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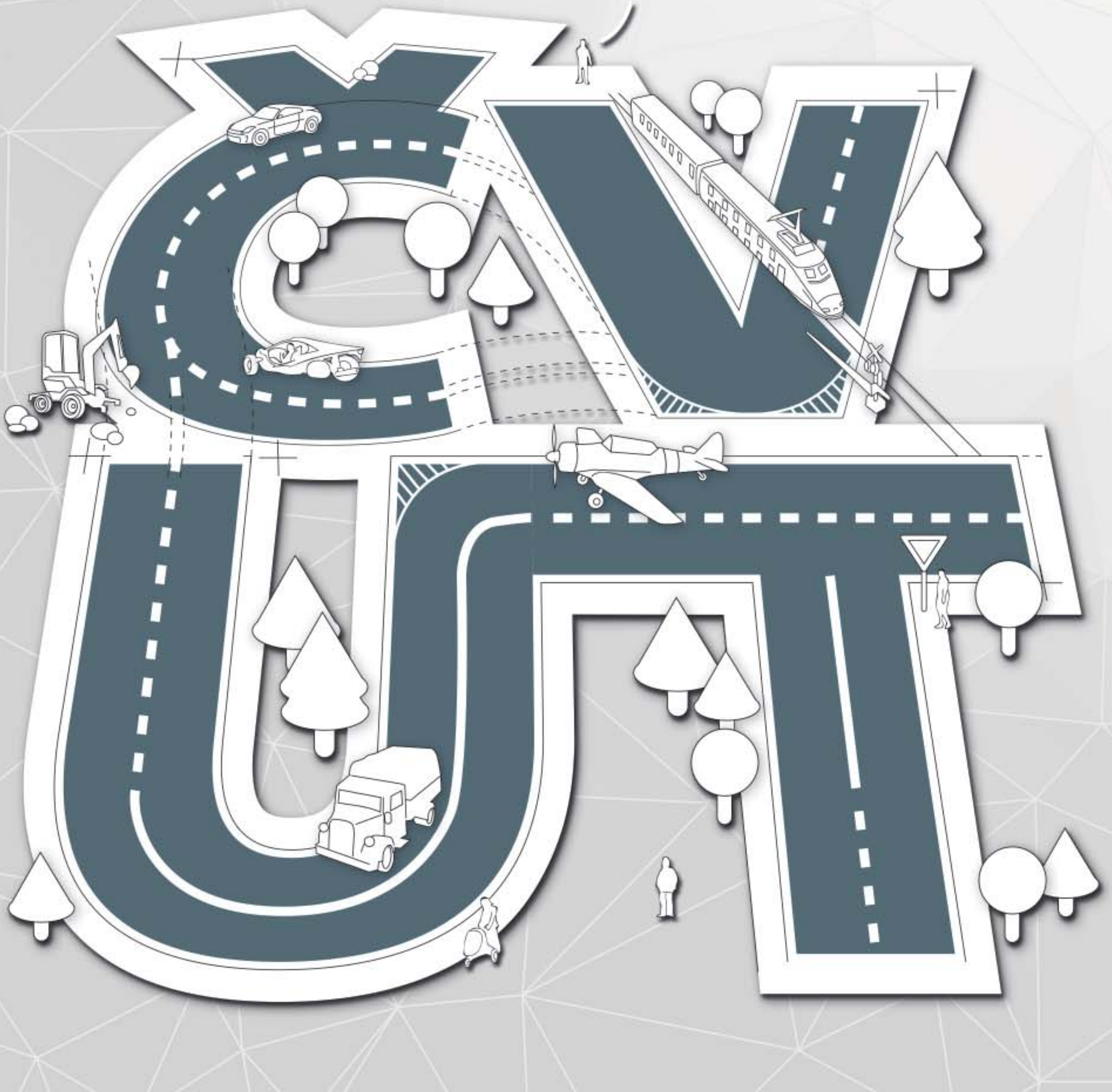

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Dear colleagues,

It is expected that 70% of population will be living in large cities in year 2050. Such cities will produce 80% of global pollution and 75% of energy consumption. The concept of Smart cities forms a system overarching the activities of smart buildings, intelligent vehicles, smart transport (intelligent transport systems) and energy infrastructure (smart grids). The synergy among these sectors must be taken into account.

Smart cities area is an example of a multi-disciplinary approach which must – in addition to the technical and technological elements – include also the areas of economics, law, sociology, psychology and other humanistic disciplines.

Ensuring efficient urban management through the adoption of new technologies, innovative business approaches and novel organizational models is going to be a big challenge – for all of us.

Yours,

Miroslav Svítek, Dean of Faculty of Transportation Sciences, Czech Technical University in Prague

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ABSTRACTS

A conceptual proposal for an expert system to analyze smart policy options for urban CEP transports

Stefan Schröder, Peiman Dabidian and Gernot Liedtke

***Abstract*— Courier, express and parcel (CEP) transports have been growing significantly. CEP is one of the biggest segments in urban freight transport. It does not only contribute to the wealth of our cities, but also comes with negative impacts such as noise, congestion and pollution. Transport policy has developed measures to reduce these negative impacts. This paper proposes a conceptual framework to analyze smart policy options. It focuses on the derivation of CEP demand and supply.**

***Index Terms*— Transportation, freight transport modeling, transport simulation, micro simulation, transport policy.**

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Advanced VANET routing design

M. Srotyr, Z. Lokaj, T. Zelinka

Abstract— **Cooperative systems play an important role in the field of telematics and automotive industry and they have a huge potential to continuously grow. To ensure proper functioning it is necessary to deal with telecommunication solutions being able to support relevant information dissemination within vehicles networks.**

There are many different approaches to networking and information distribution in VANET networks. Different approaches can meet partial requirements; however, none of the existing approaches can offer solution being able to meet all key requirements generated by the real traffic.

The conclusions of our studies and simulations so far show that an appropriate option must combine Geocast based routing type with centrally operated cluster based support. Such approach also well fits with available telecommunications system architecture applicable for VANET solutions.

Index Terms— **telematics, VANET, routing protocols, LTE, WAVE.**

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Analysis and Modelling Methods of Urban Integrated Information System of Transportation

Csaba CSISZÁR, Dávid FÖLDES

***Abstract*— Efficient and environmentally friendly management of mobility plays a significant role in the smart cities. As the transportation systems and the information systems link the components, their development is essential for realization of complex city operational schemes.**

Information is one of the most important inputs for the activities, especially in transportation. Logical and physical integration of transportation information systems and services are required by the increasing expectation of travellers and became possible by the development of the infocommunication technology. Since the results of comprehensive system and process-oriented scientific research on this area are slightly published, the devised analysis and modelling methods described here and their adaptation fill this niche.

Herewith the architecture of the entire integrated system and the model of the intelligent traveller with the personalized mobile application have been presented in more details, but the method is applicable for each subsystem with different resolutions. The results are of great importance contributing to the success of the top-down systems engineering.

***Index Terms*— analysis, information system, integration, mobile application, mobility management, modelling, personalization, transportation.**

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Behavioral approach to modeling residential mobility in the Prague metropolitan region

Jakub Vorel, Daniel Franke, Martin Šilha

***Abstract*— Residential mobility significantly influences all other urban processes: the real estate market, the location of economic activities and public services. Especially, the residential mobility influences the travel patterns and demand for transportation services. Therefore, modeling residential mobility should be regarded as the precondition for "smart" spatial and transportation planning.**

Recent approaches to modeling of urban processes regard the urban systems from the perspective of individual human actors, their preferences, decisions and activities. The micro-simulation random utility discrete choice models explicitly represent decision-making processes of individual actors in their individual contexts and allow the residential mobility factors to be analyzed on the level of individual actors.

The paper describes the application of experimental microsimulation model on the study of residential mobility in the Prague metropolitan region. It examines existing data from the point of view of availability and suitability for micro-simulation modeling, provides technical guidance for the application of micro-simulation models for scientific research and the practice of urban planning and illustrates possible outcomes of the microsimulation modeling.

***Index Terms*— Smart Cities, residential mobility, modeling.**

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Definition of a Smart Street as Smart City's building element

Pavel Přibyl, Ondřej Přibyl

***Abstract*— Smart city covers a wide range of topics. In this paper, we introduce a basic building block able to address already on a fundamental infrastructural level several of the key user functions of a smart city. This is done on a scale that can be rather easily managed. So called "smart street" is defined and introduced as a basic building block for any smart city architecture. It does not focus on transportation only (for example through signal control and management), it covers also other aspects, such as data connectivity, safety of citizens, energy consumption and many others.**

***Index Terms*— Smart city; Sensor fusion; City management.**

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Detection of Persons in a Vehicle Using IR Cameras and RFID Technologies

Jana KALIKOVA, Jan KRCAL, Milan KOUKOL

***Abstract*— A goal of this article consists in demonstrating the eCall system enhancement. We propose to enhance the system by next relevant information for emergency services – exact number of persons in a vehicle including recognising adults and children, number of disabled persons and their disability kind. Further, the system will enable to identify a driver.**

***Index Terms*— persons detection, eCall, IR camera, RFID**

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Dynamic Human-Machine Interface for Electrical Vehicle design guidelines

D.Rozhdestvenskiy, P. Bouchner, A. Mashko, K. Abishev, and R Mukanov

***Abstract*— this article deals with a Human Machine Interface of Electric vehicles starting from the history of Electric Vehicles HMI, describes currently used system elements and provide evaluation of their advantages and disadvantages. A new concept of Dynamic HMI for Electric Vehicles is introduced to improve EV efficiency in terms of energy consumption and range distance, and consequently increase their popularity among users. This interface is capable to adapt itself to user or system needs and changes dynamically based on EV battery State of Charge or reachability of desired destination. Such implementation of HMI address one of the main reason why users still prefer conventional vehicles with internal combustion engine to EV – range anxiety phenomena.**

This article aims to be a guideline for a design of new concept of HMI for EV, studies user requirements and propose a methodology of system development including concept definition and user acceptance validation methodology on vehicle driving simulator.

***Index Terms*— HMI, Electric Vehicle, Hybrid Car, IVIS, GIS, Extended navigation**

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Efficient Fine-grained Analysis of Urban Transport Accessibility

Jan Nykl, Michal Jakob, Jan Hrncir

Abstract— **We describe a novel computationally efficient method for the fine-grained analysis of accessibility in multimodal (urban) transport systems. In contrast to existing work, we use a full-detail representation of the transport system, including exact timetables and complete maps of road, footpath and cycleway networks, which enables more accurate accessibility assessment. Compared to existing work, our approach also calculates a wider range of location- and time-dependent transport accessibility metrics, including service frequency and the number of transfers for public transport and physical effort and elevation gain for cycling. Because it employs efficient single-origin multipledestination shortest-path graph search techniques, our method is also faster than existing approaches relying on point-to-point search algorithms. We demonstrate our method on the city of Prague, showing the interactive frontend for location accessibility analysis as well as the application of our algorithms for comparing the city-wide transport accessibility before and after large-scale timetable change.**

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Flywheel energy storage retrofit system for hybrid and electric vehicles

J. Plomer, J. First

***Abstract*— flywheel battery, composed from commercially available low-cost materials, can be designed as an additional energy storage system for further increasing the energy efficiency of vehicles, driven mainly in cities with frequent speed changes. Increasing demands from European Union on additional reduction of CO2 emissions in near future will offer better conditions for commercially successful serial production of hybrid and electric vehicles. Sufficient short-term power for the acceleration of a passenger vehicle in the city as well as efficient accumulation of vehicle kinetic energy during braking for several minutes can be reached even from a flywheel battery of energy capacity of about 200Wh. In combination with traction motor/generator of around 20kW and voltage 48V, the flywheel battery represents an interesting additional retrofit for conventional drives with combustion engines with positive influence on reduction of fuel consumption and therefore, also CO2 emissions. Such solution contributes to energy smart management in frame of smart city systems.**

***Index Terms*— Flywheel battery, gyrobus, hybrid drives, energy recuperation.**

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Individual Perception of Smart City Strategies

Ondřej Přibyl, Tomáš Horák

Abstract— **The term Quality of Life is essential in understanding the outcome of smart city initiatives. According to several definitions, it is one of the major objectives of activities in the area of Smart Cities. Different studies presented in this paper aim at classifying a city with respect to "smartness". The results of all such studies however look at a general index. As discussed in this paper, quality of life is highly individual. It is not true that one measure has the same impact on the quality of life of different individuals. To understand perception of all individuals within a city is difficult but necessary, if we want to model the impact of different measures on different groups of citizens.**

In this paper, the authors propose a way to gain understanding on the issue of individual perception of Smart Cities. This supports the researchers not only in modeling efforts, for example using multi-agent systems, but also in selection of projects. First, so-called life stages (life cycles) are defined to address the individuality in perception. Next, an IPSCS survey is designed and mathematical tools for survey evaluation are proposed to allow for learning more about such perception. In this paper, a survey was conducted to proof the proposed concept and methods.

Index Terms—**Quality of life; Smart cities; Survey; Life cycles**

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Mixture-based Cluster Detection in Driving-Related Data

Ivan Nagy, Evgenia Suzdaleva, Pavla Pecherková, Krzysztof Urbaniec

***Abstract*— The paper deals with detection of clusters in data measured on a driven vehicle. Such a clustering aims at distinguishing various driving styles for eco-driving and driver assistance systems. The task is solved with the help of the application of the recursive Bayesian mixture estimation theory. The main contribution of the paper is a demonstration that real measurements with non-linear relationships between them can be approximately described by the mixture model, which is known as the universal approximation. Validation experiments are shown.**

***Index Terms*—Bayes methods, clustering algorithms, data analysis, data models, Gaussian mixture model, recursive estimation.**

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Multilevel Transport Interchange

Prof. Dr. Kuanyshbaev Z.M., ENU, Dr. Arpabekov M.I., ENU, Dr. Suleimenov T.B., ENU, Kozbakova S.K. ENU

***Abstract*— The authors provide an analysis of traffic on the example of the intersection of streets Bauyrzhan Momyshuly and Tauelsyzdyk, Astana. As you know these two streets are the main transport arteries which connecting the right and left bank of the capital of the Republic of Kazakhstan. Analysis shows that at peak time formed fairly large plugs at following vehicles in both directions. Therefore, the authors of a scientific paper proposed a scheme of multilevel transport interchange, eliminating conflict points that increase capacity of interchange and ensure the safety of pedestrians.**

***Index Terms*— road capacity, intersection, traffic lane, multilevel interchange, left-hand turn, right-turn, road markings, road signs**

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Night Earth Observation for Smart Cities

Ilya Zatsepin, Miroslav Svítek

***Abstract*— The subject of this article is analysis of the methods of Earth Observing in Intelligent Transport Systems (ITS) and Smart Cities and technical characteristics of satellite data. The first part of this article presents the analysis of satellite images of the Earth's surface illumination in villages, towns and cities, selected parts of transport infrastructure, which allows monitoring the extent, intensity and quality of illumination in larger areas and then evaluating the impact of illumination on the traffic safety. The advanced processing of satellite images shall allow identification of problem areas and monitoring poor illumination within larger areas. The second part of the article analyzes possibilities of application of methods of Earth**

Observing by using acquired satellite information combined with ground-based data sources. Processing of all available information and data available shall allow designing of new applications in the framework of the concept of Smart Cities.

***Index Terms*— Satellite data, Earth Observing, Smart Cities, satellite images of the Earth's surface illumination..**

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On the Development of Urban Adaptation Strategies Using Ecosystem-based Approaches to Adaptation

Přemysl Derbek, Jana Blümelová, Jaroslav Resler, Pavel Juruš, Pavel Krč, Ondřej Vlček, Nina Benešová, Petra Bauerová, Daša Srbová, Kryštof Eben, Pavel Hrubeš

***Abstract*— Abstract—Selected aspects of currently running project UrbanAdapt are described. The project deals with the adaptation of cities on changing climatic conditions. The main project objective is to start the process of preparation of cities adaptation strategies, developing adaptation scenarios and testing the effects and benefits of particular measures. Previously developed models of adaptation impacts are used with available real data and according to several prepared scenarios to provide necessary decision making tools. The final policies have to take into account climatic conditions, available means, and devices to propose necessary amendments and solutions. Project team involves groups from different fields that cover various aspects of adaptation measures including economic analyses, policy making processes, education and dissemination to the public. The presented paper deals with the part of activities which are focused on modelling of adaptation measures and climatic impacts for the city of Prague.**

These activities include assessment of energy balance of city, in terms of interactions of solar radiation, atmosphere and urban environment. Urban environment includes not only buildings, street surfaces and vegetation, but also the processes having impact on energy balance such as the traffic, air conditioning and industry that produce anthropogenic heat which can play a role for example in summer heat waves.

The ultimate goal is to assess the impact of different adaptation measures on citizens who live in environmental conditions of growing effect of urban heat island. Thus the connection between objective meteorological variables and subjective biological indices has to be investigated. The concept of Physiological Equivalent Temperature (PET) is adopted. In comparison to single values of air temperature, air humidity, global horizontal irradiance, wind speed, and other meteorological indexes, concept of PET has added value in determining the value of important biometeorological index in easily recognizable quantity such as °C. Micro-scale models can be one way to study proposed adaptation measures such as tree alleys, bodies of water, etc.

***Index Terms*—Anthropogenic heat, heat island, model, PALM, PET, RayMan**

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Optimization of a Spare Parts Distribution System Using a Genetic Algorithm

Alena Rybičková, Denisa Mocková, Adéla Karásková, Jakub Brodský

***Abstract*— In this paper we focus on the system of the spare parts distribution for authorised garages in the Czech republic and its optimization based on genetic algorithm. Real world problem of garages supply consists of the design of the optimal location of distribution depots and the design of routes that are used for everyday delivery of spare parts. Both of these subproblems that belong to NP-hard problems are solved separately using genetic algorithm.**

In the facility location problem, the set of customers, set of potential locations of facilities and distances for all their combinations are given and our goal is to select location of facilities with the minimum costs based on chosen criterion.

In the second part of the optimization the vehicle routing problem is solved where the goal is to determine the routes described as a sequence of customers visited on this route. Every route starts and ends in the depot and is limited by capacity of the vehicle. Homogeneous fleet was used in this problem.

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Prediction diagnostic for smart cities systems

Mirko Novák, Miroslav Svítek, Zdeněk Votruba

Abstract— **Systems applied in the last few years for an improvement of the operation of tools ensuring the most critical functions in large cities must provide their functions exploiting various methods from the area of advanced informatics and system theory. One of the most important of them is the prediction diagnostics being a tool allowing how long particular system (or the whole smart cities system alliance) can still operate well, or when it approaches to the end of such reliable state. In this contribution the possibilities of prediction diagnostic apparatus are discussed as well as limitations coming from the fact that these systems must be very often considered as uncertain, especially if they interact with human factor.**

Index Terms— **Smart cities systems, reliability, prediction diagnostic, danger of operation failures, in-time warning**

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Prediction System of Occupancy of Parking Spaces

Martin SROTYR, Michal JERABEK, Zdenek LOKAJ, Tomas ZELINKA

***Abstract*— This paper presents the result of the project TA02031411 - transportation system which provides information about the predicted occupancy of parking spaces to truck drivers. Providing this information leads to optimizing the use of existing parking spaces on the highway network and also makes it easier for drivers to deciding on a suitable location for parking, which ultimately contributes to the fluency and safety of traffic.**

***Index Terms*— Prediction, Parking, Highway Network, Electronic Toll**

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Process Analysis of Transport Ticketing and Information Systems for Czech Public Transport

Milan SLIACKY, Michal JERABEK, Jindrich BORKA, Roman SKUHRA

***Abstract*— Due to the high level of development of integrated transport systems in the Czech Republic the need for standardization in this area is constantly becoming urgent. The article deals with the process analysis of a typical fare collection and information system for public transport in the Czech Republic. Results of the analysis are important for the assessment of systems interfaces from standardization point of view.**

***Index Terms*— public transport, fare collection system, information system, process analysis**

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Reduce of Criticality of Critical Infrastructure Facilities in the Railway Domain

Tomáš KERTIS, Dana PROCHAZKOVA

Abstract— **The paper deals with safety improvement of facilities of critical infrastructure in the railway domain based on integral safety management. It means that it solves not only secure facility but also safe facility that is the facility which at itself critical conditions do not endanger either itself or its vicinity, i.e. humans and other public assets. In the modern practice of safety management and safety engineering there are introduced new procedures like All-Hazards-Approach, Defense-In-Depth and for construction of critical facility safety there is used the five-layer model of safety management. The article comprises current state of appropriate railway system with ideal case based on mentioned concept and gives proposal of measures for improving the safety of followed critical facilities.**

Index Terms— **human security, safety, integral safety, criticality, critical infrastructure, facilities of critical infrastructure, railway system, security**

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Review of approaches to the problem of driver fatigue and drowsiness

Alina Mashko

Abstract— **This article maps the applications and tools for driver fatigue detection currently available and those in development, explores the experimental and research work gained on the development of novice methodologies and tools in this field. The driver drowsiness measurements have been conducted on driving simulators in the laboratories of Czech Technical University in Prague at Faculty of transportation sciences. The later experiments' technical platforms and approaches of measurements are described here along with the analysis of obtained results that are compared to those of the related work experimental experiments. The conclusions about possible best approaches will be provided.**

Index Terms— **Driver drowsiness, fatigue, sleepiness**

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Sensor Network for Environmental and Traffic-related Measurements

J. Kopřiva, P. Brynda, and M. Horák

Abstract— **The paper is concerned with the development of an experimental wireless sensor network for environmental and other measurements related to road-based transportation in an urban environment. Three new types of compact sensor units have been developed for use in this network. A "master" unit capable of measuring CO, NO_2, SO_2, VOC, dust particle (PM2.5 and PM10) and noise pollution, a "slave" unit for gathering measurements with low power requirements and a "mobile" unit for location-independent environmental measurements. An experimental network made up of master units (for pollution measurements gathering) and slave-based weather stations (for measuring dispersion conditions) is currently installed in the Spořilov district in Prague. The network is designed to provide current information about the environmental impact of roadway transportation to citizens and to the public authority.**

Index Terms— **Data collection, Environmental monitoring, Master-slave, Mobile nodes, Pollution measurement, Radio communications, Wearable sensors, Wireless application protocols, Wireless sensor network.**

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Service Quality of Train System for Visually Impaired Passengers

Michal JERABEK, Filip JAKL, Jan KRCAL, Lucie KRCALOVA

***Abstract*— An integral part of the concept of "smart cities" are information and orientation systems for visually impaired persons. This paper presents the results of the research of functionality trains system for visually impaired passengers in the Prague.**

***Index Terms*— Visually Impaired, Transportation Information System, Service Quality, Train System for Blind.**

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Smart cities approach for Colombian Context. Learning from ITS experiences and linking with government organization

Luis Felipe Herrera-Quintero, Walid David Jalil-Naser, Klaus Banse, J. Javier Samper-Zapater

***Abstract*— The forecast (world bank) related to the growth of world population tends to be around 9000 million to 2050 and most of the people will live in the cities or in conurbations, this means that, a new approach for support the development of the cities needs to be analyzed. Currently, the mankind has developed and produce a lot of technology advances and many of them are related to the Information and communications technology (ICT). In this way, ICT has become in a key element for the development of the cities, even, introduce the ICT concept in the context of the cities has provoked a new scope for the cities that is called Smart City or Digital City. In this paper, it is presented an approach for Colombian Smart Cities where have been taking in to account several experiences of deployments of solutions in the field of Intelligent Transportation Systems (ITS) taking these, like a core for several solutions for the inhabitants, in addition, government organization is presented like a key element for deploy solutions in the context of Colombian Cities where the ICT solutions can be applied.**

***Index Terms*— Smartcity, Intelligent Transportation System,**
Web Services, Internet of things.

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Smart Cities as a University Common Talk: The Case of UNIZA

Karl E. Ambrosch, Milan Dado, Aleš Janota, Juraj Spalek

Abstract— **The „Smart Cities“ topic has recently become thetopic number one in the agenda of both national and international research and development projects. This paper has been written with motivation to present various ideas of experts and professionals from an academic environment that represent different scientific fields of work such as telecommunications, control engineering, traffic engineering, information and communication technologies, etc. The authors believe that using the case of the University of Žilina (UNIZA) the multidisciplinary and synergic character of the topic may be emphasized sufficiently. Therefore a special content form of the paper has been used, based on the "question-answer" pattern. Traditionally prepared papers usually follow one of two possible lines: integration dimension – from research mono-thematically oriented on one technology only up to the fully integrated approach, or socio-technical dimension- from solution of purely technical problems up to the socio-technical perspectives and position of a human in the whole chain. This paper aims to raise a set of key questions representing the most urgent problems of today's smart city agenda and answers to them.**

Index Terms— **Communications technology, data processing, information systems, wireless sensor networks, smart cities.**

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Smart Cities as Complexity Management

Tomáš Peltan

***Abstract*— The term Smart Cities is used in many different meanings ranging from ITC infrastructure development to softfactor-based approaches and "creative cities". This paper interprets smart cities as an approach to the problem-solving based on deliberative complexity management. This enables both to increase the range of tools available to Smart City approach and to use the large body of complexity and sustainability related research literature with broad range of historic case studies.**

***Index Terms*— Smart Cities, complexity, sustainability.**

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Smart Region as a Complex System and some notes to its Design

Jiri Bila, Martin Novak, Jan Pokorny

Abstract— **The paper discusses the means and methods of design of Smart Region. Region and landscape are too large for the classical description. Moreover, they are too heterogeneous - and require mixed formal means. In other words - there is impossible to form a central feedback control block. The paper follows two issues: - Motivation for the design of Smart Regions. It is emphasized the emergence of situations of instability and emergency situations such as wet and dry cycles, interruption of small water cycle, decreased volumes evapotranspiration (plant respiration) and its impact on high volumes of energy flow outgoing into the atmosphere, strong storms (tornadoes) and floods. – Computation network for the content and the area of a Smart Region. The examples illustrate application of the method for a very dense and industrial region and for the region with rich vegetation and low density of cities and industry.**

Index Terms— **Evapotranspiration, biodiversity; extreme temperatures; Controlling Smart Region in Design phase; Computation by a Knowledge network**

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Smarter traffic control for middle-sized cities using adaptive algorithm

Zuzana Bělinová, Tomáš Tichý, Jan Přikryl, Kristýna Cikhardtová

***Abstract*— The paper presents urban traffic control method suitable and tested for a small urban areas enabling more fluent traffic and thus increasing the throughput of the controlled area. The model is implemented in the adaptive Traffic Dependent Control module for higher control of the area designed for the optimization of the intersection signal plans, providing the best improvements for intersections with irregular traffic.**

***Index Terms*— urban traffic control, travel time, intersection controller, adaptive control**

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System alliances as a tool for solving Smart Cities problems

Vít Fábera, Mirko Novák, Miroslav Svítek, Zdeněk Votruba

Abstract— **Basic information on Smart City modeling approach based on the concept of the System alliance is presented. An advantage of this approach inter alia is that System alliances are naturally able to model the synergic effects on interfaces and to minimize various negative impacts. Two ways of interfaces modeling within the alliance are discussed: (i.) Quantum–like models and (ii.) the utilization of the duality: automaton – language. In the first case the superposition of states or even the entanglement concepts are suitable tools for recording non - orthogonal interface parameters and resulting phase sensitivity of the respective interface. In the second approach processes on interfaces are modeled as mutual translations of specific languages. Due to significant uncertainties the methodology of genetic algorithms and grammatical evolution are tested.**

Index Terms— **Smart City; system alliance; interface; uncertainty; genetic algorithm; grammatical evolution; quantum models**

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System approach to study of traffic accidents with hazardous substances presence

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***Abstract*— The traffic accidents with presence of hazardous substances have been occurred at transportation on roads, rail roads, rivers, seas, oceans and in air. To the origination of such accident there has been contributed the items as: vehicle design, traffic speed, roadway design, environ round roadway, skill and defects in driver's behavior, and also the properties of shipped hazardous substances. On the basis of integral safety concept the considered accidents are solved as mobile sources of risks. The paper contains the results of research obtained by critical analysis of impacts of relevant accidents in the word and in the Czech Republic, and proposals of measures for upgrade of safety of considered shipping that improve protection of humans from hazardous substances.**

***Index Terms*— human security, safety, traffic accidents, hazardous substances, critical infrastructure, impacts.**

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Testing, Troubleshooting and Modelling Tools for Communication Part of Smart Grid

Tomáš Hégr, Jiří Vodrážka, Zbyněk Kocur

Abstract— **This paper deals with a data transfer testing and modeling in communication networks supporting energy distribution. The concept of Smart Grid, which promises highly efficient and dynamic energy systems, has to be backed by convenient communication systems. The contemporary electrical grid incorporate some form of the digital communication to be able to deliver desired availability and reliability at all levels. This means that the communication systems are inseparable from the electrical grid itself. While power-engineering uses well proven methods for the grid testing, the data networking, in this particular area, is still evolving. The paper analyses advanced methods for testing and modeling of data transfers in communication networks and presents selected practical experience.**

Index Terms— **Smart grid; Communication network; Data transmission; Internet of Things.**

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The Use of Vehicle Manoeuvre Test Data for Forming and Approval of Physical Model

Josef Mík, Jana Kadlecová

Abstract— **The contribution describes the already performed dynamic driving tests of a high-load road vehicle and an articulated vehicle composed of a towing vehicle and a semitrailer. The driving tests consisted of standard and extreme manoeuvres what means the acceleration, the braking at variable intensity and an evasive manoeuvre. The tests were conducted at different load of the semitrailer as well as with a single towing vehicle. The three-axis accelerometer was located on the car frame and in the cockpit.**

The contribution as well includes the assessment of the measured data and the description of its use during the creation of a physical model of the vehicle simulator movement. An intention to simulate the movement in such a way the impacts on the driver are as real as possible in comparison to real vehicles exists, thus the vehicle can be replaced by a simulator.

Index Terms— **Truck simulator, human-machine interface, validation data**

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Transportation, intelligent or smart? On the usage of entropy as an objective function

Ondřej Přibyl

***Abstract*— In this paper we discuss the paradigm shift that has to be understood by the decision makers as well as societies in the field of transportation. It is not sufficient to focus only on mobility as the current strategies do, but we need to look at citizens quality of life as whole. It is affected through different aspects, and only one of them is transportation. We need to provide a better way to participate in activities – increase accessibility of goods and services. This cannot be done with look at transportation only. We need to understand the entire organism of a city. This has been recently understood by the Smart cities initiative. A smart city is defined within this paper as an alliance system, i.e. a system where particular subsystems use the common resources in a synergic way. In order to make this concept work, an objective function following the above mentioned principles must be provided. In this paper, we offer entropy of a city as a promising candidate for such objective function.**

***Index Terms*— Entropy, Intelligent Transportation System, Smart Cities**

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Urbanization, the cornerstone of air traffic growth

Petra SKOLILOVA

***Abstract*— It is well known that economic growth is a key factor of air traffic growth, but another explanatory variables playing a major role in air traffic evolution are: population growth, urbanization and new middle-class emergence in developing countries. Another level of air traffic is the increasing connectivity between people and regions. At first, it can be viewed as a consequence of economic growth but it is also a facilitator: directly with the multiplication of new routes and the increasing capacity in airports which extend the supply for future journeys and indirectly by stimulating the economy through infrastructure investments and the business attract. While the world total population will increase from 7 to 8.3 billion people in 2030, the urbanization growth rate is expected to be 2% per year, representing 60% of the world population or 5 billion people in 2030.**

Migration is also an air traffic vector. With the globalization of the economy, more and more students feel that studying abroad is positive for their future careers. One million international students come from East Asia & Pacific area to study in North America and Western Europe, which is the number one hosting region with 2 million international.

Finally, simplifications of visa policies, with visa on arrival programmes replacing the traditional visa, a form of deregulation, is also having a positive impact on air traffic growth.

***Index Terms*— economic growth, urbanizations, air traffic growth, connectivity, air traffic forecast, air traffic economy, population growth**

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Use of ICT in Smart Cities. A practical case applied to traffic management in the city of Valencia

Marta Pla-Castells, Member, IEEE, Juan José Martinez-Durá, J. Javier Samper-Zapater and Ramón V. Cirilo-Gimeno

Abstract— **The whole process of converting a city into the new concept of Smart City implies the improvement of the efficiency and quality of services made available by governments and businesses and a corresponding increase in citizens' quality of life.**

This process requires a series of actions that include data collection, processing and use of this information for its dissemination among citizens. For example, it is necessary to promote the use and reuse of information from the government or private entities as open data and therefore made more useful and appropriate for citizens. Technologies such as sensor networks, ubiquity, connectivity infrastructure-vehicles and others, become essential elements to achieve this goal.

In this paper we present some relevant aspects related to these lines of action in a Smart City and their application to the traffic management data in the city of Valencia.

Index Terms— **Information and Communications Technology, Linked Open Data, Smart City, Traffic Management.**

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Variable selection for prediction of time series from smart city

Martin Macaš

Abstract— **Most information and communication technologies systems providing some form of intelligence to future smart cities will more or less use data-based predictive models. Since the amount of data collected increases rapidly, it is becoming crucial to select proper data that are relevant and useful for the specific predictive model. The importance and usefulness of two wrapper feature selection methods is demonstrated here on 23 time series appearing typically in smart city area. Particularly, high dimensionality reduction is achieved without sacrificing the prediction performance for energy consumption, temperature, price and people's presence prediction. Only for thermal discomfort prediction, high dimensionality reduction causes small increase of mean average prediction error typically less than 1%.**

Since the two methods are comparable from the dimensionality reduction and prediction performance point of view, sensitivity based pruning is recommended, because of its less computational demands.

Index Terms— **Smart Cities, feature selection, prediction, time series.**

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FULL PAPERS

A New Perspective on the Planning of Parking Spaces

Josef Kocourek, *CTU in Prague Faculty of Transportation Sciences*,
Jiří Čarský, *CTU in Prague Faculty of Transportation Sciences*,
Jana Jirků, *CTU in Prague Faculty of Transportation Sciences*

Abstract — **The requirement for parking spaces is a necessary part of each project documentation, from which a new investment plan will be made. Determination of needs for parking spaces is also part of any land–use plan. The reason is that needs for parking are an important point in urbanization and town development. The number of parking spaces is important not only for the planning of new constructions or development plans, but also for existing territories and the modernization of existing buildings after assessment etc. The total number of parking spaces is sequentially specified from the input parameters and coefficients set in the technical standards. These are either partially inaccurate, or do not correspond to the real requirements for parking and parking spaces in general. This article examines smart parking to make parking easier and more efficient than the way in which need for parking spaces are currently calculated (nowadays is used calculation according to ČSN 73 6110 "Design of urban roads").**

Index Terms — **project, parking, smart parking, legislation, urban roads, school, catering, restaurant, organization, usage of technologies**

I. Introduction

IT is typical that for more regional and supra–regional units the needs for parking spaces are not calculated according to the standard ČSN 73 6110 "Design of urban roads", but that these needs for parking are determined according to their own regulatory measures as they try to adapt to local conditions (e.g. Public notice No. 26/1999 of the Collection of Prague).

The reason for creating these ordinances is that we can find different characters of local areas (historical centers, peri–urban areas, etc.), the size of the territory, the nature of public transport and other services.

But even in spite of these differences in the basic document on which the regional or local documents are based, the above mentioned standard ČSN 73 6110 "Design of urban roads" must be used. Strict compliance with the prescribed procedure, how to obtain the required number of overall parking spaces, is determined by tracing individual factors such as availability index, walking distance, the coefficient of reliability, coefficient of line frequency, the coefficient of reduction of number of parking spaces, etc. As a result of this it is often forgotten to include the possibilities to not only build new parking spaces, but also to organize their usage properly.

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II. Coefficient of Walking Distance to Stop

Through all the stages and the monitoring indexes closely, we can find, that in the current standard of calculation of the total number of parking spaces is most likely a mistake. This is a paragraph within the walking distance. The calculation is used mainly for calculation in "difficult conditions" for each zone or buildings, that are located in areas with good public transport connections, but in the total this calculation may have a large impact on the total number of parking spaces.

The calculation of "the index of availability" is as follows (According to standard ČSN 73 6110 "Design of urban roads"):

- *Index of availability*

$$A_D = \sum A_F \quad (1)$$

A_F ....public transport line frequency

$\sum A_F$ .....the sum of all public transport line frequencies of all stops that are reachable in the area

- *The metric line frequency unit*

$$A_F = \frac{60}{A_N} \quad (2)$$

A_N ....coefficient of entering time

- *Coefficient of entering time*

$$A_N = A_Z + A_C \quad (3)$$

A_Z .... time needed to reach the bus stop

A_C .... the average waiting time for the arrival of public transport vehicle

- *Time needed to reach the bus stop*

$$A_Z = l \bullet v \ [s] \quad (4)$$

l .... distance *[m]*
v .... speed *[considered 1,4 m/s]*

$$A_Z = \frac{l \bullet v}{60} \ [min] \quad (5)$$

The goal is to find the determination of average time needed to reach the stop. We can consider the average walking speed of *v = 1,4 m/s* for an uniform movement, which is one of the basic patterns of mechanics, where mechanics is one of the oldest parts of physics.

In the available documents (for example mathematical or physical tables) are laid down two basic formulas of the movement. This is a calculation of the trajectory and speed within the harmonic motion.

$$s = v \bullet t \quad (6)$$

s .... trajectory *[m]*
t .... time *[s]*
or rather

$$v = \frac{s}{t} \quad (7)$$

By modification of the basic formulas (4), (5), (6) and (7) we can set the time needed to reach the stop:

$$t(A_Z) = \frac{s}{v} \ [s] \quad (8)$$

or

$$A_Z = \frac{(s/v)}{60} = \frac{s}{60 \bullet v} \ [min] \quad (9)$$

It is clear that the input quantities entering both established formulas for the calculation of time t (according to the calculation of the walking time to the station according to standard ČSN 73 6110 "Design of urban roads"), are identical, and that the error is given by the mathematical operators "times" and "divided by".

By comparing the results it is evident, that the existing method leads to inaccurate calculations of the total number of parking spaces. These inaccurate calculations bring higher numbers than it should be properly determined.

In the current text of standard ČSN 73 6110 "Design of urban roads" including the Change of standard "ČSN 73 6110 Change Z1 (Change 02/2010)" this inaccuracy not only affects the time needed to reach the bus stop A_Z, which is always significantly higher than the one using the modified formula (9), but also at the same time reduces the availability index and level of availability of the territory.

From these calculations the coefficient of number of reduction of parking spaces is determined, which will be higher and as demand of this multiplication there will increase the total number of parking spaces. This inaccuracy was also already mentioned in one of the master´s theses at the Faculty of Transportation Sciences (CTU in Prague).

An adjustment of this formula (9) will bring more precision and accuracy of the result, but doesn´t work with the global decision–making aspects. Those are, for example, the attractiveness of the territory, the kind of city transport or public transport etc. It would also be appropriate to deal with the territory as a whole and not just as one particular part.

It would be desirable to replace the distance to the bus stop by the distance – circle showing us the same distances from different parts of the area to the bus stop. With this technical parameter, such as distance – circles, or the availability of the bus stop, is determined the position of a new bus stop. The variable should be the default measure for the availability of the territory.

III. Determination of Parking Spaces According to the Functional Units

According to the character of the landscape, the territorial development plans are nowadays also designed and planed not only as large mixed – use objects with a predominantly residential character but also with other uses such as administrative spaces or cafes. These services are primarily designed to meet the needs of local residents, or residents of a nearby area, which are in a relatively acceptable walking distance. Uses for persons from a border area are then minimal and for this reason there are not as far as so much set demands on parking spaces.

In contrast to the needs for parking spaces (with reference to the standard ČSN 73 6110 "Design of urban roads", Change of standard "ČSN 73 6110 Change Z1 (Change 02/2010)") the requirements of such parking spaces are neglected. The numbers of parking spaces are decided by developers, but as these buildings include non–residential spaces, the developers do not set the correct numbers of parking spaces. For this reason, the company vehicles of the people working in the administrative areas are parked for a period of non–use in the available parking spaces and therefore reduce the capacity of the parking spaces that are designed for other purposes, for example to visit the housing section.

Functional breakdown of the areas of the non–residential character are divided in table No. 34 of the standard ČSN 73 6110 "Design of urban roads" and the relevant Change of standard "ČSN 73 6110 Change Z1 (Change 02/2010)", where the individual "pointers" are further divided into subgroups with the relevant criteria of the required number of parking spaces. Areas of public restaurants or catering have become the exception of this subsequent subdivision in the Change of

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standard “ČSN 73 6110 Change Z1 (Change 02/2010)”. These areas have been provided for only one subgroup – the “restaurant”, which in its original form (01/2006) of the standard ČSN 73 6110 “Design of urban roads” was divided into 4 groups (please see Table 1.).

TABLE I
A MODIFIED PART OF THE TABLE NO. 34 OF THE STANDARD ČSN 73 6110 “DESIGN OF URBAN ROADS” – FEATURED BASIC INDICATORS OF ALL PARKING AND PARKING SPACES FROM THE CHANGE OF STANDARD “ČSN 73 6110 CHANGE Z1 (CHANGE 02/2010)”

Type of structure	Specific unit	The number of special purpose units to 1 parking	The number of parking spaces [%]	
Parking space			The short-term	The long-term
Catering – restaurant	Area for guests in m^2	4 to 6	70	30

By distribution to only one subgroup, smaller areas of business, such as cafés, are disadvantaged. This is due to the fact that main courses are not usually served and the delay of serving the customers is not as long due to the preparation and consumption of main courses in these smaller businesses. These Cafes are most commonly placed in multi–purpose objects. The subsequent calculation of parking spaces generates for these smaller food service facilities a necessary number of parking spaces. It would be appropriate to divide this area into 2 subgroups, for example restaurants and cafes.

It would also be good to prove that the individual coefficients and also the ones in other areas of calculation of parking spaces in the above table are inaccurate (table No. 34 of the standard ČSN 73 6110 “Design of urban roads” – Featured basic indicators of all parking and parking spaces from the Change of standard “ČSN 73 6110 Change Z1 (Change 02/2010)”) A good example that can be taken is education.

When a standard elementary school, which has 2 classes for each level of schooling (2 × 9 classes) and an average number of 20 students per class, is taken as an example, the required number of parking spaces is 72, with 58 parking places for short–term parking and approximately 14 parking spaces for the long–term parking spaces.

Without any long consideration it is evident that the needed number cannot be realistically achieved in the existing buildings, but that it cannot also be achieved in the new buildings where it is counted with a higher number of parking spaces.

The main request for parking is only in the morning, when the parents take their children to school. In the afternoon, this request decreases significantly due to dispersion of class hours at different times for each class. The pupils at this age don´t have any claims to the parking spaces, and therefore it is important to propose a sufficient number of long-term parking spaces and spaces of the K+R type “Kiss and Ride” according to local conditions of placement of the school. One possibility would be using these parking spaces at specified times (e. q. afternoon / night) for people living in the area.

IV. SMART PARKING SYSTEM

On one hand part of the planning is legislative, on the other hand many times the current need is not optimized well and to its maximal potential. Parking in big cities is becoming more and more difficult. Many drivers spend too much time looking for a parking spot and this increases CO2 emissions and blocks traffic within the city. Monitoring of different approaches (smart parking and enumeration according to ČSN 73 6110) is the first step to finding a solution. Foreign articles deal more with design and the implementation of prototype of Reservation-based Smart Parking System (RSPS) that allows drivers to effectively find and reserve the vacant parking spaces.

The idea of good optimization of the current parking places in cities including the usage of modern technologies to achieve "Smart parking" is missing. In many cases legislation states that there are not enough existing parking spaces built, but when using the correct methods of smart parking, the numbers would be sufficient to serve the general demand for parking, mainly in the centers of the cities, where the number of parking spaces is given historically.

In many cities there is a requirement for new parking houses to increase the parking capacity due to ineffective use of the current capacity. This means that new investments are made into the search for suitable place within the city that fulfills the purpose to ensure required capacity.

In the Czech Republic, the classic city parking system doesn´t often fulfill the requirements for quality and is not always in harmony with the legislation ČSN 73 6056 (Parking areas for road vehicles). The question then is if it is more effective to reconstruct the current parking spaces or to add new parking spaces (for example build a new parking house) or to optimize the current number of parking spaces by using available technologies. It is known, that for one parking space there is needed 14 m^2 and that by cancelling of this parking space the space can be used for other purposes (green areas, parks etc.). Parking houses could then be built in border areas of the city so the influence of higher car traffic would be minimized and separated out of the city center (especially if there is historical center included). If the parking house is needed, then the possibility to park other means of transport (cars with alternative fuel, bicycles etc.) should also always be included. Today, the parking houses are mostly built for cars without thinking of combinations with other means of transport

To have good working city parking, it is necessary to use existing technologies that connect the already existing systems (detectors) on the surface parking with the systems in the parking houses. It is an expensive solution, however by using the right technologies (cameras, mobile phones, navigation systems etc.) this "smart parking" system brings an effective solution of using the available capacities in the city without a need to change and build new parking spaces. A good example is the possibility to book a parking place in advance. The benefit would be not only for the driver (time saving, going straight to the parking without a need to search for free parking space around), but also for the city, as the driver would shorten his route to minimum.

If the usage of "smart parking" system would be implemented, the city parking system could work much more effective and the whole view on the parking spaces planning could be changed completely.

V. Conclusion

The needs for parking are determined by a lot of aspects these days. There are determined not only by the density and capacity of the transport networks, the time course of the day and the capacity of the parking areas, but also affected by the quality of public transport, the availability for cyclists or pedestrian traffic, among others.

Therefore, not only should be parameters for the calculation of the total number of needed parking spaces be made more accurate so that the proposed number of parking areas could match the real request, but also using modern technologies should be used to achieve the smart city parking. For this reason, this article only draws attention to the inaccuracies that are valid in the current standards with the possibilities given. In the future, there will be hopefully found such parameters, that can be subsequently integrated into the regulations and standards related to designing of communications.

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Data Transfer of Vehicle Indicators for Processing in Data-Center

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***Abstract* — This abstract describes the interaction of vehicles with data centers for exchange, processing and retrieval solutions for standard and non-standard road traffic situations. There are also descriptions of the technical equipment used to create links between objects.**

Keywords—vehicle speed limit, wireless module, data-center, warning light, controlled area, driver.

I. Introduction

In period of high motorization of urban traffic and pedestrian flows large role in ensuring road safety in intensive sections of the road network is assigned to the drivers of vehicles. It is assumed that drivers observe the traffic rules and have a balanced manner of driving and continuously takes into account important indicators such as the safe distance, speed, maneuver, etc.

Unfortunately, these indicators are often neglected by drivers and do not provide full safety in intensive sections because psychophysiological reaction of drivers on the road situation during heavy traffic or congestion is critical. Especially there is a demonstration of aggression, which is usually accompanied by increase of speed, frequent change lanes, using the horn unnecessarily and failure to provide the right-of-way to other road users. Undoubtedly, there is a high probability of traffic accidents between vehicles and pedestrians if the problem will not be solved sequentially.

II. Present Road Traffic Conditions

The Fig. 1 shows the average values of overrunning in the Republic Avenue (Astana, Kazakhstan), made by finding the median of numbers from the exceeded registered values of vehicle speed. As can be seen, the third road lane shows the maximum value, where drivers exceed the speed limit from 51 to 95 km/h at different times of the day in an area with a speed limit of 50 km/h.

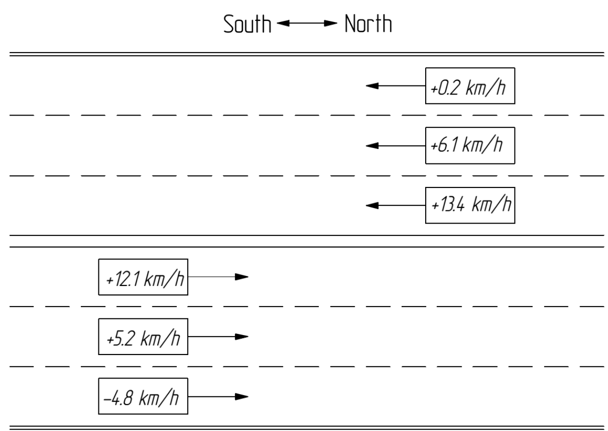

Fig. 1. Average values of overrunning by the lanes in the Republic Avenue, Astana (speed limit 50 km/h)

The main reason of overrunning is the personal qualities of the driver and the nature of his driving. Traditional methods of influencing the driver for safety, such as a limit signs, warnings and penalties do not work effectively in the absence of a permanent control and monitoring of the activity of vehicles. It is possible to obtain new data of activities involved in specific area if the influence to the driver will be inside the car directly on the board or instrumentation panel, warning him about the speed limits on specific sections of the road network, thereby allowing or denying choose the speed when entering or exiting the driver out of the speed limit zone. Data will be collected and processed in the data center of the governing body or company and keep logs of statistical data. (Fig. 2) [1]

III. Technology and Equipment

The opening of data center for receiving, processing and storage promotes activity analysis of vehicles in areas which covered by base stations by indicators such as speed, number of braking rate and stay in a particular area by frequency of entry and exit. Base stations are focused on receiving and sending data to the vehicles as distance and signal quality. [3]

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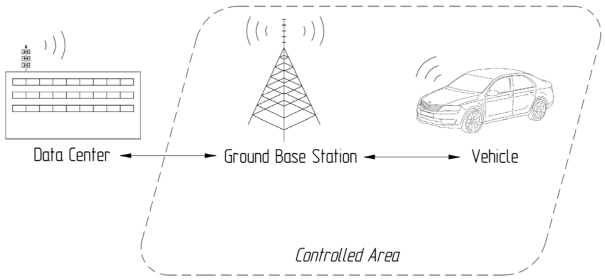

Fig. 2. Scheme of data transfer between the vehicle, base station and data center in the area of restrictions

There is necessary to install the wireless module (Fig. 3) for networks such as GSM, CDMA, or LTE to create a connection with the vehicle on board together with the executive controllers and devices on the bus in the electronic engine control unit with the output data to the instrumentation panel. Availability of module light and warning signs will alert the driver about getting into the zone of the restrictions and will be automatically disabled in exit. [2]

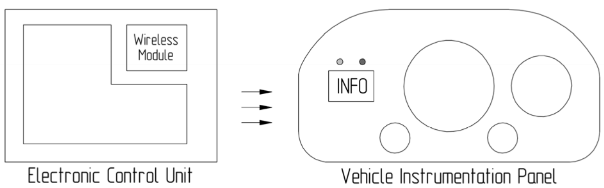

Fig. 3. Installing a wireless connection on the electronic engine control unit; module light and warning indicators

The novelty of this interaction technology is to receive more information about the vehicle than it was accepted earlier by traffic control centers. Mobile and wireless communications system is theoretically able to process and transmit large amounts of data that would create activity map in the zones of restrictions.

IV. Conclusions

One should distinguish general information of the vehicle from the driver's personal information, which protects him or her from external observation. Optionally, driver can permit to transmit location data for better monitor traffic activity, increasing the security level or in the case of extreme disasters.

Undoubtedly, this technology can discriminate drivers who have the right to choose the mode of movement individually on general city roads. Despite this, provision of safe speed in intensive sections, such as the business center or densely populated residential area is a priority measure. Based on the past experience and statistics indicators the desire of drivers observe the safe speed is not a positive trend. Analysis and collection of data about the vehicle and pressure towards speed limit likely to be a necessary step when the critical marks of traffic situation in the area and statistics of traffic accidents will be achieved.

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ITS/Traffic Management Project for Johannesburg-Pretoria Area in South Africa

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Abstract—**Severe traffic congestion is experienced on freeways in South African metropolitan areas. Congestion has a negative effect on productivity, the running costs of vehicles, the amount of time people spend with their families, and the environment. Merely providing additional road capacity within metropolitan areas, is not an ideal or always appropriate solution, and alternative solutions must therefore be explored in conjunction with infrastructure expansions, in order to manage congestion. An important aspect is the management of incidents, such as crashes or breakdowns. The speed of response to an accident has a direct influence on the safety of any persons involved in the emergency, as well as the extent of congestion caused directly or indirectly by the stationary vehicles. The South African National Roads Agency, together with the local authorities has therefore established an Intelligent Transport System (ITS) project for Gauteng freeways to manage traffic, and to provide road users with traffic conditions on a real time basis. Therefore, SANRAL aims for improved incidents, reduced congestion, increased safety, provision of information to public transport role players for public transport management and data aggregation for evaluation of changes and impact of measures with a view on further deployment.**

***Index Terms*—ITS, South Africa, Traffic Control**

I. Introduction

Severe traffic congestion is experienced on freeways in South African metropolitan areas. Congestion has a negative effect on productivity, the running costs of vehicles, the amount of time people spend with their families, and the environment. Merely providing additional road capacity within metropolitan areas, is not an ideal or always appropriate solution, and alternative solutions must therefore be explored in conjunction with infrastructure expansions, in order to manage congestion.

The South African National Roads Agency (SANRAL), together with the local authorities has therefore established an Intelligent Transport Systems (ITS) project for Gauteng freeways to manage traffic, and to provide road users with traffic conditions on a real time basis.

II. Underlying Studies and Background

Studies leading to the decision making were performed by the various transport responsible organizations.

South Africa is a highly industrialized country due to mining activity. The last 30 years have seen duplication of population from 30 to 60 million. The major areas have grown 20% in the last five years. While the major agglomerations are increasing population, space is still abundant compared to Europe, leading to a widespread network with large distances.

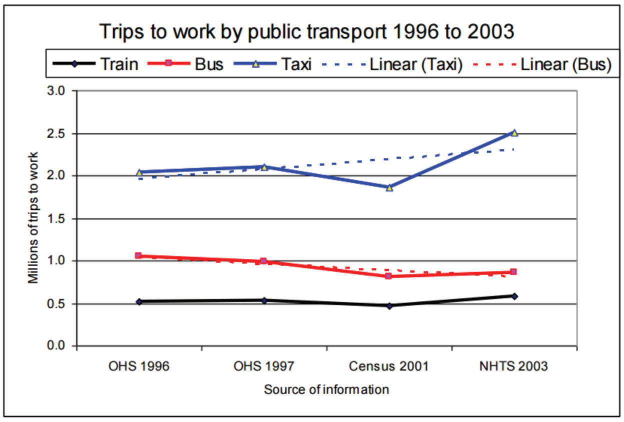

Fig. 1. Use of public transport

The use of public transport has only grown moderately, while car ownership per household has been constant [5] [6]. This has led to a situation of relative growth of number of trips by car and strongly increased traffic on all major roads.

Another major concern is the decrease of road safety. Fatal crashes have increased by more than 15% in only 2004-2006.

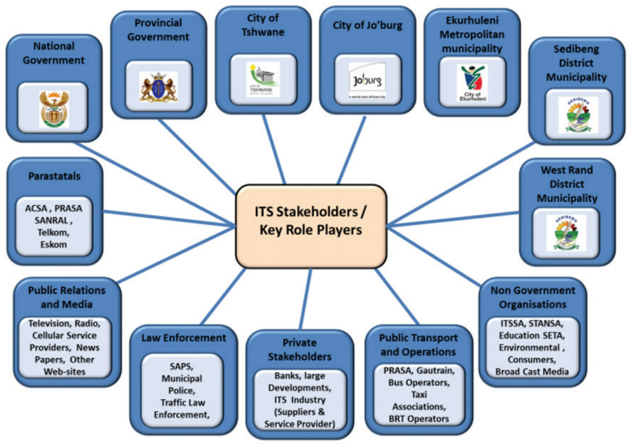

Fig. 2 – Key ITS Role Players in Gauteng

The matters above led to the development of a 25 years intelligent Transport Master Plan [7]. According to the plan,

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SANRAL has the following aims:

- Improved Incident Management
- Reduced Congestion by smart management
- Increased Road Safety
- Provision of information to public transport role players for public transport management
- Evaluation of the effectiveness of ITS technologies with a view for possible further deployment

The above targets have been converted into concrete action and the following new systems and services have already been implemented or are under implementation, proving the relevance of the studies and the urgency of the need to act:

- Comprehensive Intelligent Traffic Management Systems in all major cities
- Advanced Public Transport Management Systems in about 20 major cities
- Road Pricing to fund infrastructure
- Gautrain high speed metropolitan rail
- Regional Intelligent Transport Systems with rapid reaction force for handling accidents in the major conurbations like Gauteng (Johannesburg-Pretoria), Cape Town, Durban and Port Elizabeth,

The latter of the measures represents the relevant project described hereunder.

III. Roadside Implementation

Over an 18 months period, the following systems have been implemented:

- Fiber optic communication Backbone for communi-cation between the field devices and the Network Management Centre (NMC)
- CCTV Cameras
- Variable Message Signs
- Ramp Metering
- Wireless communication
- Traffic detection equipment
- Integration and management software
- Incident recovery, towing and medical vehicles, as well as a motorcycle based medical service.
- The Network Management Centers (NMCs)
- The system is operated by more than 300 staff.

IV. Network Management Center

The Network Management Center (NMC) is responsible for receiving all the inputs from the different sensors deployed via a communication backbone, to process them and to provide the required output. In basic terms the role of the NMC is to execute an overall co-ordination function due to the large amount of role players.

The following main functions take place at the NMC:

- Visual monitoring of the network from real time video feed
- Detection of incidents by means of information received from field devices
- Determination of travel times on the road network
- Dissemination of information to the public by means of radio reports, variable message signs, web, sms, etc.
- Own operation and liaison with emergency services for the effective management of incidents
- Direct liaison with public transport call center to inform about: Traffic conditions, incidents, traffic prediction, and planned events debriefing sessions with affected parties after incidents

Emergency vehicles to act on the ground

- Incident recovery vehicle
- Light tow recovery vehicle
- Heavy tow recovery vehicle
- Medical recovery vehicle
- Motorbike medical recovery vehicle

V. MOTORIST/PUBLIC TRANSPORT INFORMATION

Dissemination of information to road users, public transport operators and commuters is one of the primary services provided by the Network Management Centre. Information is the activation of a variety of communications media to relay traffic conditions and location of incidents to road users, public transport operators and commuters. The information assists them inter alia, in selecting their mode of travel, route, and departure times. By influencing motorist behavior (by recommending diversion routes around an incident, for example), authorities can improve travel conditions and traffic flows. Motorist information can be categorized as either pre-trip or en-route.

Pre-trip information can provide the motorist with current roadway and/or transit information prior to deciding upon the time, mode, and route of travel. Whether provided to motorists at home, the workplace, or multi-modal locations, this capability can help relieve congestion by giving the motorist the information to reroute, delay start of the trip, shift modes, or avoid travel altogether.

A. Pre-Trip Information

On-Line services to access the Internet represent a means to disseminate pre-trip traveler information. A web site has been constructed for the Gauteng freeway network that shows:

- Real-time traffic flow information via color -coded maps
- Expected travel times between different points on the freeway network
- Road closure information (e.g., for construction or maintenance)

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- Real time video images (still captures or streaming video)
- Camera selection
- Travel advisory information for route planning
- Links to other web sites
- Pre-trip traffic information will also be available via radio reports, SMS services and a call center.

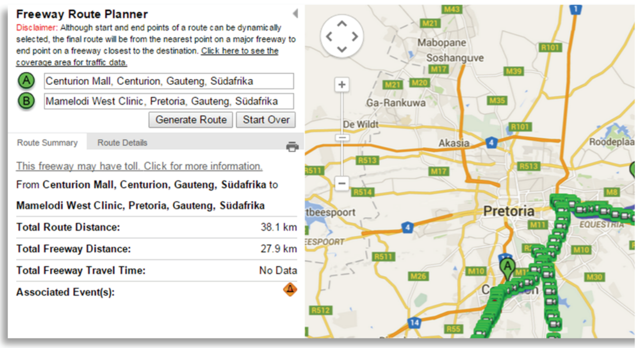

Fig.3 Pre Trip Route Plannin

B. *En-Route Information*

Traffic information is also forwarded to radio stations and possibly television whereby the public can receive updated information before or while they travel.

Users can subscribe to an SMS service that provides them with information about incidents as well as progress with the clearance thereof.

In order to communicate with the public while travelling, electronic sign boards called variable message signs are placed at strategic positions that allows the operator to give information about incidents, road works etc. by means of preprogrammed messages. There are also electronic signs placed at high accident spots such as Buccleuch and New Road that warns travelers automatically to slow down when a queue is building up in front of them.

➔ See https://www.i-traffic.co.za for the public information site.

Fig. 3. Home Screen showing areas of high traffic, identical to the areas where the system is established.

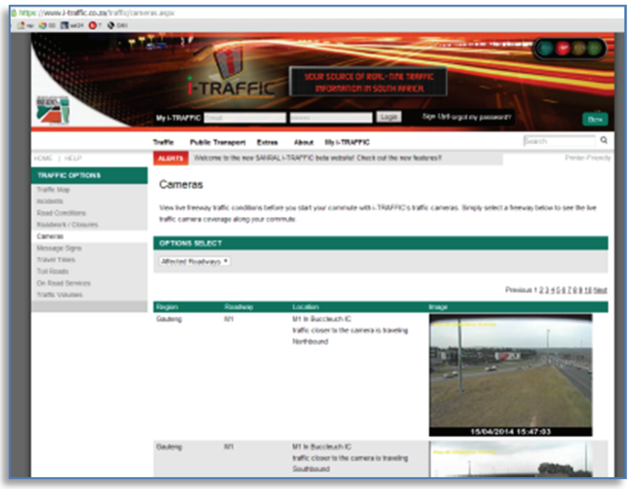

Fig. 4. CCTV Cameras showing traffic situation. accessible to all public in real time

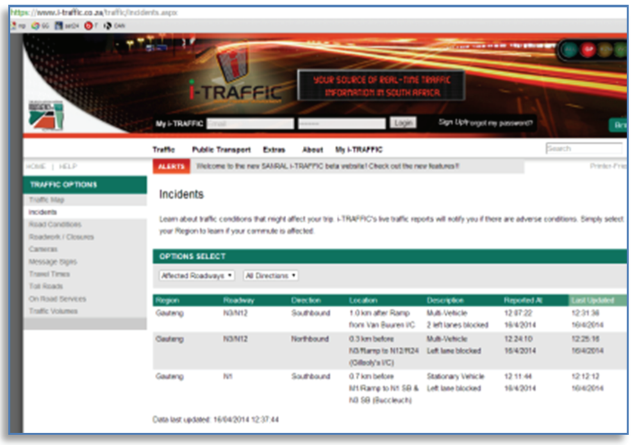

Fig. 5. Incident list, accessible to all public, with clearance reporting

VI. Conclusion

While results on traffic or individual utilization of the system are still being researched, the fact of the implementation and availability has been a major step forward for management of transport in South African Agglomerations. The system allows to produce proper data about traffic behavior, travel and congestion patterns. This will lead to further research and adaptations or enhancements when data have been analyzed and interpreted.

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Optimization of the Routes of the Urban Public Transport in the Regional Centers in Russia

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The article is devoted to the problem of optimization of route network of urban passenger transport . This paper is the result of the analysis carried out, that covered this problem on the example of Orel public passenger transport. The article provides the method of optimization of the route network , based on the principle of minimizing of the time, passengers spend using the system of public transportation. The results of this work have been applied to the routes of Orel public transport network.

Key words route transport network, route, public transport station, shuttle bus , passenger.

I. Introduction

Nowadays in the majority of Russian cities there is the growth tendency of the number of private transport, that in turn leads to significant increase in the use of the urban road network, worsening of ecological situation, increase in accident rate. [1,2,6,7,10,11,12]. Increasing attractiveness of urban passenger transport seems a durable solution of this problem.

Many scientists devoted their works to the problem of route services of urban public transportation C. Brand, G.A. Currie, D. Habarda, K.R. Jacques, H. S. Levinson, L.B. Mirotyn, A.V. Velmozhin, M.E. Antoshvily ,B.L. Geronimus, etc. The problem of the quality of the passenger transportation has been studied by J. Cibulka, V.A. Gudkov I.V. Spirin.

The purpose of this article is to develop a method of optimization of route network of urban passenger transportation in the regional centers. For this purpose, the following specific objectives have been pursued:

1. Identifying the major problems in the work of public passenger transportation.
2. Developing the technological scheme of passengers' movement, identifying the temporal characteristics, at every stage of travelling by public transport.
3. Developing the methodology of optimization of route network of passenger transport in the regional center, based on the minimizing of time consuming at every stage of travelling by public transport.
4. Testing the proposed methodology on Orel route network of public passenger transport.
5. Determining the expected economic effect of the optimization of route network.

I. The problems of urban public transportation in the regional centers.

The state of the system of urban public transportation in different cities has a range of common problems. One of them is the problem of underserving population during the pick hours. New and developing areas of many cities face the problem, connected with the lack of the routes, which results into the failure to satisfy the passengers' demands, which leads to the growing number of connections and the resultant loss in time and money. In many regional centers transport service of population is carried out by municipal and private carriers. This fact has a number of negative consequences, namely competition between carriers in struggle for the passengers leads to non-compliance of the intervals between the vehicles, violation of the traffic regulations, which in its turn strongly affects traffic safety, violation of the traffic regulations, which in its turn strongly affects traffic safety. In most cases private carriers own a fleet of a rolling stock from a small capacity class. In the separate regions the number of routes, which are served with the small capacity buses attains 70% [2,3,4,8,9] It has negative effect on the traffic flow ,as it increases the use of route network of urban public transportation

Optimizing the route network of public transportation seems a durable solution of this problem.

II.

The prevalent criterion of optimization of the route network of the urban public passenger transport is the time, that the passengers spend travelling by means of public transportation [1, 10, 11].

The methodology that has been developed is based on the minimizing of the time passengers spend using the system of urban public transportation. [1].

Generally, the total time, that the passengers spend travelling by public transportation can be calculated using the following formula [1, 13]:

$$t_{пас} = t_{под} + t_{ож} + t_{передв} + t_{перес} + t_{от}, \quad 1)$$

where $t_{под}$ -the time spent by the passenger to get to the station by foot, in hours;

$t_{ож}$ - time, spent by the passenger waiting for the route vehicle at the station, in hours;

$t_{передв}$ -time, spent by the passenger travelling by public transport to the necessary station, in hours;

$t_{от}$ -time, spent by the passenger travelling from the station to his destination by foot, in hours;

$t_{перес}$ - time, spent by the passenger on the connection, h. The time ,spend on changing the public transport may include time for travelling from one station to another (if necessary), time spent waiting for the appropriate vehicle and time, spent travelling by the appropriate route vehicle. In case the change of vehicle is not necessary: $t_{перес} = 0$. Time spent on the connection can be calculated using the formula [1]:

$$t_{перес} = t'_{под} + t'_{ож} + t'_{передв}, \quad (2)$$

for which $t'_{под}$ -time, spent by a passenger on travelling from one station to another by foot in case there is a necessity to change the vehicles, h.

$t'_{ож}$ - time, spent by the passenger waiting for a route vehicle to change, h.

$t'_{передв}$ - time, spent by the passenger travelling in the vehicle for the connection, h.

The scheme of movement of passengers is presented in figure 1.

As following from the above mentioned the target function for defining the optimum route network of urban public transport can be presented in the following form:

$$E = \sum_{i=1}^{m}\sum_{j=1}^{m}(t_{передв_{ij}} + t'_{передв_{ij}}) \cdot П_{ij} +$$
$$+\sum_{k=1}^{K}(t_{ож_k} + t'_{ож_k}) \cdot П_k +$$
$$+\sum_{i_1=1}^{m_1}\sum_{i_2=1}^{m_1}(t'_{под i_1 i_2} \cdot П_{i_1 i_2} + ,$$
$$+П_{i_1} \cdot t_{под i_1} + П_{i_2} \cdot t_{от i_2}) \to \min \quad (3)$$

where $i=1,2,...,m$ – are the consecutive numbers of the sub-districts ,where the passengers start their movement;

$j=1,2,...,m$ – are the consecutive numbers of the sub-districts of destination;

$k=1,2,...,K$ – are the routes of the urban public transportation;

$i_1=1,2,...,m_1$ – are the consecutive numbers of the stations of the beginning of movement;

$i_2=1,2,...,m_1$ – are the consecutive numbers of the stations of the completion of the movement;

$П_{ij}$ -the number of passengers, who have been transported from sub-district i to sub-district j ;

$П_k$ - the number of passengers who have used *k*- of the urban public transport route;

$П_{i_1}$ - the number of passengers whose transportation began at station *l*-

$П_{i_2}$ - the number of passengers whose transportation finished at station *r*-

$П_{i_1 i_2}$ - the number of passengers, who have walked from station *l*- to station *r*-.

The design and engineering process for the route network is characterized by the fact that the optimum variant can be elaborated at the intersection of the interests of three sub-systems: "city", "passenger", "carrier" [10, 11, 12].

The sub-system "city" is, as a rule, presented by the administration of the municipal entity. The main criteria the city administration has to the route transport network are the following: providing reliable transportation of the citizens from the centers of the passenger traffic to its periphery; environmental damage caused by the motorized transport, the safety of the passenger transportation [18, 19, 20].

The carriers see the transportation as a source of income, hence their main objective is to increase the profit, they get operating the route and lower the operational costs.

The passengers are interested in the travel-time and cost of the tickets, level of comfort and safety, regularity of traffic of route transport vehicles. [18, 19, 20].

III. The methodology of the optimization.

The approbation of the method was conducted on the Orel route transport network. The structure of the public transportation in Orel is presented in table 1.

Table 1 is the structure of the public transportation in Orel

The type of the passenger service	The number of the routes	The number of transport vehicles
Tram	3	92
Trolleybus	9	100
Bus	59	574

All the information necessary for optimization of a route network of urban passenger transport can be received by the survey of passenger flows, but none of the methods can provide the most complete and reliable information, therefore it was decided to use a combination of several methods (Figure 2). The selection of the methods is based on the integration of specialists' opinions (a priori ranking). The experts have chosen questioning, the table method and the silhouettic method. The combination of these methods is characterized by the extensive list of the indicators to be determined of citizen mobility , high completeness, and authenticity of the information obtained, possibility of the application in the conditions of Orel and relatively low cost and labor input.

For the processing of the results a database, which can automatically receive the following statistics and data was developed: the correspondences of the passengers, the transport volume, the fullness of the vehicle, the passenger traffic according to the directions, time, stop points, routes, etc.

The conducted survey of the passenger traffic was divided into three parts

1. A complete survey of the passenger traffic for Orel urban public transportation conducted in April-May 2011 [8,9].

2. A sample survey of passenger traffic for seasonal routes for transportation of the Orel citizens to the summerhouses ,situated in the suburban zone, which was conducted in August- September 2013[2].

3. A sample survey of passenger traffic in the sub-districts "Vygonka" and "New Botany", which was conducted in April-May 2013[4].

During the survey the following data, connected with the citizen mobility in Orel and necessary for the optimization of the urban route transport network, was received: inter-district movement of different passenger groups, passenger traffic for the routes, stations, hauls, the fullness ratio of vehicles, observation of the intervals of movement and so on.(table 2)

Table 2 shows the results of the survey of different groups of passengers in Orel who have a right for travel benefits.

The category of privilages	The frequency of trips			Total for a week	The average number of trips per day
	1-2 trips	3-4 trips	> than 4 trips		
Trams					
Pensioners	196	108	42	6188	2,21
Schoolstudents	62	40	24	2380	2,42
Students	78	162	86	6902	2,86
Other privileged category	38	22	18	1498	2,37
Total for the type of vehicle -Tram					**2,47**
Trolleybus					

Pensioners	492	228	64	13468	2,34
School-students	82	90	34	3990	2,56
Students	370	658	270	26558	2,75
Other privileged category	46	32	28	2100	2,72
Total for the vehicle type -Trolley					**2,59**
		Bus			
Pensioners	140	68	18	3892	2,31
School-students	14	10	4	518	2,31
Students	86	140	28	4928	2,58
Other privileged category	34	14	8	994	2,36
Total for the vehicle type- Bus					**2,39**
Total					**2,48**

IV. The major technical-economic ratios

To determine the efficiency of the made calculations a comparison of the major technical-economic rations of the schemes of organization of transportation before and after the optimization was conducted.

The result of the optimization was that the total time passengers spend travelling by the urban public transportation in Orel decreased from 286 thousand hours to 269 thousand hours.

The economic effect of the application of the made calculations and of the optimal route transport network can be measured by comparing the results in the use of the urban public transport according to the previous scheme and the optimal scheme. This effect is the result of:

– reduction in demand for personal transport,

– reduction in requirements for fuel, lubricants, lowering the wear of parts and components of vehicles ,that is the consequence of the decrease in the number of intermediate stopping points.

In the result of the sizing of the operational route scheme in Orel, which consists of tram, trolleybus and bus routes, in the period of one rush hour of a working day the total mileage of 54363.64 km was received.

The total mileage, which was calculated in the result of sizing of the optimum scheme is that of 48522,5 km in the period of one rush hour of a working day for all the vehicles on the routes.

The reduction of the demand for transport produces the most conductive effect. .The adoption of this new route transport network should produce the effect on the optimization of urban public transportation routes in Orel, that equals to 98651,35 rubles per a peak hour of a working with the same number of transported passengers

The optimization has resulted into the fact that the number of bus routes has decreased by 4 units, while the number of the trolley and tram routes remained the same. The number of rolling stocks has decreased in the result of replacement of transport vehicles of the "especially" small capacity (9-15 seats) by the vehicles of small (16-30) and medium capacity class (table 3).

Table 3 represents the percentage ratio of the capacity categories of the route vehicles

Capacity category	Percentage ratio of the capacity categories,%	
	Before the optimization	After the optimization
Small seating capacity of 9-15	35	21
Small seating capacity of 16-30	34	42
Medium seating capacity (31-60)	26	32
High seating capacity (60 and more)	5	5

The changes in the route network of public passenger transportation have affected the privileged categories of the citizens in the following way: the number of socially significant routes has increased from 30 to 36. The changes in the routes, which are providing some privileges, were based on the results of the questionnaire survey of the passenger transit, conducted by means of the inter-district interview of different privileged categories of the citizens.

V. Conclusion

The methodology of optimization of a route transport network which has been elaborated makes it possible to develop a route network for the regional center, based on the minimization of time passengers spend using the system of urban public transportation. The possibility of determining the cost-effectiveness of every route makes it possible to eliminate the unprofitable routes at the design stage. The assessment of the adequacy of the optimized model is planned to be conducted during the survey of the passenger traffic in 2016.

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Photocatalytic Air Depollution in Contaminated Cities – Creating Healthy Environments

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Keywords**—— Air purification, TiO_2 photocatalysis, Healthy environments**

A. Walls as Air Cleaner?

Imagine turning your building walls into one giant efficient air cleaner that cleans the air inside and outside, doesn't make noise, doesn't need direct power input to run, doesn't need maintenance, doesn't break down, will work for many years with the same unchanged efficiency, and doesn't produce any side effects.

Impossible? Not quite! Highly oxidative photocatalytic effect on TiO_2 surface can decontaminate our environments.

From the physics prospective, TiO_2 is N – type semiconductor. FN® (Functional Nanopaint) photocatalyst substance's "miracle" lies in the energy difference between the valence and conducting band of 3 – 3.2 eV. The electrons (e-) on the valence band can be excited by the light of the wavelength of 365 nm or shorter, and transitioned to the conduction band. Broad corresponding holes (h+) on the valence band then generates active oxygen and hydroxyl radicals with a high oxidation potential.

The oxidation potential on activated TiO_2 is higher than of ozone or chlorine and practically all common organic toxic molecules decompose on contact with this surface.

Photocatalysis is not based on chemical agents and this physical effect is permanent as long as it is illuminated by the soft UVA light.

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Photocatalytic FN® film cleans air simply by reacting with pollutants under the daylight or its equivalent. A thin layer of FN® coating applied on the wall surface cleans the air of carcinogens, viruses, bacteria, toxins from mites, smoke, smells, allergens, and other pollutants. Not only it cleans the air, but also provides a UV protection and self-cleaning ability to the base paint or surface, and inhibits mold and fungal growth. All the above helps to create the healthy and clean environment we wish to live in every day.

FN® contains photocatalytic nanoparticles of titanium dioxide. A typical sized room of 50 m^2, treated with FN® creates a TiO_2 active surface bigger than the equivalent of 2 football fields. Photocatalyst TiO_2 standard - Aeroxide P25 used in FN® products is much more effective than for example sol-gel products. It was thoroughly examined, scrutinized and documented in thousands of scientific and practical studies. It has been proven as very effective cleaning tool for NOx and other exhaust gases.

Another positive "side-effect" of cleaning organic compounds from the air is that it removes odors; cigarette smoke or kitchen smells after cooking and frying. FN® layer also prevents fat or smoke and other unwanted molecules from depositing on walls, windows, kitchen or furniture, and keeps the house cleaner for a longer time without developing musty odors.

FN® is a very gentle and non-aggressive way to create a healthier and cleaner environment in hospitals and public places. Not only does it not leave behind more poisons as is typical for most of cleaning products with aggressive chemical agents, FN® also kills and quickly decomposes bacteria, viruses and spores, including any toxins created by their decomposition. When standard disinfectant or cleaning products are used, dead viruses/ bacteria decompose slowly, often producing more toxins that are released back to the environment. This doesn't happen in photocatalysis, which burns the dead bacteria and toxins from their decomposition. FN® ecologically removes dead microorganisms.

FN® coating has a biocidic effect although it is based on completely non-chemical way of killing bacteria. It can be used together with other cleaning or disinfectant products. Moreover, the active layer will quickly remove chemical agents, reducing their exposure and negative effects.

C. City Depollution

Self-cleaning facades with protection against UV radiation, ageing, color fading, degrading microorganisms, dirt, soot, mud, tars, graffiti, add stickers, chemicals, bio-agents, war chemicals and other pollutants, while functioning as a solution to the air quality problem? Yes, it is emerging reality today!

With the decontamination efficiency of around 50% photocatalysis burns organic pollutants, and with the same rate it removes NOx of the air. We can literally convert every building or sound barrier into an air cleaning eco-machine, compensating the civilization impact.

There are millions of small sources of pollutions such as automobiles. We can use the same model to achieve a reverse effect using millions of small areas coated by photocatalytic surface to decontaminate the atmosphere.

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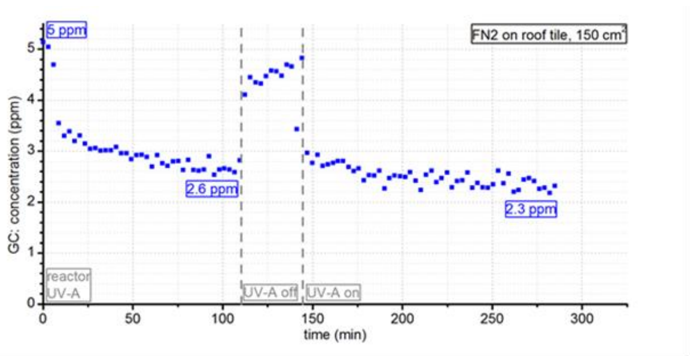

Fig. 1 Measurements of rapid removal of organics on FN coated surface

Practice Smart Urbanisms for Smart Cities

Michal Postranecky, *Ing. Arch.*

Abstract — **Smart design process of new urban developments and existing urban structures rehabilitation is examine in this paper based on collaborative multidisciplinary approach and smart tools and methods.**

Designing new urban structures requires a deep study of invisible information inside existing cities' environment. This is possible because recent progress in research methods and techniques of collecting data.

Analytic results of cleaned big data tailored to the specific order award urban designers with new opportunities to analyze behavior of individual entities inside and outside of urbanized areas.

Physical models and virtual reality can be combined and visualized using augmented reality interface. Results are modified based on live data feeds or changeable variables requested by designer or client.

Designing process with a collective impact approach has to continuously accommodate to accelerated changes and implementation of future artificial intelligence.

New kind of structures and features are already appearing in smart cities concept. But the most important unit of new smart design approach has to be actively engaged citizen.

Keywords — ***smart cities, urbanism, engaged citizen, big data, open data access, collective impact, augmented reality, BIM, GIS, PIM, ICT***

I. Introduction

Smart cities movement is proposing wide spreading definitions mostly with the same base – create and maintain better and livable space for theirs citizens, or improvement of quality of life with a use of the most recent and future methods and technologies.

Although smart cities definition is all about cities, life in countryside and rural areas is important the same way. Finding a successful urban design solution to smart cities concept requires the same care about those, who live outside of city boundaries. Many inhabitants of large cities will move back from cities to open sprawl areas. One of reason is using smart technologies, which allow them to stay connected with their clients or work team using new ways of communication technologies.

There are specific problems urban designers have to solve related to scale of development. Illustrative model with city occupant in the center of system as main stakeholder is proposed. The amount of citizen's engagement in city management activities and city's subsystems (energy, transportation, utilities, etc.) through smart technologies allows many of them to be more then subject to an anonymous crowdsourcing for big data analytics. Citizen should be given an open access to cleaned, evaluated, and interpreted research information. Interactive tools like city web portals are used for this purpose.

Social media are a new tool urban designer and his team should be using to engage recent or future citizen in smart cities design process. Close collaboration between citizen as main city stakeholder, and designer, developer, maintenance agencies, municipality, decision makers, providers of city subsystems, and other third parties should be strong during whole life cycle of each urban development. Some models of these active engagement opportunities are introduced.

Smart design requires better understanding of neighborhood as a basic urban unit in developed area. Customized communication networks are used for interchange of information between individual members of neighborhood, and related agencies and other parties.

Providing smart design requires from urban designer, architect or team members knowledge to use new tools (software) and technologies not only for presentation of their ideas, but for complete preparation of project documentation, record of collected data, and complex system simulation.

Smart cities concept covers cities of size a small village as well as large megacities. Each of these urban structures has many layers with unrepeated structure of subsystems, and independent patterns inside each of them. Changes in one of layer of development may cause changes in other layers. Identification of those relationships and understanding related processes using smart visualization tools, gives to designer's team, and each of team member opportunity for effective collaboration during design process, and presentation to client and public.

This smart model should be continuously used and maintained throughout whole life cycle of development and in ideal situation compatible with all control systems of individual city subsystems providers. The same way urban designer should be a part of team who is maintaining this model and make upgrades to a model from his discipline point of view.

Physical body of urbanized areas has many parts with different structure and density. Changes are happening with different speed. Municipal policies, zoning codes and master development plans should start facilitate smart technologies to reflect coming changes in city life, and absorb amount of knowledge witch is generated by smart elements of city and other entities. To make this happen, politics and workers at government agencies has to be continuously educated to understand need of this change. Properly visualized solutions and tools has to be used help them recognize why smart city is more effective to operate and organize, and why it should improve livability and quality in citizens' life.

II. Smart City Definition

A 'Smart Cities Initiative' is widely understood as a quality of life improvement by implementing an 'Information and Communication Technology' (ICT) to city structure systems and city organization management processes.

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Based on region and location where 'smart cities methodology' is propagated, different way of smart approach has to be applied.

Defending basic poverty in some regions without an infrastructure using ICT is in a contrast with situation in more urbanized regions, where congested dysfunctional urban transportation, polluted environment, unsustainable energy consumption, and similar problems are trying to be solved.

Using a mobile network in rural and less developed areas, can be helpful in creating virtual neighborhoods, set up a community system policies, infrastructure, and collect important data. Information can be interchanged between government and citizen as well as between each other in system. It sets a foundation for an accelerated process of building a collective intelligence in controlled area of interest, allows coordinated solution defending natural disasters, environmental or epidemical catastrophes, and more. Smart technologies should help with an improvement of an educational process, open access to endless amount of information, help to improve health care system, food redistribution and local agricultural processes, and etc. In the same moment local heritage may be better embraced and "recorded" for next generations.

Enforcing urbanized areas with smart solutions in sprawl type of development or overcrowded cities and their downtowns comes with diverse type of challenges.

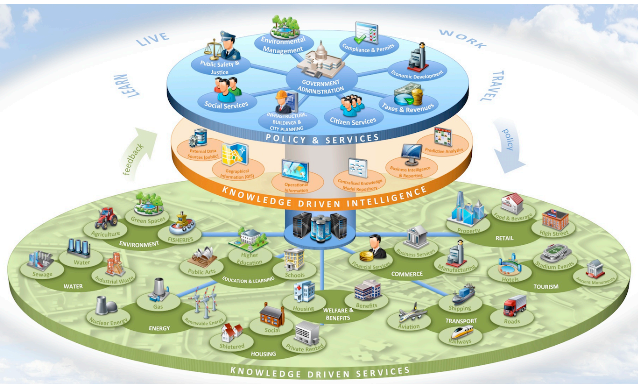

Fig. 1: Illustrative example - Intelligent city of the future schematic diagram by Be Informed, an internationally operating, independent software vendor. (http://www.beinformed.com/BeInformed/webdav-resource/binaries/pdf/solutions/intelligent-city-poster.jpg?webdav-id=/Be%20Informed%20Bibliotheek/0000%20WEBDAV/WebDAV%20StatContent.bixml), (smart government is in the center of the model and top down approach)

In past the "smart" concept in urban systems was mainly understood as tool creating solid base for centralized arrangement allowing top down governance approach. Today, when mobile communicating virtually everywhere in urbanized areas access to internet, social media are developing new behavior in open communication between all city's stakeholders, setting up virtual communities in clouds.

Most of smart cities models are set with government in the center controlling ICT distribution and administration. This paper prefer alternative model with citizen, in the center of smart city initiative playing role of main stakeholder, and controlling direction and speed of smart city development.

Difference between those two models is, that in case of 'government' model, the smart city initiative is

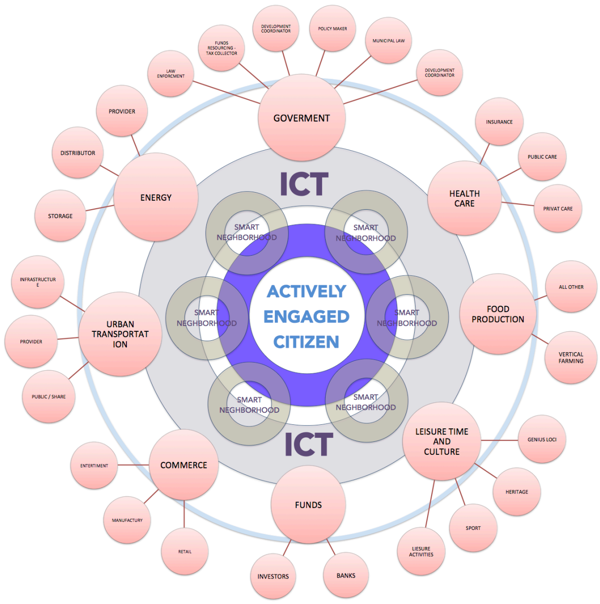

Fig. 2: Schematic diagram – Smart city model with engaged citizen in the center of the model and ICT core connecting all city systems

administrated from one locked system, and strategy of system architecture and direction of development is directed by changing political representation, prioritizing their particular interest for only certain amount of years. Proposed 'engaged citizen' of future smart city model builds a strategy based on stronger role of citizens networked together by ICT in smart neighborhoods. Government is still in control of basic functions of city's system (tax collector, policy maker, law enforcement, social services, public transportation, safety and defense, etc.), but smart city development initiative depends on amount of actively engaged citizens networked in smart neighborhoods.

III. World Urbanization

According to 2014 revision of the World Urbanization Prospects (10 July 2014, New York) 54 per cent of the world's population lives today in urban areas, a proportion that is expected to increase to 66 percent by 2050. Projections show that urbanization combined with the overall growth of the world's population could add another 2.5 billion people to urban populations by 2050, with close to 90 percent of the increase concentrated in Asia and Africa, according to a new United Nations report launched today.

The 2014 revision of the World Urbanization Prospects by UN DESA's Population Division notes that the largest urban growth will take place in India, China and Nigeria. These three countries will account for 37 percent of the projected growth of the world's urban population between 2014 and 2050. By 2050, India is projected to add 404 million urban dwellers, China 292 million and Nigeria 212 million.

In 2014, there are 28 mega-cities worldwide, home to 453 million people or about 12 percent of the world's urban dwellers. Of today's 28 mega-cities, sixteen are located in Asia, four in Latin America, three each in Africa and Europe, and two in Northern America. By 2030, the world is projected to have 41 mega-cities with 10 million inhabitants or more.

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Overall, nearly half of the world's 3.9 billion urban dwellers reside in relatively small settlements with fewer than 500,000 inhabitants.

The global rural population is now close to 3.4 billion and is expected to decline to 3.1 billion by 2050.

While Africa and Asia are urbanizing rapidly, the regions are still home to nearly 90 per cent of the world's rural population.

IV. Smart Cities Beyond Tomorrow

Urban designers, planners and architects are in permanent quest for ideal city solution and creative innovations.

Cities beyond tomorrow will change their visual appearance and spatial configuration. New materials and presence of ICT in virtually every part of objects around us networked together will bring modifications in construction, activities and citizens' behavior. Visible information will be present everywhere.

Development of physical urban structure takes much longer time then improvement of smart technologies. Many factors like zoning and building codes, city master plans, municipal laws, approval process, political behavior with particular interests, and insufficient financial funds are mostly the reason for big delays in use of more advanced materials, technologies and techniques in construction process, and slows down smart urban development and placement of smart technologies.

Fig. 3: Illustrative example – high-rise sprawl in Hong Kong, China. Photo by Michael Wolf

To fulfill prospects of rapid increase in world urbanization, developments in regions with fast growing development may face the enormous problem to secure a real quality of living space and livability in this space.

A. Urban Transportation system

Transportation and other city infrastructure systems require new type of organization and management. As technology improves and communication techniques allow faster and more precise solutions for critical situations based on decisions made virtually with no time delay are implemented to advance existing systems. It should create more space and partially increase a capacity in existing structure. New developments should be already planed with ICT as a part of solution.

City centers, city edges and development sprawled in countryside will become more dense as result of fast urbanization of already developed areas by people moving in to cities. The heavy traffic, congestion, overcrowded public transportation with negative effect on ecosystem and social environment is already present in all megacities, and also in most of smaller size cities. Urban transport system calls for new proposals of sustainable and functional solutions based on advanced ICT. Urban traffic management is moving toward adaptive control systems, coordinating all transportation in area. Proposed sharing services and autonomous vehicles with other types of urban mobility services for public transportation will request new type of transfer points and lending areas. New parking structures will have to be built to accommodate higher amount of vehicles. Advanced organization and smarter use of recent resources will force decision making stakeholders to quickly increase an ICT implementation in to all related systems leading to high quality solutions.

B. Intelligent buildings and mega structures

Smart city will contain intelligent buildings networked by their operators and connected in to a city system network through cloud communication technologies. New types of intelligent mega structures will be built with multifunctional mixed use, own environment and internal autonomous systems, including telematics solutions for people and goods distribution around space, organized in 3D matrix.

C. Smart Energy

Smart batteries and new types of energy storage, recharging systems, energy management and new alternative sources of energy allow individual stakeholder, or group of stakeholders efficiently operate their energy consumption. Special apps will help to decrease amount of this consumption. It a will enable more independence on city distribution systems. New of-grid type solution will put some stakeholders to a new position. It creates an opportunity to collaborate with energy distributors as partners, not just as consumer.

D. Vertical farming, waste, water and sewer management

New and existing cities will have to make a place for vertical farming structures and organize distribution of daily production around neighborhood or town. Vertical farms will be connected to waste management, and water and sewer treatment facilities using smart technologies, also organized in vertical setup, using less land and higher control of safety protection and quality of job.

E. Manufacturing

Manufacturing complexes will maximize robotization of production processes. New types of industrial development inside of city borders will be forced to built more vertical structures to secure valuable land in city limits.

F. Connection of working and living place

Urban development will challenge their designers with necessity to connect, combine and mix work production place with place of permanent or temporary residency. It will require building all other amenities supporting citizens' working week living cycle as close as possible in surrounding neighborhood. A smart solution 'under one

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roof' will have to be proposed to developers to reach all important services in walk or bike able distance, also eliminating negative weather conditions.

Citizens will increasingly use 24/7 online services with short time delivery and order many services and goods by 'one click' setup applications.

Fig. 4: Illustrative example – Density of recent development in Whampoa, Kowloon, Hong Kong, China (yanarthusbrtand2.org)

G. *Independent Smart Neighborhood*

Smart neighborhoods with predominate amount of their engaged citizens will raise more power as basic unit of city life organization. Neighborhood stakeholders will have ability to coordinate their activities, actions and operations using information applications through their smart mobile devices, wearable gadgets and through all objects connected into an Internet of Things.

H. *Positive Smart Gentrification*

Process of recycling old development with new mixed used structures will force responsible decision makers find new areas for open space activities in more dense formation of city centers.

Gentrification process will progress in a good way in existing cities with implementation of new smart structures and elements in city's physical body where higher living standard is usually present. Some of advanced smart elements will be applied there sooner then in other parts of city to maintain luxury life style of their occupants.

I. *Sprawl Areas upgrade and redevelopment*

Widely criticized sprawl development will be partially redeveloped and refilled with new structures and smart components. Parking areas around shopping centers will serve as brownfields allowing new citizens to move to this type of urban development. Changes in urban transportation and structure and organization of parking system will be requested also around new 'town centers'.

J. *Future Artificial Intelligence as Part of Smart City*

Very new and specific problem to solve occurs with a need to accommodate future autonomous artificial intelligence elements, machines and other objects in physical structures of cities (docking systems, recharging facilities, new types of elevated structures for urban transportation systems, drones goods transportation platforms, and much more).

All smart elements and object (intelligent buildings, homes, streetscape, utilities access point, things, materials, etc.) will be grouped and networked together by Internet of Things in Network Of Everything.

Recent society is entering an 'App Age Period'. The evolution in communication, networking and connectivity tools and activities will build knowledge, which future generations will need to operate an artificial intelligence (AI) objects and add-ons to their physical body or other AI devices like Personal Surrounding Objects (PSO).

V. Smart Neighborhood

City urban structure is naturally split in to parts by physical barriers like terrain morphology, rivers, communications, by human kind development like fences, parking lots, shopping centers or markets, parks, industrial, sport, educational and other types of facilities, and etc. Each part of city creates its own urban fabric with original relationships. Those city parts are more divided into neighborhoods partially by design, but mainly by theirs inhabitants' decisions, based on combination of distances and common social activities, and property management services or type of ownership.

Use of ICT and social networking between dwellers creates alternative virtual neighborhoods in cloud. This neighborhood in cloud has no physical barriers.

Smart neighborhood can be measured by amount of activities coordinated through social network, by amount of smart technologies applied in their structure and mainly by amount of active members in their network.

Knowledge coming from analytics of communication between neighbors can help to find faster solution to existing situations and problems, and build them more sustainable way.

Some neighborhoods may even become an alternative operator to buy and distribute cheaper energy, Internet or other services.

VI. Actively Engaged Citizen

Actively engaged citizens are becoming the most valuable stakeholder in a smart city concept. Open access to clean analyzed data by individual citizen is the main pre-requisite to his engagement. A citizen engaged in smart city operation and management should be award for his activities.

Urban designer has an opportunity to use social media, group chatting, or web portals to connect with individual citizen or group of citizens, eventually with whole neighborhood, and engage them in design development process and even more in property management process.

All mobile or Internet connected entities are used as a resource of big data collection and analysis. It helps systems operators to improve their services. They may identify hidden processes and actions and prepare solutions leading to improvement of livability and quality of citizens' life, and sustainable social environment of whole community.

To keep citizens engaged in smart city model, using city web portals or customized apps public trust has to be gain first. People need to know how safe are their data and

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secured against fraudulence. Private policy has to be clearly set up and declared to citizens.

The environment of customized smart applications give citizens increased ability to communicate with government agencies and decision makers. Citizen can participate more powerful way in an operational processes of city, control decision makers, and other third parties. Using smart devices with almost constant access to Internet gives citizen opportunity to communicate with other parties on virtually any time.

Citizens have to have an open access to all important data sets provided by city agencies. As great example is 'Kansas City Missouri Open Data Portal' (https://data.kcmo.org)

Fig. 5: Illustrative example of open online communication and access to data and information - Kansas City Missouri Open Data Portal.

VII. Collaborative Design Approach

Smart cities urban designer and architects are facing to many challenges created by ICT involvement in new development and society. An integration of information and communication technologies in physical body of city call for different Team setup, and new organization of work. Necessity to interchange growing amount of data between each member and team control center, and modifications in project infrastructure, sophisticated control process, and new city features and smart elements are changing designing process.

Future and existing developments are filled with smart technologies. This situation request a connection of two worlds – 'urban designer or architect's world' working with visions based on past experience, creativity, and endless imagination, and 'world of system engineers' who have an ability to analyze data, unhide and unlock hidden information and processes including related connections in urbanized areas based on their pragmatic systematical approach.

Collective knowledge is developed and combined during design process when free design ideas and calculated pre-designed system solution are applied together in one smart model of urbanized territory. Having system engineers, as part of core on project team, opens a new opportunity to develop effective analytic methods closely related to problems and tasks in developed area.

A. Design working process

By type of project, urban designer, planer or architect is typically, as originator of design, coordinating whole project. Each Team has its own workflow method and use different tools and techniques to create, visualize and present results of its work.

Team has traditionally a lot of experts, covering specific disciplines and parts of project documentation. Some of them create main core group of Team. Other specialists are asked to collaborate only for specific tasks.

Specialists usually get first a basic layout from design leader with a set of instructions called specification. Specialists then provide an independent search for connection points, capacities of individual sources, code issues, etc. After then they draw schematic plans and diagrams describing structures related to their disciplines, and write their part of specification with set of requested parameters. Appointed project coordinator provides coordination of all drawings information released by individual specialists. Drawings are usually organized in layers. Each layer carry set of information. Layers can be switch on and off. All drawings are recently created on computers using specific software. Project is almost always presented for approval process in printed 2D version. After one design phase is approved, working process moves to following one. Certain amount of data details is collected, recorded, and released at each phase of design mainly in text format.

B. Accommodation GIS and BIM in working process

For approximately last decade many project facilitators are broadly upgrading to design methods using GIS (Geographic Information System) or BIM (Building Information Modeling) type software. To be able share collected data 'buildingSMART', formerly the 'International Alliance for Interoperability' (IAI) developed Industry Foundation Classes (IFCs) as a neutral and open specification for Building Information Models (BIM).

BIM is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle; defined as existing from earliest conception to demolition. (National BIM Standard-United States™ Project Committee).

GIS is a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. (https://en.wikipedia.org/wiki/Geographic_information_system)

In recent time internal end external structure of urban design team, methodology and processes of work are changing in relation to more advance implementation of ICT during project development. Individual phases of designing process are interconnected by specific type of databases and information attached to plans and each object and element in plans. BIM and Project Information Management (PIM) are taking ubiquitous role in organizing all project data. All objects parameters and information about design process; including all design versions and history are transferred to the next phase of project lifecycle to constructors, operators, property managers and owners.

Digital Map of project knowledge with searching ability in text, drawings, photos, audio, video and more formats

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allows each member of Team as well as client, subcontractors and other city stakeholders (with appointed privileges for access) to have an instant access to endless diversity of information about project across all disciplines. Part of an approval process and quality check of project documentation will be in future done by specialized software applications.

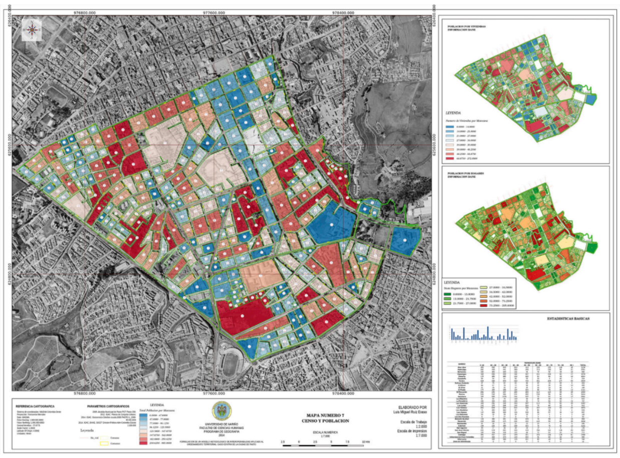

Fig. 6: Sample of map created with QGIS Open Source Geographic Information System (GIS) licensed under the GNU General Public License (https://www.flickr.com/photos/131735363@N06/16934676110/in/pool-2244553@N22)

To better understand project data and information, physical background of development model with overlaid augmented reality can be built. Visualization is provided in conjunction with a simplified model's background, expressing changeable urban development and building structures systems. Processes based on data input (connection and communication between autonomous vehicles, potential flood damages to city streetscape, overpassing damaged parts of city utilities, etc.) can be simulated in visible way. It is important specially when big developments are planned like whole new, part of city or mega structures.

During urban development and construction, record of final state of execution of development's physical structure should be provided and stored in specific GIS or BIM model's layers. Model should also record placement of all smart censors in area, smart construction elements and eventually in the future network together with them. It allows, after development is finished and passed to property or neighborhood manager, continuous update of stored data and analyze processes in this phase of development lifecycle. This may uncover new facts and relationships designer could not know or predict during design process.

An appointed member of original Team should continuously monitor during whole life cycle all parts of development and periodically analyze processes inside a developed community, and propose new upgrades to improve life of occupants of facilities under smart project surveillance.

Project lifecycle starts in the point, when Team is created and common goals are set up. Then it ends when original development is demolished and recycled.

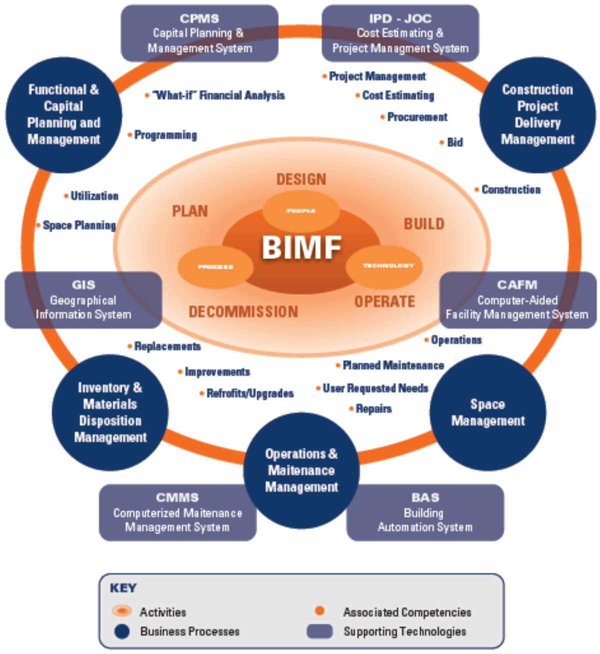

Fig. 7: Schematic diagram of BIM Framework proposed by RIBA (Royal Institute of British Architects), Efficient Construction Project Delivery Methods - Sustainability - 3D, 4D, 5D BIM - IPD, JOC, SABER, IDIQ,

Designing smart developments request set of new means and methods, new type of devices to record design and parameters of processes designer expect to create in new development, customized software, and mainly new specialists on team working very close to urban designer.

C. System engineering approach

Close collaboration between urban designer, planner or architect and system engineer in one Team makes common cause. System engineering approach based on big data analytics construct exact theoretical models of cities with system solutions for each modeled situation. They configure architecture of city system behavior and city network, and define basic elements and blocks of system. Those elements and blocks attributes and parameters can be modified during modeling. Simple or complex activities and behavior can be simulate and visualized in virtual city system models. Those theoretical models with ability to calculate and predict individual or chained reactions in city activities based on alternative input help find answer how should be smart development organized, operated and maintained.

D. Collaborative Impact Design Approach

Reflect use of advance method to prepare design and project documentation not only changes in design team are necessarily as well as significant change in working methods.

This paper is proposing Collaborative impact approach method supported by use of ICT.

Collaborative impact approach method in all phases of development's life cycle will enhance a quality of design, development and process of maintenance of developed facilities, and following upgrades and possible re-development activities.

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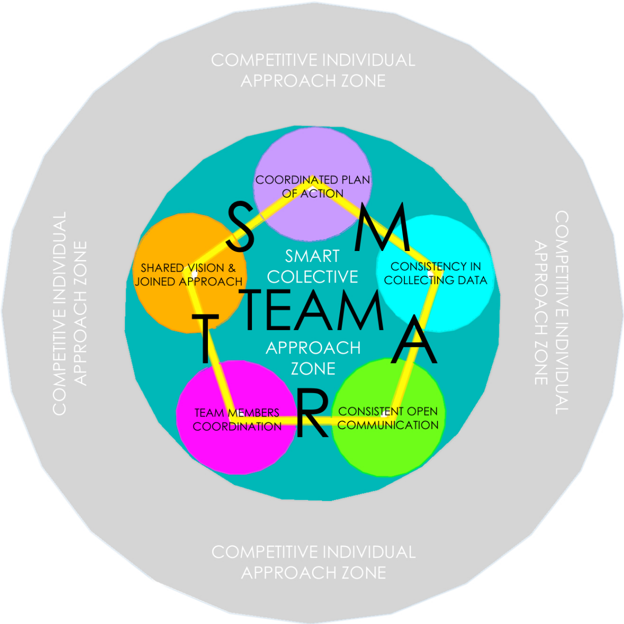

Fig. 8: Schematic diagram of Collective impact design process approach set of pre-requisites.

The collaborative impact approach in design process is based on associative thinking ability of each team member, actively integrated diversified knowledge leading to common complex solution and communication tools with ability constantly visualize physical structure and processes inside an area of interest.

Each team member has a particular set of expertise covering different discipline in system.

The *collective impact design approach* comes with these prerequisites:

Smart Vision and joint approach to achieve the best result leading to award stakeholders including maximum amount of citizens with advanced quality of life

Constantly *coordinated plan of action* agreed by each member of Team

Consistency in means and methods of *data collection process* throughout whole Team

Consistent, trustful and open communication between all members of Team, with sensitive data protection

Front office enforced by ICT, administrating and coordinating Team and flow of information across the Team, with responsibility to handle and store systematically aligned data about project to data administrator of next lifecycle phase.

Using methodology of collective impact approach for work organization and information management process, allow each core member on design team take a lead role with an constant opportunity to discuss work directions, partial results, recent activities and decisions with all other members of Team.

VIII. Conclusion

New development and redevelopment containing smart elements needs to be supported with new smart type codes, easy accessible and well searchable, and simplified from structure and language viewpoint. They should be written with less segregation of individual functions and should unlock opportunity to add new elements based on smart technologies into a city structure. They should allow major changes in future city, additions and improvement.

One of the most important prerequisite to functional smart city is an educated decision makers and municipal law makers.

Implementation of Information and Communication Technology in all urban development systems is inevitable to secure a sustainable environment and improvement of livability in the future beyond tomorrow.

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Smart and decentralized energy as a part of complex energy system

Hynek Beran

New technological development brings about new challenges. The former role of distribution system was only to provide the energy flow from central power plants to consumers. The technology has rapidly changed during last 15 years. New renewable and microcogeneration energy units have been developed. They can cover significant part of energy consumption at the place they are located. The consumption of energy has also other new features, e.g. intelligent buildings or electromobility. Finally yet importantly, the information systems are able to control distributed structures with many elements and provide the predictive control. Significant part of the production is dependent on weather (solar on the radiation, microcogeneration on temperature, air condition also on wind etc.). The electricity consumption, however, is still dependent on the rhythm of the society. We produce the energy at noon from the sun, but we still want to switch the electric light on in the night.

The main benefit of new technologies is usually evaluated at the final consumer. We can observe mainly energy savings and also raising of the "smart" comfort. The demand side management advantage is usually calculated from the side of the market. The marked itself has been distorting by the massive subsidies. The real price to the commodity is now less than one half of the price for the final customer, the real motivation on the hourly market is almost negligible. The main motivation is not to "buy cheap on the market" but to save money, i.e. to buy minimum on the market burdened with a mandatory subsidy policy. Customer usually "buys" also unwanted subsidized energy that would be on a liberal market declined.

From the point of view of the whole energy system, two main benefits can be observed:

a) Security of supply, when the decentralized system can reliably provide a part of energy during the blackout of the central system. The local production is usually lower then energy needs, the main task is to control the system to limit the consumption and support strategic priorities in the survival mode (e.g. hospitals, refrigerators at home etc.)
b) Cooperative behavior between the central and decentralized energy system. This new system requirement is of the same level of importance as to comfort of the consumer. The smart solution can either "consume" the public comfort that electricity is available all the time, or it can contribute to such feature of the energy system. If the price for the system stability is now equal to zero, it can be also financially evaluated in the near future.

The origin of Fig. 1 is the actual proposal of the energy policy from the Czech Ministry of Industry and trade. The diagram shows the expected changes of the energy mix in the Czech Republic. The proposed policy is to continue nuclear production, to lower the fossil part of the mix and to substitute a part of production by the renewables and cogeneration (gas).

The energy system needs balancing. This covers 3 types of balancing:

a) The period of the year
b) The daily and weekly period, i.e. the rhythm of the society day/night, working day, weekend
c) Ancillary services. The part of power plants must be ready to cover instantaneous changes of the balance between the consumption and production.

The above mentioned features are mainly provided by lignite coal plants. On the other hand, the renewable and microcogenatation energy production is dependent on weather; in the case of weather changes it needs more balancing capacity. When being implemented chaotically, at raises the regulation requirements to the central energy system while its ability to regulate is lowered. This is the big danger for the future:

a) We can invest future power plants twice: once for the time the energy is available from new sources and secondly as the reserve when it is not available. We spend twice more money; other question is who is the responsible party on the market oriented system.
b) We can risk the blackout during some weather constellation.
c) We can try to find more sophisticated solutions based on the knowledge on the system and weather and the social rhythm forecast.

The next figure shows the simulation of competing between nuclear and photovoltaic energy. The model has been developed at the Centre of applied cybernetics and has been used at the Czech TSO to simulate the need of ancillary services.

The yellow curve represents real energy demand – one week. Photovoltaic power (green) have maximal production at noon and they compete with nuclear power plans (blue). The

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pump storage hydro power plant (red) can only absorb part of the energy.

Taking into account the reality that investment expenses to nuclear power belong to most expensive ones, one can ask who pays the difference between the invested potential and such reality. If nuclear power plants deliver 10 or 20% less energy due to such competition and fi we are calculating capacity payment or contract for difference, it will be 10 or 20% more expensive, including the difference.

The good news for "smart" energy experts is that in the moment of such competition all the "smart" consumers are welcomed in the system to consume the energy, to accumulate it etc. If investment to the smart solution is cheaper than to lose a part of nuclear energy, we can build the full complementarity and reliability of such system as its economic optimum.

The last figure shows the real data from the Prague energy company. (System Lancelot was used for this calculation – the real snapshot of the screen is shown in Czech.) Photovoltaic energy production (blue) is compared with the air condition consumption (red). Different daily maxima can be observed, as the buildings have heat capacity. From this example, we can see that such relatively simple application cannot reliably work without other elements, e.g. heating water or electromobility.

The decentralized energy solution become more sophisticated and less predictable from the central system. The example is the aqua park which can either heat water using cogeneration being the electricity producer or to use the surplus photovoltaic electricity for the same purpose being the electricity consumer. The final behavior depends on weather and price forecast. In such situation, the balance of all aqua parks in the country cannot be forecasted from the meteorological forecast only. He methodology becomes more similar to the forecast of the traffic flow as we have there intelligent elements instead of the simple weather dependent ones.

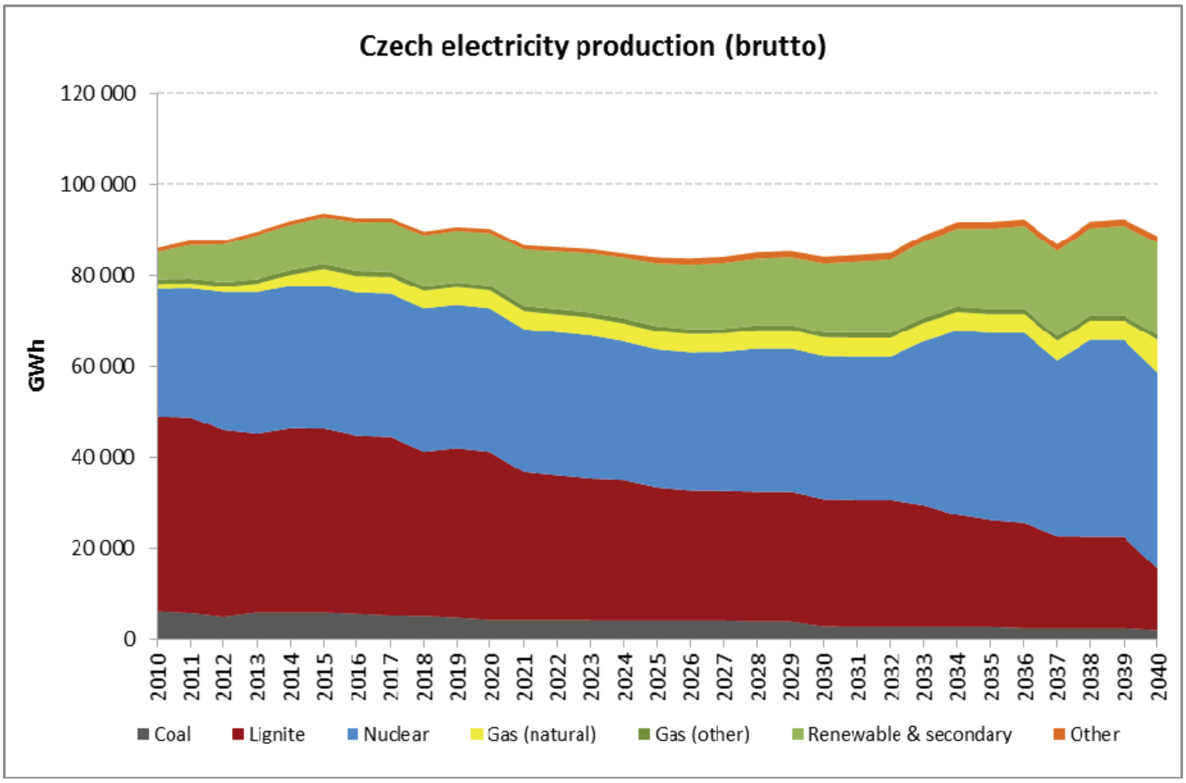

Fig. 1

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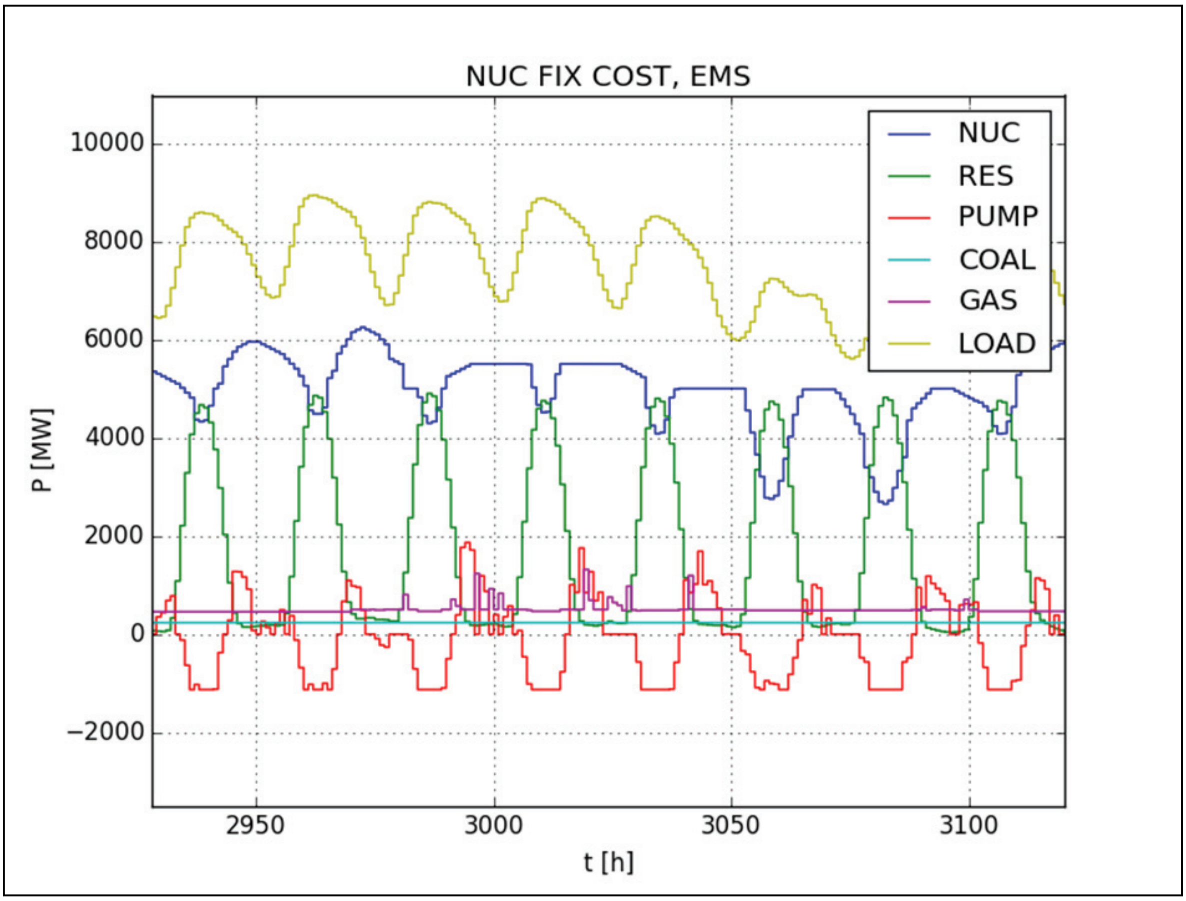
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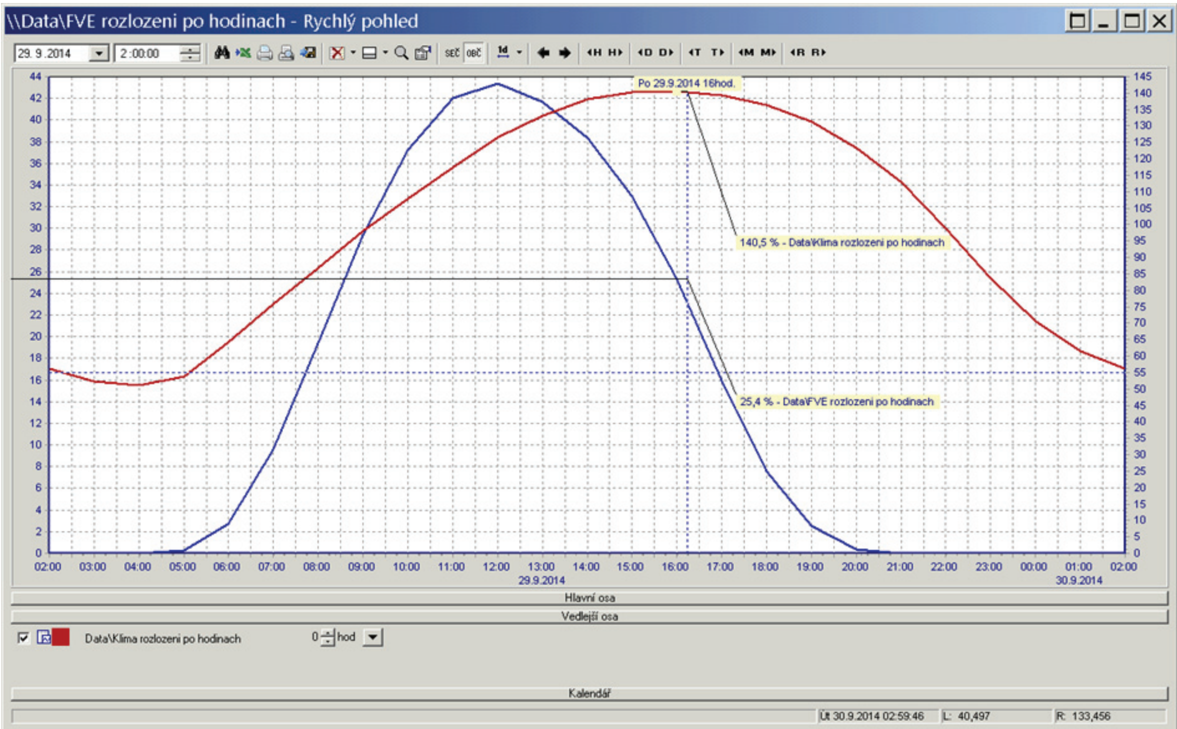
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Fig. 3

Smart city – traffic solution of the future

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***Abstract* — Urban areas sustainable development is a challenge of key importance. It requires new, efficient, and user-friendly technologies and services, in particular in the areas of energy, transport and ICT. However, these solutions need integrated approaches, both in terms of research and development of advanced technological solutions, as well as their deployment. The focus on smart city technologies will result in commercial-scale solutions with a high market potential. The aim of this paper is to design an appropriate traffic control in Žilina with the use of intelligent transport systems. Cost model will be designed in Aimsun modelling program based on the created traffic model that is able to quantify the input data or quantify the data which may then be the base for "cost model" input data calculations. The creation of a traffic model in Aimsun program will be a key step of this paper's solution.**

***Index Terms*— intelligent transport systems, smart city, sustainable development.**

I. Introduction

Sustainable development is such a way of human society development, which harmonizes economic and social progress with full preservation of the environment. Road transport is one of the biggest violators of sustainable development by creating negative externalities. The traffic system must be optimized in order to ensure all the requirements necessary for sustainable development. Intelligent transport systems significantly reduce the negative external costs through the use of information and communication technologies. Successful development of new technologies and their application enables us to find solutions for sustainable development. One of the main objectives of sustainable development is to preserve the environment for future generations at the least modified form. Therefore, we have to build smart cities that make use of information and communication technologies in order to use resources in smarter and more efficient manner, what results in the savings of cost, energy, negative externalities and improvements in services and life quality.

Smart city is the solution for the future and its importance will grow worldwide because in 2005, 50% of the world's population lived in urban areas and consumed around 75% of all energy produced. Currently, approximately 72% of all EU citizens live in urban agglomerations and the proportion of urban population continues to grow and is likely to exceed 80% by 2050 (source: European Commission).

Intelligent transport systems (ITS) deal with the use of information and communication technologies in order to improve transport performance, economy, efficiency, safety, ecology and transport comfort. The basic functions of ITS, applicable in all transport modes, include traffic control and regulation, intelligent vehicle features, electronic charges, management of rescue forces, public passenger transport management, journey planning, traffic information provision, fleet management and freight transport logistics. The importance of ITS for Slovak economy is still increasing. The competitiveness of our country combined with the traditional industrial production and a strategic location in the centre of the European continent will be directly dependent on the permeability of transport routes, especially on road and rail infrastructure, and on the quality of related services which enable efficient and economical transport of goods and passengers. However, the Slovak Republic will face the significant reduction of investment resources and the inability to further increase the density of transport network in the near future [1].

II. Smart City

There are many definitions of smart cities concept in scientific literature, such as:

A highly developed urbanized area that creates sustainable economic development and high quality of life through a

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number of key areas such as: economy, mobility, environment, inhabitants, life quality and city municipality.

Excellent results in these key areas may be achieved through the strong human capital, social capital and intelligent transport systems infrastructure.

B. Cohen (climate strategist) used another formulation in his research study called The Top 10 Smart Cities on the Planet: "Smart cities use information and communication technologies (ICT) to be more intelligent and efficient in the use of resources, resulting in cost and energy savings, improved service delivery and quality of life, and reduced environmental footprint—all supporting innovation and the low-carbon economy". [1]

One of the important requirements is to achieve the change in thinking, which is built on the concept of shared economy. Shared economy is the concept of a social change in the 21st century. It is the concept of a human, who does not need to own the things of daily consumption and is capable of using common products thanks to the existing offer from various communication tools.

This concept includes the schemes from various areas:

- transport field such as sharing of vehicles, bicycles, public transport
- from the area of energy such as concepts of a shared electricity production
- from the perspective of public space such as investments and activities sharing into the joint projects
- from the social field such as sharing of living space, food and so on.

It is possible to state that the concept of a smart city and sharing economy leads to the decentralization of political and economic power, to the economic efficiency and reliable behaviour towards the environment we live in. The whole concept can be divided into the political (city management level), social (level of city residents) and technological level (business level).

The concept of a smart city is trying to make the best use of smart technologies in order to influence the quality of life in a given city in such a way that there would be synergic effect between different sectors (transport, logistics, safety, power engineering, building management, etc.) with regard to energy consumption and life quality of citizens in a given city.

At first sight, smart cities are not particularly different from the "ordinary" ones. After a closer look we can say that congestions do not occur in them and people are more satisfied since they know what is happening around them now and what will happen in the future because they breathe fresher air and also because they are able to save some money for the life in the city.

However, there is a long way to such a condition that requires billions of euros in investments and mainly changes in the thinking of local politicians as well as the citizens. [2]

III. The Concept of Smart City Solution

As we mentioned before, smart cities are communities of people who communicate and use the flows of energy, materials, services and financing with the aim to speed up the sustainable economic development, stability and high quality of life.

European Innovation Partnership (EIP) on smart cities and communities is trying to significantly speed up the deployment of smart urban solutions of integration technologies from energy, transport and information and communication technologies (ICT) on an industrial scale.

EIP partnership was formed in July 2012. The aim of this partnership is to seek activities that are able to provide Europe with three advantages: [4]

- a significant improvement in the life quality of inhabitants,
- increase the competitiveness of European industry and innovative small and medium-sized enterprises along with a significant contribution to sustainability,
- meet the EU 20/20/20 goals of climate and energy sustainability.

An agreement on strategic implementation plan, which currently focuses on three main areas is the first outcome of the EIP partnership:

Sustainable urban mobility - alternative energy sources, public transport, effective logistics, planning;

Sustainable urban blocks and neighbourhoods – improve the energy efficiency of buildings and neighbourhoods, increase the share of renewable energy sources and improve the habitability of our communities;

Integrated infrastructure and processes throughout power engineering, information and communication technologies and transport - connection of infrastructure facilities in order to improve the efficiency and sustainability of cities [4,5].

The whole concept of smart city solution must demonstrate the following elements - components that can be divided into:

Intelligent buildings:

- Energy efficiency of buildings
- Environmental quality of buildings management
- Building administration management
- Integration of services for intelligent buildings

Intelligent networks:

- Economical energy networks
- Energy – saving water economy
- Economical transport networks

Intelligent transport systems:

- Intelligent traffic management at junctions
- Managing energy consumption of vehicles
- Static traffic management
- Public transport management
- Traffic processes management
- Dynamic traffic information for drivers
- Ecological management of traffic and so on.

IV. Intelligent Traffic Management

One of the most important parts of smart city is also intelligent traffic management that is based on obtaining relevant traffic information, such as actual intensity of individual communications, which have to be available online. Based on these data, it is then possible to predict the future

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intensity of crucial roads and junctions in the city by modelling important traffic parameters and thus estimate the parameters such as traffic intensity, time of arrival, origin and length of the congestion, vehicle delays, number of stops, and then intelligently direct the traffic. [7]

The characteristic feature of urban agglomerations is the fact that a big number of vehicles is concentrated into a limited space and it is usually not possible to extensively increase the range of communications. Therefore, it is necessary to achieve their better usage and traffic quality. Urban transport is optimized especially for two categories of users, namely for individual automobile transport users and public transport users. Intelligent transport systems in cities improve efficiency of the transport network and increase the safety of road users.

Higher level of control is also linked with higher technology costs. However, higher level of control should ensure better traffic flow and resulting benefits – savings of delay time, number of stops, fuel consumption, the quantity of produced emissions and so on. A "cost model" is created in order to evaluate these benefits in the cities. This "cost model" is built on the basis of cost - benefit analysis. The model represents an economic assessment of the effectiveness of investments into the ITS.

V. Traffic management model in the city of Žilina

Traffic model in Aimsun was created in order to simulate traffic in Žilina. Aimsun is an integrated transport modelling software, developed and marketed by TSS - Transport Simulation Systems, Spain. Aimsun software is used by government agencies, municipalities, universities and consultants worldwide for traffic engineering, traffic simulation, transportation planning and emergency evacuation studies. Aimsun allows the modelling of various transport networks: urban networks, highways, roads, bypasses, and their combinations. [8]

The model of the road network in Žilina was created in Aimsun program as closely as possible. The model includes nearly the whole communication network of Žilina. During the model creation various aspects were taken into account: length, maximum speed limits and restrictions at individual sections; no entry, one-way communications; junctions, rights of the way at uncontrolled junctions, and present control plans at signal controlled junctions.

The area was divided into smaller parts, in which an assumption of transport attractiveness or productivity was established in order to carry out the traffic assignment. Particular centroids as origins and destinations of the transport processes are in the model represented by: residential areas - the main neighbourhoods of Žilina, all entries into the city, as well as the places with large number of parking spaces – such as department stores and so on.

OD matrices for these centroids were calculated based on the traffic-sociological and origin-destination traffic surveys conducted by the University of Žilina in Žilina. The intensity on transport network was then specified from the OD matrices for defined centroids. Lines and arrival times at stops based on the current timetables of suburban bus transport and urban public transport were defined for the bus transport vehicles.

The created model consists of 2 531 sections with the total length of 317 km, 1 005 nodes, 46 centroids, 18 lines of urban public transport and 48 lines of commuter bus transport.

Simulation in Aimsun provides various outputs, which are divided into the groups such as: network statistics, section and turn statistics, subpath statistics, O/D matrix statistics and public transport statistics. For each groups, there are generated statistics as the mean flow, density, mean speed, harmonic mean speed, travel time, delay time, stop time, number of stops, total travel, total travel time, fuel consumed, pollution emitted; the differences among groups are in the inputs into calculation and in the units, into which the outputs are calculated.[9] Delay time, number of stops, fuel consumption, and CO_2 emissions statistics were used for our evaluation of the traffic control in the city of Žilina.

The cost model was created for the evaluation of costs and cost savings and for payback time calculation. This cost model is designed for the comparison of two variants, the first of which is usually base (present) state and the second variant includes proposed changes. The essential part is a comparison of cost savings (of particular users in the case of new equipment introduction) and costs for building, operating and maintaining the new equipment. It is important to be aware of uneven costs distribution over time, the highest costs (building/acquisition) are expected only once during the first period, and operating and maintenance costs are expected during other periods. On the other hand, costs savings (benefits) are expected to be equal during the whole operation period. Therefore, in order to assess the effectiveness of the proposed solution, the long-term development of individual costs (costs savings) should be monitored. The overall benefit (profit) or loss is calculated as the sum of profits and losses for the whole period. The mathematical principles of the model are described in the article of the authors Kubíková – Kalašová - Černický [10]. Costs model input data were: Aimsun simulation outputs, fuel prices, emission prices, delay time prices, number of stops prices, building (acquisition) costs, operating costs, and maintenance costs.

Based on these two models we can evaluate smart traffic control benefits at the specific traffic network – traffic network of Žilina. Also we are able to calculate the payback time of investments into the ITS. We compared following situations: (1) basic state and actuated traffic control at all signal controlled junctions, (2) basic state and actuated traffic control with public transport preference at all signal controlled junctions, (3) basic state and central traffic control.

(1) Basic state and actuated traffic control at all signal controlled junctions

At present, 11 signal controlled junctions and 6 pedestrian crossings have traffic lights at the territory of Žilina. The basic state represents the year 2014, when actuated traffic control was only at 6 signal controlled junctions – junctions of the street Veľká okružná, and the junction I/64 Rajecká – Dlhá. Other junctions were fixed controlled. This basic state was compared with smart control, in which all 11 junctions have actuated control. We did not calculate new signal control plans for the junctions, the actuated control was designed as follows:

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minimum greens were set 10 s shorter than greens in fixed control and maximum greens were set 10 s longer than greens in fixed control. For example, if the phase length in the fixed control was 23 s, the minimum green for actuated control for the phase was set to 13 s and maximum green to 33 s. Allowable gap for phases extension was set to 4 s.

In economic terms, it is rather an expensive solution. The reduction of operating costs would be achieved, for example through the use of LED signals instead of conventional incandescent lamps.

This solution would require:

- new project documentation,
- traffic controllers replacement,
- traffic lights replacement (incandescent lamps for LED),
- traffic lights cables replacement,
- probably CSS poles replacement as well,
- the use of traffic detectors (cameras, loops or Wimag),
- ground and other work.

The outputs of Aimsun program simulation: Outputs such as 2.29% decline in delay times on the transport network, 1.58% reduction in the number of stops, 0.25% reduction in fuel consumption and a 0.25% reduction in the quantity of produced emissions were achieved by the simulation of basic state and actuated control on all signal controlled junctions. From this statement can be concluded that the intelligent management in the form of actuated control on all signal-controlled junctions in the monitored area would have a positive effect on the traffic situation.

TABLE I
THE DIFFERENCES BETWEEN BASIC STATE AND ACTUATED CONTROL AT ALL SIGNAL CONTROLLED JUNCTIONS

	Delay time (%)	Number of stops (%)	Fuel consumption (%)	CO_2 emission emitted (%)
Car	-2.1	-1.51	-0.03	-0.02
Commuter Bus	-27.81	-2.75	-1.39	-0.88
PT Bus	-2.23	0.16	0.2	0.13
All	-2.29	-1.58	-0.25	-0.25

If we quantify individual costs and cost savings in the cost model, we can assume that investment into the change of control from basic state to actuate would be returned to individual users of the transport network in less than three years. The savings of individual users would reach the system cost in about 12.5 years, if we only took into account fuel consumption. Return time would be very high (almost 38 years), if only public transport vehicles were taken into account. (Delay time and number of stops – 95 years, fuel - 276 years).

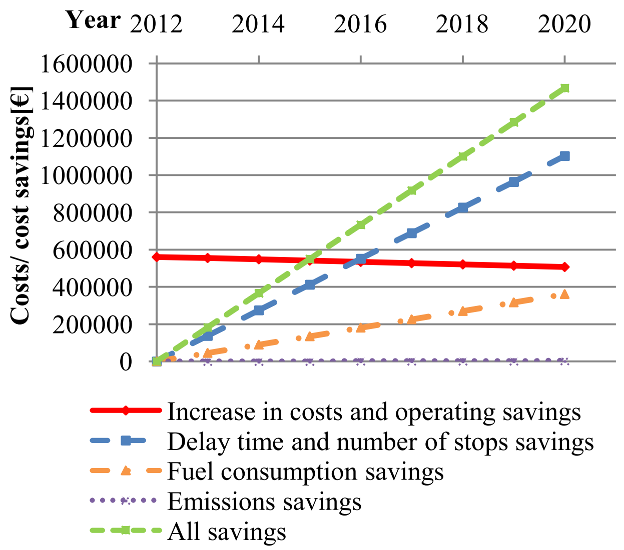

Fig. 1. Development of costs/cost savings in time – Actuated traffic control

TABLE II
PAY BACK TIME OF ACTUATED CONTROL

	Operating savings	Delay time and number of stops savings	Fuel consumption savings	CO_2 emissions savings	All savings
All vehicles	83.6	4.1	12.7	1172	2.9
PT vehicles	83.6	95.3	276.5	36290	37.9

(2) Basic state and traffic response control at all signal controlled junctions with the public transport preference

Efficient and well-organised public transport services bring significant benefits to economies, the environment and society. Public transport is a key tool in facilitating green growth, liberating cities from the consequences of traffic congestion and enabling citizens to live healthier lifestyles.

In economic terms, this is a more expensive solution in comparison with actuated control. Following requirements need to be met in order to apply traffic response control:

- develop new project documentation of all signal-controlled junctions,
- equip traffic controllers with the module of preference, replace the traffic controller for a new one in case of an old controller,
- define a new control logic,
- build a network consisting of logon and logoff detectors,
- equip preferred vehicles with the system for logging in and logging out (vehicle computer, radio transmitter) - all public transport vehicles of the Transport Enterprise of the city of Žilina (44 pieces) and all vehicles of SAD Žilina (70 pieces).

Based on the outputs from Aimsun modeling program, an introduction of active preference for public transport vehicles combined with dynamic control in the city of Žilina could lead to more significant reduction of the delay time for public

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transport vehicles (62.01% for commuter buses and 5.2% for public transport buses), while the increase in the total delay time of all vehicles on the transport network would not be so significant (2.35%).

TABLE III
THE DIFFERENCES BETWEEN BASIC STATE AND ACTUATED TRAFFIC CONTROL WITH PUBLIC TRANSPORT PRIORISATION AT ALL SIGNAL CONTROLLED JUNCTIONS

	Delay time (%)	Number of stops (%)	Fuel consumption (%)	CO_2 emission emitted (%)
Car	2.84	2.02	0.27	0.25
Commuter Bus	-62.01	-10.09	-4.39	-2.64
PT Bus	-5.2	-2.53	-0.89	-0.67
All	2.35	1.6	0.04	0

Total fuel consumption of public transport vehicles is lowered by 10.9% for commuter buses and by 2.53% for public transport buses and CO_2 emissions are lower by 4.39% and 0.89%, while the total fuel consumption of all vehicles is higher by only 0.04% and based on the model outputs, CO_2 emissions output would be almost unchanged (0% difference).

Since in this case there was a deterioration in the statistics of all vehicles on the entire transport network, cost model outputs consider this solution disadvantageous from an economic point of view (Fig. 2) and thus the calculation of payback time for all users is not valid. It is possible to see the savings of these vehicle categories on the right in Fig. 3, where only public transport vehicles with preference were taken into account.

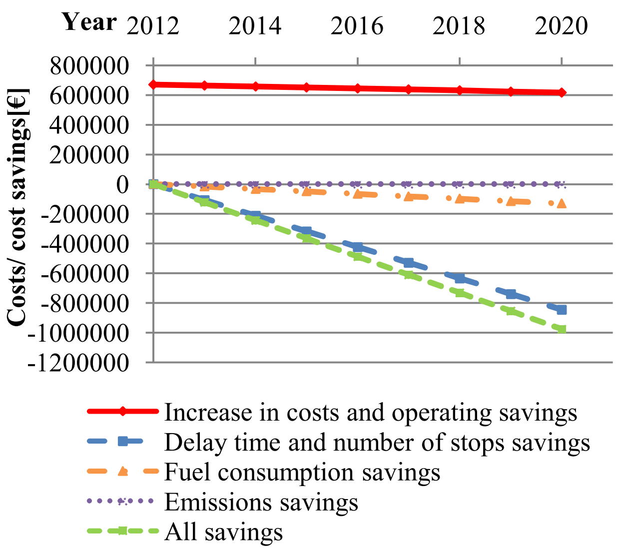

Fig. 2. Development of costs/costs savings in time – Actuated traffic control with public transport preference – all vehicles

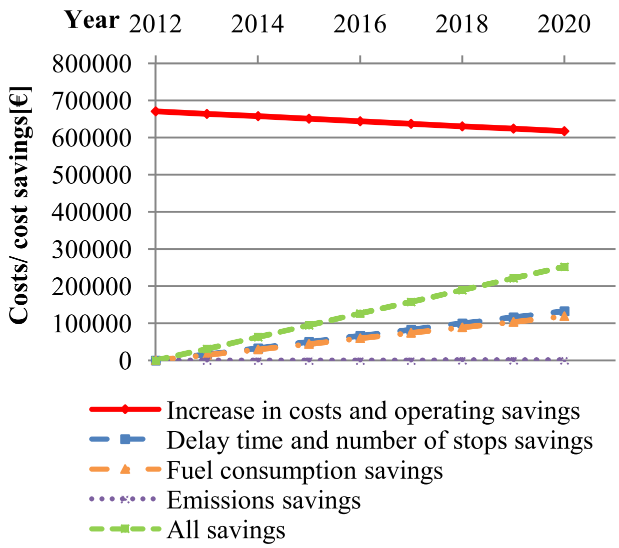

Fig. 3. Development of costs/costs savings in time – Actuated traffic control with public transport preference – public transport vehicles

According to the cost model, the savings of this system would be returned after 17.3 years, what is quite a long time. The main purpose of public transport preference is to make it more attractive, however, it is not included in the payback time. This may be displayed in a more favourable modal split and thus in the overall reduction of the intensity on communications network with preserved mobility.

TABLE IV
PAY BACK TIME OF ACTUATED CONTROL WITH PUBLIC TRANSPORT PRIORISATION

	Operating savings	Delay time and number of stops savings	Fuel consumption savings	CO_2 emissions savings	All savings
PT vehicles	99.9	40.4	45.2	5260	17.3

(3) Basic state vs central control

In this section, we are comparing the basic state with central control using MOTION optimization method. Software Aimsun is designed in the way, that it can simulate sophisticated methods of control and optimization (TRANSYT, SCATS, SCOOT, FAST SCOOT UTC, UTOPIA, UTOPIA, VS-PLUS, ETRA, SICE, Telvent, Telent, ZGZ Prio), but only in cooperation with other software purchased for the modelling and optimization of a given control and optimization method [11]. Authors do not own this software. However, MOTION is a method for decentralized intelligence, where individual controllers are left with substantial local intelligence. The controllers work in one second increase in traffic responsive mode (dynamic control), while the traffic control centre optimizes other regulated variables, such as the maximum length of green, cycle time and offset over a longer period of time (15-30 min) [12]. Due to this fact, the evaluation is performed with the cost of central

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control. The change of traffic characteristics and cost savings (benefits) are considered the same as for the actuated control presented in section “(1) Basic state and actuated traffic control at all signal controlled junctions”

In order to implement this option on the modelled network, it would be necessary to:

- build traffic control centre and purchase optimization program MOTION,
- reconstruct junctions controlled by fixed signal plans and modify the control of these junctions to actuate
- complete the transport network with strategic detectors
- connect individual controllers and strategic detectors to the traffic control centre.

Evaluation based on the cost model

Even though, this is economically the most expensive solution, it is possible to see from the outputs of the "cost model" (Fig. 4) that from the point of view of all transport infrastructure users it is still a convenient solution and the return from investment would be approximately 5,8 years (Table V).

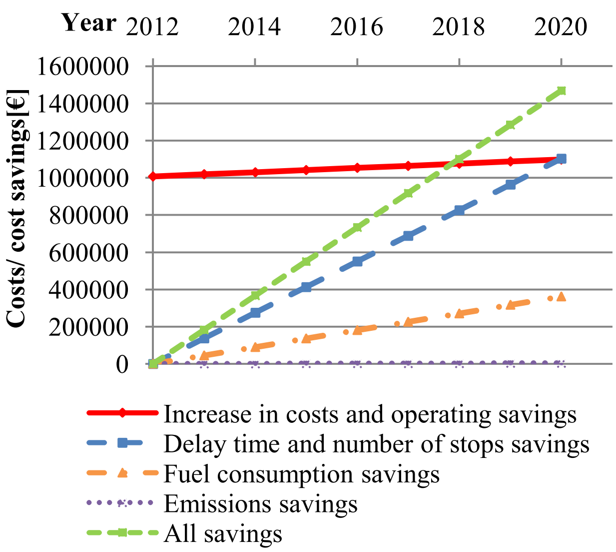

Fig. 4. Development of costs/costs savings in time – Central traffic control

TABLE V
PAY BACK TIME OF CENTRAL TRAFFIC CONTROL

	Operating savings	Delay time and number of stops savings	Fuel consumption savings	CO_2 emissions savings	All savings
All vehicles	N	7.9	29.9	N	5.8

N – Operating and maintenance costs are higher than savings cost

The design of suitable traffic management for the city of Žilina: Due to the current traffic situation and possibilities of the city of Žilina and with respect to the results of testing different principles of transport solutions, we propose to apply a model with actuated traffic control for all signal controlled junctions. It is proposed with the condition that in case of obtaining a sufficient amount of funds, the central control with a preference of public transport vehicles would be applied.

VI. Conclusion

Smart cities cannot be built overnight. Most European cities have a long history behind them since they gradually expanded from small settlements along rivers into the present form of houses and workplaces for millions of people. It takes years to build such a city. It is necessary to start today and it should be noted that even many Slovak cities are already doing or trying to do things like the collection and evaluation of information in complex information systems or in the area of urban development planning. The process of creating smart cities in Slovakia requires the existence of a proper long-term strategy, which has to be an inseparable part of the Slovak republic's transport policy. That is the only way how to achieve the maximum return from investments into the new intelligent infrastructure. Current situation is unfortunately bad and this strategy does not exist. The solution should be provided through the models of traffic processes and their impact on the overall effectiveness of the organization and management in the city. It is important that the other parts, which are equally significant from the long-term view, were not neglected within the current partial significance of certain smart cities components (such as transport). The cities of the future will be much larger than current cities. Millions of people will live in them and they will travel daily for work and hundreds of thousands inhabitants of post-productive age will live in them as well. And this conditions have to be taken into account now.

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Transport Systems Concepts for "Smart Cities"- Transport of People and Goods

Kumpošt, P., Bínová, H. and Padělek, T.

Abstract— **Urban mobility of people and goods in major cities is crucial for sustainable economical growth and the corresponding life standard. Increase in both transport of people and goods in large conurbations is currently affecting mobility of people and goods and causes environmental deterioration. Not only are the vehicles held up in traffic congestions, but they are also blocking the way to vehicles of public transport. This results in decline in mobility of the city residents. Excessive noise and exhaust fumes produced by road transport affect particularly city centres, changing their character as well as making them less attractive and more harmful places to live. The cities try to provide both their residents and visitors with a quality cultural and social life, convenient shopping, supply the shops and restaurants with goods, provide public transport services, education. And this requires a flexible and reliable transport system. To be able ensure these services, cities need quality logistics, which, however, involves an immense number of trips made by the delivery vehicles. The number of such trips has to be efficiently reduced, or at least regulated.**

Index Terms— **smart cities; maximizing quality; quality of life; city logistics**

I. Introduction

THE incessant growth and expansion of cities brings along an ever increasing intensity of traffic. The demand for fast and quality transport of people and goods does not only depend on technical and construction specifications of the transportation infrastructure, but also on intelligible route marking and destination signs, adequate capacity of roads and intersections and these days also operational control and systematization of traffic, which responds to a current traffic. Findings of several studies show, that people are more contented when they are sufficiently informed about the current or planned state of their surroundings and can at least partly influence the course of future events. The enormous popularity of social networks only supports these claims. The advancement of information and communication technologies fuels the demand for up-to-date information not only about economy and trade, but also traffic information about the area the person is travelling through, regardless whether they are drivers, passengers or pedestrians. The solution to this lies in the concept of so called "smart cities".

Today, the term "smart cities" also comprises the usage of new technologies and systems for management and decision making during strategic urban planning and growth of the city. The typical feature is a mutual cooperation of individual systems in order to ensure high efficiency. This mainly applies to transport, power engineering, living environment, education, health care, social care safety and security.

If we restrict the problem only to transport, then city traffic data collection and processing will be the fundamental and key element in traffic management and transport telematics systems. The collected data serve for operating variable road signs, toll systems and the system of public transport. Intelligent traffic management requires 24/7 city traffic data collection concerning the current density and traffic stream properties on all important roads. These data can be measured by in-roadway sensors or devices located in close proximity to road - such as cameras. The collected data serve for predicting future traffic loads and dynamic traffic management.

II. Transport of People within the Cities

As the cars are becoming more affordable and car maintenance and running costs are decreasing, the traffic in the cities is gradually becoming congested. To discourage car owners from driving in the inner-city areas, road congestion pricing schemes, considered as intelligent traffic management tool, can be implemented. But be this measures efficient, an adequate existing road network must be ensured, otherwise imposing road tolls in selected parts of the city will lead to traffic congestions in other parts. The intelligent traffic management has to be closely connected with a sophisticated and dynamic system of public transport which is able to respond appropriately to current demands, some of which can have longer lasting impact on traffic situation, or immediately solve the traffic situation in real time. Such situations can

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include high air pollution levels and weather conditions when driving restrictions or car bans from some parts cities have to be imposed, or when the number of residents living in a certain part of a city suddenly increases.

A quality urban transportation system is a crucial part of the infrastructure of big cities. It applies both to transport of people - either in the form of public transport or personal motor vehicles, and transport of goods - freight transport. Transportation in a large area has to be perceived as complex, interconnected system which is affected by many input and output factors. Transport of people within cities has always been of prime importance and most major cities have developed rapid transit systems of public transport - underground, railways, that are interconnected with other modes of transport so as to provide transport in adjacent areas.

III. City Logistics

Developing urban areas, where the transport of goods has an important role represents a significant challenge these days. After a more detailed look at these areas, we come across a term city logistics.

The term "CITY logistics" is defined as a set of all operative and dispositive measures that are related to ensuring required and efficient distribution of real goods across the city and that do not pose a burden for the environment and are approved according to a type, amount, time, stowage factor, environmental factor, including the transportation of people." (Vgl. Ihde, G.B.: Transport, Verkehr, Logistik, München 1984).

This implies applying the principles of logistics concerning distribution of parcels goods in large urban areas. In a distribution centre, the goods are unloaded, sorted, grouped and then redistributed. The choice of a suitable type of a vehicle and trip optimization reduce the number of vehicles necessary for this task, reduce the maintenance and running costs, increase efficiency of the car fleet and reduce the negative impact on the environment.

City logistics principles can be applied even in transport of people, mainly concerning commercial activities and services.

City logistics concepts usually follow one are a combination of more following logistics principles:

- City distribution centre
- Optimization of the delivery car fleet
- Distribution of goods by other means of transport /alternative means of transport
- Truck route enforcement and regulations, city truck permits
- Imposing road tolls and road infrastructure charging
- Night-time distribution
- Urban area management
- Goods mobility management and company logistics management
- Truck network and restriction Maps
- Alternative ways of distribution
- Information and telematics technologies

The above mentioned systems and logistics approaches are in real life combined in order to meet the needs of urban planning and to meet the needs of all parties involved (city residents, city councils, carriers) with the aim to reach highest possible efficiency. The optimal combination and setting can eliminate the negative impacts of road freight transport on the living environment, eliminate congestions caused by freight transport and to reduce the numbers of trucks and lorries in city centres and, in addition, to ensure economical growth of the city.

A. CITY logistics and transportation of people

*1) **ICT** (individual car transport, personal motor vehicles)*

- enabling individual car transport
- not beneficial for the city
- additional burden on the city
- impact on environment
- parking facilities
- ICT is difficult to control
- always used by certain groups of residents
- ICT vs the quality of public transport services

*2) **PT** (Public transport)*

- PT provides transportation services for people and enables transportation of specified items to ensure the urban mobility
- basic features
  - transport inequalities
  - periodical character of PT
  - shuttle type of operation
  - short distances between stops
  - sensitive to breakdowns and imbalance
  - flexibility
  - unified management
  - unified fare system
- factors affecting PT
  - inner city structure
  - relation between the city and the outskirts
  - transport infrastructure
  - leisure time activities (possibilities and local customs)
- passengers´ requirements
  - clear public transport lines routing
  - regular public transport capacity and periodical offer
  - good connections with other modes of transport
  - synergy with outer city links and region
  - united appearance
  - wheelchair access
  - modern fleet
  - rapidity and reliability
  - fare
  - cooperation with systems **P+R and B+R**
  - modern stops

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*3) **IPTS** (Integrated public transport system)*

- suburban transport
  - city - suburb transport connection
  - meeting demands for quality transport
  - individual car transport, bicycles, motorbikes, pedestrians, Public Transport
  - catchment are 40-100km
- IPTS as an example of suburban transport
  - organizational-economic subsystem
  - fare subsystem
  - transportation subsystem
  - benefits for - passengers; ordering party; carriers; transportation authorities

IV. Logistics and Transport of Goods in an Urban Area - City Logistics

One of the aforementioned logistics approaches, the City distribution centres (CDC), play a pivotal role in the distribution of goods. CDC is a logistics facility which is located in the vicinity of the monitored area that the facility supplies. Such areas are in most cases city centres, where the goods are supplied by means of consolidated parcels, which means optimizing the capacity of delivery vehicles. The whole process of delivering goods is solved like this. Supplier companies that supply the shops, hotels or restaurants in the area, unload their goods in the CDC, where the goods is reloaded and delivered to particular places by CDC cars. CDC delivery vehicles are dispatched according to pre-arranged times, which significantly helps to reduce their number on the roads and reduce the number of kilometres covered. These vehicles are often propelled by alternative fuel, which means that they have minimal impact on the environment. The advantage of this logistics approach is, that the suppliers can avoid traffic congestions and offers complex solution to supplying the given area with goods. CDC is also used for supplying big shopping centres, where massive goods-supply activities can be expected.

CDC is often complemented by other logistics approaches, e.g. information system, by restrictions on non-CDC trucks in the area, delivery locations can only be served at predefined times or intervals, or only vehicles using alternative propulsion are allowed. However, at the same time, it is necessary to bear in mind that establishing a CDC is financially demanding as it requires high investment in constructing a new centre or costs of renting and running a warehouse. Repetitive unloading, storing manipulation with goods and reloading them onto CDC trucks means additional costs. These activities also affect administrative costs and information costs, which can lead to increasing the delivery costs.

The most common reason for opting for this approach is a bad traffic situation in the area, insufficient conditions for direct store delivery and increasing pressure of the society to ban trucks from the city centres in order to reduce air pollution and improve urban environment and social situation.

A. Implementing the principles of City distribution centres should:

- reduce the number of trucks in the area
- reduce vehicle kilometres and the number of truck trips in the city
- reduce congestions, air pollution and noise pollution
- improve the look of the city centre and the streets by lowering the number of trucks in the centre
- more reliable distribution of goods
- offer services with an added value for end consumers and increase the standard of services provided
- optimization of the logistics and supply chain

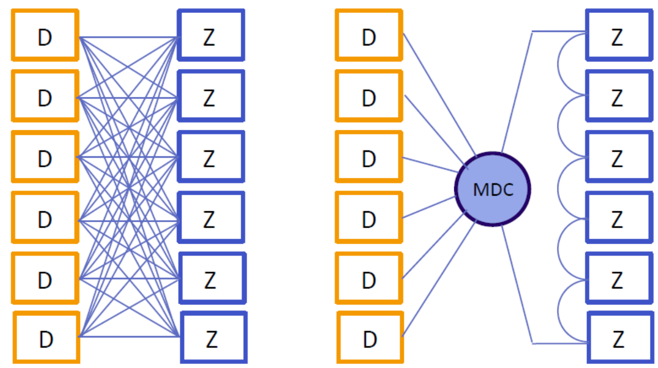

Fig. 1. Implementing the principles of City distribution centres. MDC = CDC= City distribution centre. D = S= Supplier. Z= C= Customer

B. Transportation solution to district areas

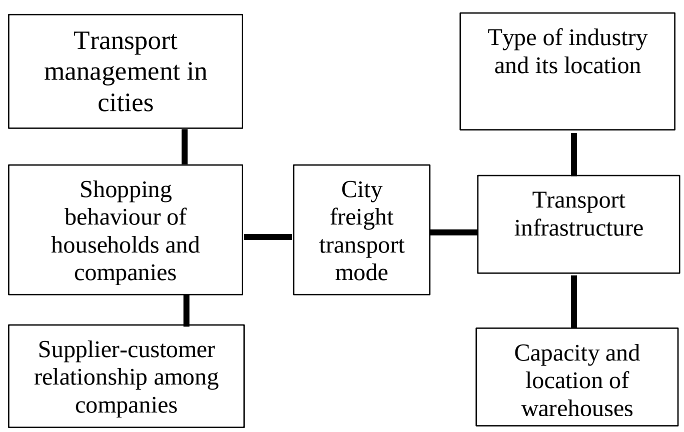

Fig. 2. Factors affecting freight transport in urban areas

V. Transport of People in the Cities

In large urban areas the demand for transport of people is enormous, that is why public transport should be given priority opposed to individual car transport, which has lower capacity and is a major contributor to traffic congestions. Conurbations also use several modes of transport with regard to their capacity (underground, trams, buses). To make public transport competitive and attractive for the users, regulators should ensure the optimization of the system by introducing

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optimization schemes.

Many a large city has several public transport companies, yet these companies do not exchange information and do not coordinate their timetables and connections. This makes the whole system very chaotic and user unfriendly and does not enable the traveller to plan their trip quickly and easily. The main task for a regulator is to unify the tickets and travel passes and improve the interconnectivity among different transport networks.

These days passengers can use several mobile applications that enable finding the most convenient or quickest connection. Thanks to GPS modules, the mobile devices can plan the route from the nearest stop/station and the users are automatically served their favourite destination, which makes the trip planning straightforward. Mobile applications can also be use for purchasing tickets, which are transferable and intermodal and make getting around easier.

The vehicles of public transport can be fitted with GPS modules, which enables monitoring and tracking of individual vehicles and providing the drivers with information so that the passengers would not miss their connection. This functionality ensures connection between individual lines and follow the plan of the regulator/coordinator.

These modern intelligent systems help to make full use of public transport, meet increasing demands of passengers and make travelling by public transport more attractive.

VI. Conclusion

As the cities grow and develop, the demand for transport of people and goods increases, however, the capacity of transport infrastructure is limited. Therefore optimization of individual processes is inevitable, as the capacity of the existing infrastructure cannot be only increased (e.g. by adding new lanes to an existing roads, or by building new roads etc.). That is why new technologies are being used, and their affordability enables more efficient cooperation of all systems of transportation. This applies both to transportation of people and goods. Mobile internet applications provide drivers and passengers with up-to-date information about the traffic situation in the city and help passengers to find a connection which helps to rise standards of services.

Smart cities concept is not limited to transportation processes, but deals with other areas of life (power engineering, environment, state service etc.) Therefore we have to make sure that the standard of services in all areas will be raised equally, communally. This process has to be coordinated so as to ensure highest efficiency in all activities.

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