represents the complex of the following components:

$$M = <O,S,G>$$

where O represents a thematic component – ontology, that determines aggregation of modelled concepts in regarded subject area; S – spacial component, space and spacial relations between ontology concepts; G – graphical component, representation of ontology concepts with a number of graphical symbols (graphic primitives).

One of the distinctive traits of city management situation center is association of situation management model with geographical location, therefore geographical system is its essential part. However, situation center operation covers not only data representation according to developed model, but also modelling, estimation, forecasting of situation development, thus it is reasonable to apply intelligent geo-information systems (Popovich, 2013).

Major elements of hardware and software complex based on intelligent geo-information system concept are the following subsystems:

- geo-information interface;

- registration and documentation subsystem;

- real time scenario replay subsystem;

- cartographic information database and server;

- WMO database;

- situation awareness ontology database;

- information exchange database;

- operative support subsystem;

- intelligent support subsystem;

- electronic documentation subsystem.

Situation center's hardware and software complex design is given in Fig. 1.

As informational sources, information center uses various sensors, antenna systems, communication channels, video and audio sources. Main task of information sources is to provide adequate informational model of the city.
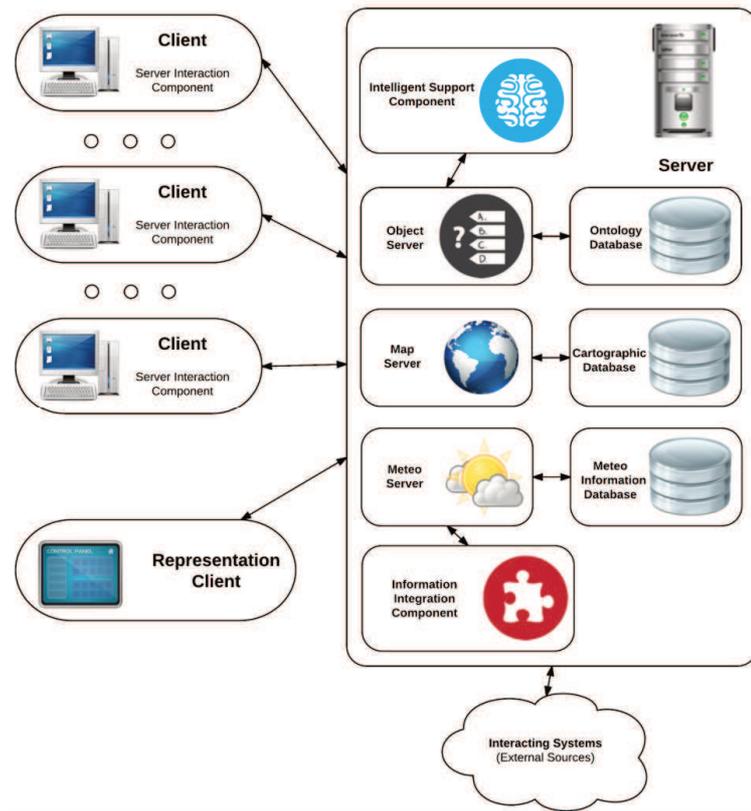
Fig. 1: Situation center's hardware and software complex design.

6 CASE STUDY OF BONCH-BRUEVICH UNIVERSITY SITUATION CENTER

As an example of successful implementation of situation center's concept on practice we present a case study of situation center, created for needs of St-Petersburg State University of Telecommunication (Bonch-Bruevich University). This situation center was designed to provide university's administration with means of operative and efficient management of university entity.

The peculiarity of this case rests on the fact that university is not concentrated in one area but is spread across the whole city: educational units and dormitory accommodations are situated in different buildings in various parts of the city, often far apart. Therefore, we use geo-information interface to provide visualisation of all university objects and attribute information about each object (Fig. 2 and 3).
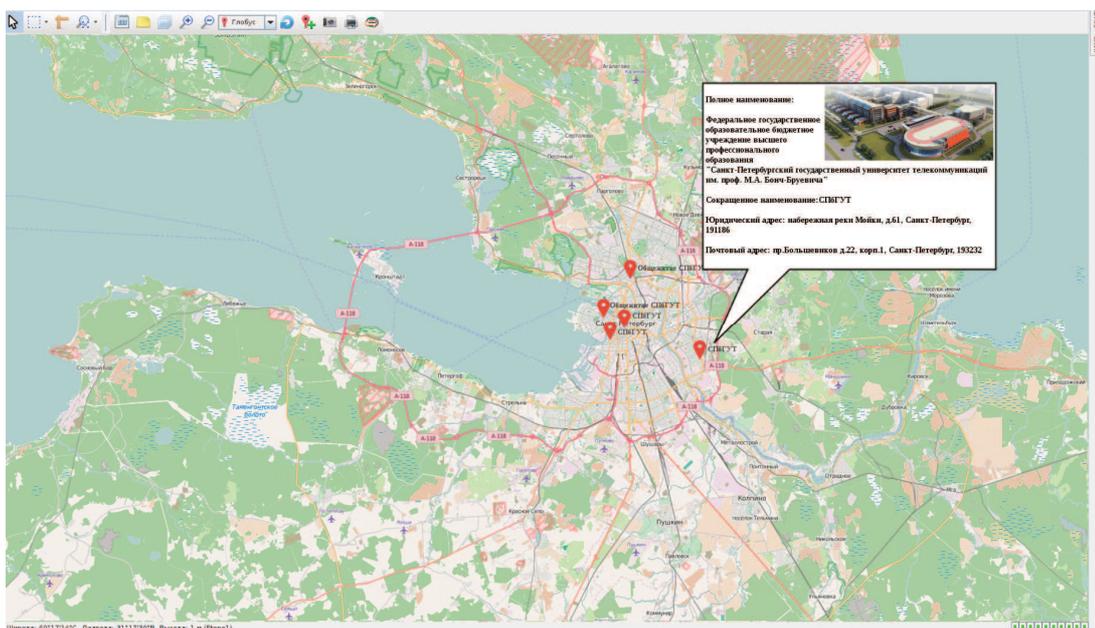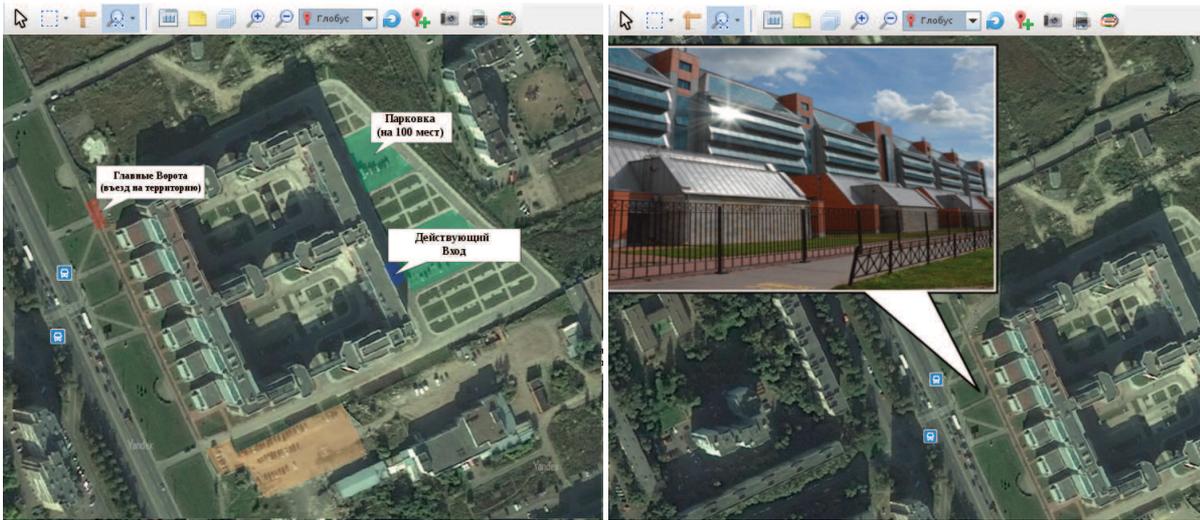

Fig. 2: Univercity's units on cartographic base.

Fig. 3: Attribute information about university objects.

Software also provides access to inner structure of university buildings (Fig. 4). University staff is able to have access and to manage inner systems like: surveillance cameras' feed, fire alarms, signalisations and others. It allows to simplify management processes and decision making in case of emergency situation occurring.

Additional software for the university situation center is electronic documentation plug-in, which allows to manage all university documents from educational plans to administrative orders in one space, to exchange messages and documents between staff in real-time.
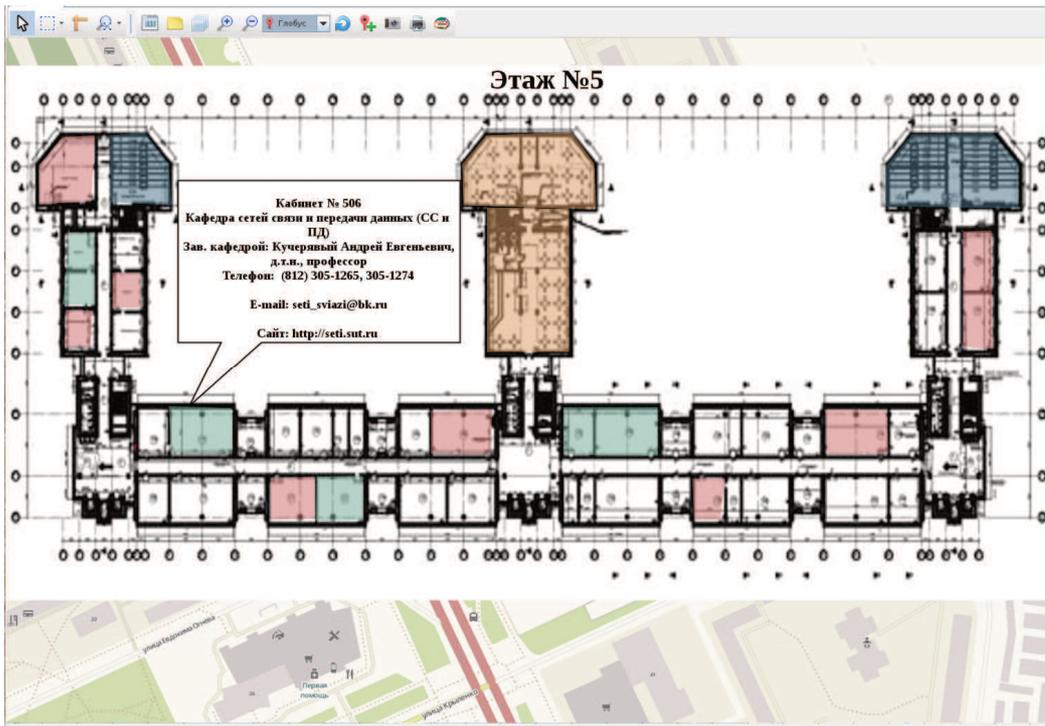

Fig. 4: University building plan of one floor with attribute information about each room.

Situation center room is presented in pic. 5. Six display panels are intended for visual presentation of aggregated actual information about university. There are six separated workplaces for situation center operators, in order to monitor different kinds of university situations and to collect various kinds of information for further display on main screens. University administration is to be seated at large table right in front of main screens.
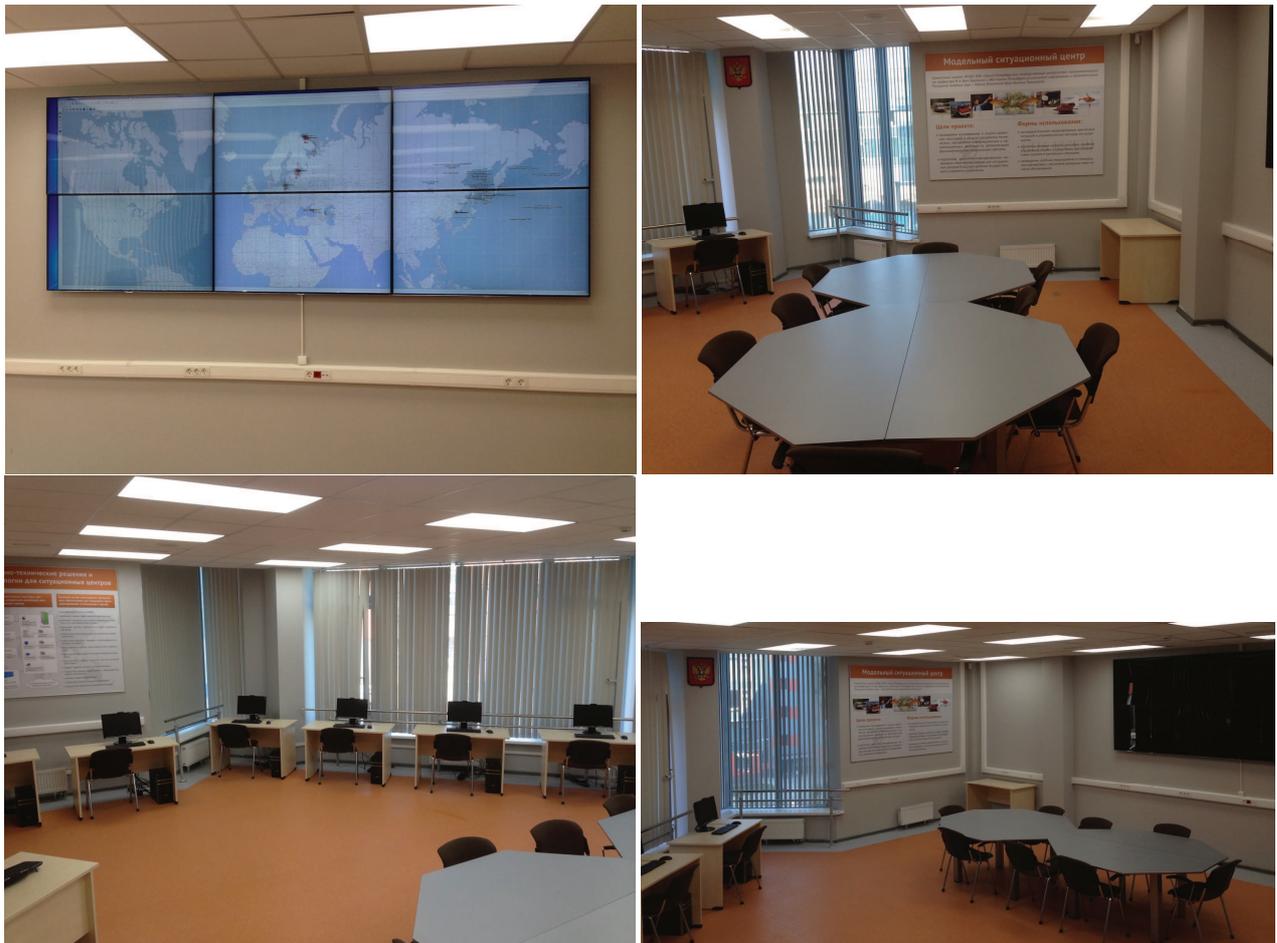
Fig. 5: Actual look of situation center room.

7 CONCLUSION

The main purpose of city situation center development is provision of up-to-date hardware and software systems that contribute to effective decision making and city management. Development and implementation of this situation center will allow:

- to enhance opportunities of strategic management decision making;
- to rise effectiveness of data representation – to present blocks of information prepared beforehand, oriented on administration needs, in order to enhance effectiveness of decision making process;
- to rise work productivity and quality collective interaction and decision making;
- to enhance city safety;
- to optimise city resource management.

8 REFERENCES

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