Network Centric City. Computer Science Vision of Urbanization

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1 ABSTRACT

Any modern city in all respects is a complex phenomenon incorporating manifold of entities like governments (city and districts levels), plants, railway stations, transportation systems and many others. However, there exists one entity that from physical and informatics points of view may serve as a universal basis for the above manifold, and this is a computer network of the city. Indeed, everybody while pursuing certain objective can have an access to some storage of information, or to another townsman, or to other entities. Network is also a universal system for communication and control systems; on the .other hand, the network by itself is only the set of performance capabilities and nothing beyond.

City Network (CN) can be represented as a complex hierarchical system of different nodes. At that, each node is understood as a simple network's node or a local network or a system of local networks, that joints some subset of users or end clients. The fact that the CN structures and functions represent a real city life is not fantastic any longer.

The above assumption evidently leads to a consequence that Network Centric City (NCC) idea should be selected as a new subject of research and investigation. Obviously, NCC is not a simple network. So, the main idea of such representation of the advanced urbanization is to perceive global ideas and processes (business processes) underlying the city control and government system, population distribution, quality of life control and assessment, medical systems, transportation systems, ecological conditions' assessment, disaster prevention, etc.

The paper intends to look at the urbanization problems from computer science point of view. Up to date city is presented in the light of the network centric idea. Computer network at a physical level includes different networks at least as follows: optical networks, different kind of wireless networks, cell networks, etc. Different important problems of urbanization could be solved provided that a topology of city networks, their functions, descriptions, location and other data are available. Moreover, NCC can be used for future planning and urban development.

2 INTRODUCTION

The idea of considering a modern city as an element of the advanced ICT is not a novelty. Many ideas in this area have been evolved and appeared in print since the 70-ties of last century, so, an extensive literature is currently available. This issue also is actively discussed at the CORP conferences, and in this regard the below references give an outlook of the papers published during five last years in the CORP Proceedings. At that, it is worth noting that investigation of the modern city as an "electronic city" was carried out from the standpoint of townmen and/or city architects investigating the urbanization problems. Thus, reference [1] introduced a concept of "Network City". Many habitual attributes of a conventional city are allegorically represented by their electronic analogues like, for instance, [1]:

"bookstores ←→bitstores,

stacks (in libraries) ←→ servers,

galleries ←→ virtual museums, etc."

And Internet is considered as the network basis.

The other publication [6] notes that «It is incorrect to believe that websites represent a cyber city or a virtual-city because they can only represent a part and never the whole city. These websites, holding information about cities, are popularly known as cybercities, cyber cities, digital cities, e-towns, e-cities, informational cities, intelligent cities, telecities, virtual cities, virtual environments, virtual worlds, etc.» The above is difficult to argue with. Naturally the modern city can hardly be represented exclusively through the internet.

The following important comment [10] concludes that «In today's global economy, competition does not occur between countries, but between cities». Indeed, the up to date competition level first and foremost exists between megapolises rather than between countries. This is why many megapolises turn into centers of economics that forms the megapolis appeal in other aspects as well, e.g., Hong Kong, Singapore, Shanghai, New-York.

The idea of representing the modern city as a certain virtual network looks rather productive. So, networks of various types are developing amazingly fast due to their unlimited capacities to provide for a fast and efficient access to heterogeneous information and for various systems management. Here the wireless communications component of the virtual network takes on special significance. It is noted in [10] that «Some of the reasons cities cite for setting up their wireless infrastructure include:

- • Economic development
- • Social betterment
- • Government efficiency
- • Tourism and Marketing»

Thereby, the importance and promise of the wireless networks is accentuated.

Currently one might say that the network centric architecture of the modern city should be singled out for further discussion as an independent subject of inquiry. Notion of "Cyber citizen" (CbCz) is the most important component in the network centric concept. Modern megapolis does not exist without a man, thus, the NCC idea cannot be correct. CbCz is the main consumer of information, main source of information and plays a key role in NCC.

First and foremost NCC is aimed at providing for individual rights, political and religious liberties, ecological safety, for individual needs satisfaction and accounting for his/her opinion regarding the complete scope of the modern megapolis problems like ist vital activities and development; protection agaionstt terrorism, gangsterism and other infrigements of public and individual life. Economics, finance and manufacturing determine a potential of the modern city and form the basis for developing its other constituents including CbCz.

An extremely fast running of all processes, especially, in decision-making both at individual and governmental levels is the principle issue in NCC. At that, so called nonmaterial assets – information and knowledge- take on special value.

NCC is defined by forming a new sector in the megapolis vital activities that is informationware being realized through the megapolis information system (NCIS).

NCIS penetrates into all spheres of the moderm megapolis vital activities from individual to public and from informational to manufacturing.. Основной продукт NCIS major product are data, information and knowledge.

Information security along with megapolis protection against potential threats including the tightly bound informational and physical ones.

Finally, NCIS evolves two important constituents of an individual: consience and every day life. The individual evolution inevitably affects the modern megapolis as the habitat of other cathegory that is the megapolis modern information community.

Thus, under the angle of NCC idea the modern megapolis can be represented by three constituents: decision-making system and city management (NCDMS); system realizing the passed laws and managerial decisions (NCDRS), and system for information-ware of the two above systems (NCIS). Major objective of NCC idea is to assure high level of comfort for individuals living in the city or visiting it on business, for rest, tourism, etc.

3   NC INFORMATION SYSTEM

Generally speaking, the city information system could be considered as a certain system of elements: development or delivery of information resources (computers, software, telecommunications facilities, office equipment, non-electronic information resources, etc.); generation of data; information and knowledge

(science, education, ideology, politics, mass media, scientific and technical information services, observation and monitoring systems, internet); information services (education, libraries, museums, post, communications, financial activity, governmental activity, legal services). It is clear, that the collection of the above constituents will be somewhat different for each megapolis. However, the given collection is rather some system aimed at solving definite problems and meeting definite needs of the modern megapolis than just a collection. The following definition for the megapolis network centric information system is proposed in the above regard.

NCIS – is a system and a complex of interrelated organizational and technical measures intended for the acquisition, collection, transmission, processing, storing, layout, and representation of information, software, computer communications and equipment to be used at supporting decisions made in favour of the citizens, business and the city managerial bodies.

It would be quite appropriate to single out five relatively independent subsystems in NCIS:

- 1.information acquistion subsystem (sensors' system);
- 2.subsystem of information collection, processing, representation, storing, and output (data processing centers, information and knowledge storages, web sites, and other sources);
- 3.computer communications subsystem:
  - o data transfer channels from the sensors' system (USB, KB, space, radio relay links, cell and satellite communications, telefone and fiber-optic lines, television and digital Telefone channels);
  - o computer networks (local computer networks, Intranet, Internet).
- 4.software and computer hardware subsystem;
- 5.security and information protection subsystem.

Because of certain limits this paper will only discuss some of the above subsystems in detail.

3.1 Network subsystem (не вижу в предшествующей части)

Network subsystem is a global virtual network that uses all possible physical channels for information exchange, thus, covering the modern megapolis.

Note, that the modern megapolis represents "a state in miniature" and reflects the modern society structure. Aggregate of peoples' cumulative activity. Economics, politics, culture, education, science, security, medical care, ecology, etc. Information generation and consumption are the most important activities. Information is recognized as the most important resource, and new information technologies become basic technologies forming other activities based upon complex network architecture.

Modern city could be represented as some system that is penetrated by another important system – system of networks for exchange of data, information and knowledge. This is, in fact, a system of computer networks that supports solving problems of data exchange between all kinds of computer systems and citizens. Computer networks also provide for the city communications with the "outside world" within the same state as well as within the "world web". Computer network forms a basis for creating other advanced networks like television systems, cellular communications, various scales observation and monitoring systems, space systems and many others.

At that, up to now the physical networks used to develop spontaneously and to complpetely neglect any intercoordination and planning as needed for the city unified integrated network.. Moreover, a considerable set of physical networks is autonomous and not ideologically interrelated. The above is caused by many reasons including the fact that many physical and logical networks are commercial and, thus, compete with each other. Nevertheless, from the point of view of the unified city structure this situation cannot be acceptable since it generates many new problems and does not solve the old-established ones. Problems of ecology, electromagnetic compatibility, individual rights and other could be attributed as new problems. The problems of fighting against gangsterism, terrorism, street criminality, narcotism belong to the cluster of old-established problems.

Also a strong duplication of networks exists in some places, and their complete absence in other like the megapolis outskirts. In a consequance the megapolis faces an irrational use of active space, energy overrun,

noises generation, as well as other negative factors.Table 1 gives a retrospective of dynamics in growth of various St. Peterburg networks during several past years.

So, an effective planning and developing the computer networks system is the first priority task for the modern megapolis that requires a complex approch to its solving. At that an engagement of versatileprofessionals is a must as well as specifying the specialized research programs at the city governmental level.

#	Cathegories of computer (physical) networks run in St. Petersburg	2000	2003	2006	2009
1.	Networks, distributed computer systems under federal jurisdiction, Ministries and authorities.	5	6	12	16
2.	Networks, distributed computer systems under St. Petersburg Government, regional and municipal jurisdictions	3	8	21	24
3.	Commercial networks	11	26	58	76
4.	Specialized networks and distributed information systems (Universities' networks, networks of R&D institution, etc.)	5	12	18	22

Table 1.

3.2 Sensors' subsystem (в предшествующей части: sensors' system)

Under a certain angle of consideration the modern city could be represented as a systems of heterogeneous nature and purpose sensors..In this case the situation is pretty much similar to the network system situation.There exists a great number of various sensors that are not interrelated within a unified system due to the same reasons as in case of the network system (Fig. 1)

In the precence of advanced sensors' system many problems would be solvable at an absolutely new level. The tasks like ecological monitoring, weather status, situation in the streets and city districts on the whole, transportation system status and traffic flows as well as many other would be resolved at an absolutely new qualittaive level.
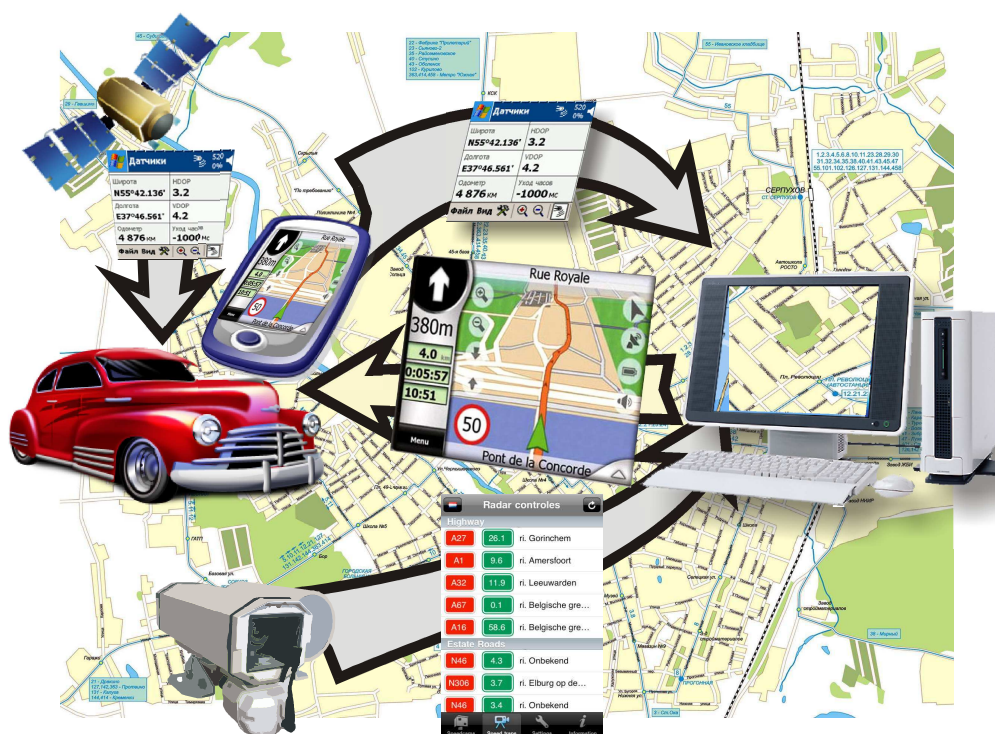

Fig.1 representation of th emodern city as a sensors' system

It is expected that in the nearest future human beings living or located within a city boundary will play a role of the main sensors. The human beings can and must be the main information sources regardring the environment as well the observation objects, at that, his/her level of health and psycho-emotional condition should be observed (Fig. 2).
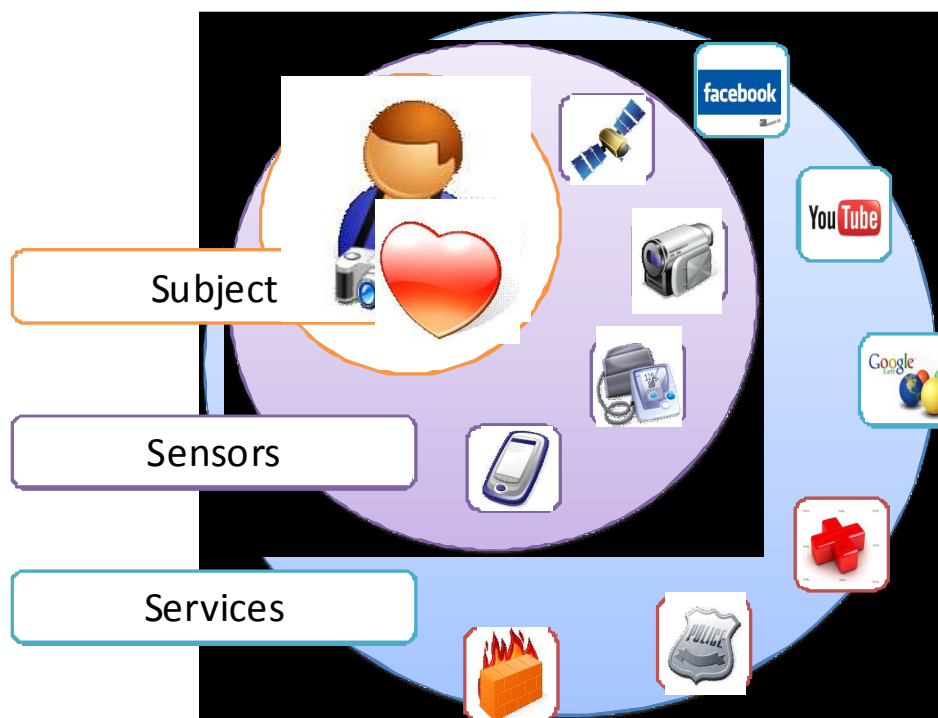

Fig.2 Human being – sensor and observation object in the modern city

For instance, in presence of proper sensors and matching monitoring system the preventive health care as well as acute care and medical treatment for the megapolis residents can acquire an effectively new level.

3.3 Selfsynchronization ???

Considering the fact that the modern megapolis is a strongly stratified envirinment any subsystem, city element (starting with its resident) from the computer point of view should possess an important property of self-synchronization. Here self-synchronization is understood as a capacity to enter the global network and to interract with its other members. It seems impossible in the present day reality to build a city where each resident, each social or other organization would be assigned strict regulations in behaviour and activities. This is why the property of self-synchronization supports a possibily of decentralized existence and management for all entities of computer network from the abstract to physical ones.

Thus, the information system (IS) builds a foundation for the modern megapolis, and all its activities and development are based on this foundation. Advanced IS lays the basis for a comfortable living and functioning of .CbCz, that is a computer mapping of a human resident..

4   NC DECISION MAKING SYSTEM

View on the modern city as on the sensors' system and global computer network puts in the forefront absolutely new requirements to the conventional city management problems and tasks as well as to the city development, reactions to man-caused and natural cataclysms.Presence of the distributed and advanced computer network and sensors' system gives unique opportunities in regard to a whole set of problems faced by the modern city as well as comprehensive facilities for optimizing all expenditures aimed at upkeeping the high habitational comfort.

On the other hand the above presence of advanced computer network and sensors' system generates a number of problems related to huge data flow and a need of making decisions in real time. The more data exist the more reliable is the knowledge of a real situation, on the other hand huge data flow generates a problem of data processing and interpretation. In the long run an uncontrolled data level brings the

investigated situation near the situation specified by the problems caused by data deficit. So, in the above case triggers the dialectic law: "everything and nothing are two extremities that converge".

To solve the above problem a concept of data harmonization, integration and fusion could be used [16], that would allow for organizing a decision-making system at different hierarchical levels.. The concept of developing large-scale corporate systems and large-scale monitoring systems could be adopted by the given idea.

In addition to the substantiated development of different hierarchical levels the problem of making decisions at the given hierarchical levels takes on a special significance. Under the angle of the city management the considered hierarchical levels could be: house (community), residential area, district, city. The hierarchical levels could be easily singled out in a number of city services like police, health care, emergencies control, and other traditional city services. A near-term outlook would likely take a city resident and his/her "Cyber citizen" (CbCz) as an entry hierarchical level for the most city systems and services.

Problem of making decisions in the modern city is a nontrivial task as respects a definite individual [3] or various city services and systems. Accountibg for conventional mathematical methods of decision-making one cannot but admit that they have a limited range of applicability as well as a limited possibility of their use. In this regard lately the interest is attracted by the systems of artificial intellectuality that easily incorporte mathematical and simulation models and also allow using heuristics and expert knowledge, thus, targeting at a new quality in application of decision-making support systems. First and foremost, they exhibit high flexibility and customizability, almost unlimited capacity to be modifidied and evolved, as well as to be connected up with a wide range of models' classes. At that, such systems can and must be available for an average resident being in possession of a regular mobile- or smart-phone.

5   NC DECISION REALIZATION SYSTEM

In a computer era the made decisions' realization system functions in a highly variable situation. At that, depending on the made decision level, for instance, strategical, operational, tactical the time of decision obsolescence will significantly differ depending on the level. Note, that .costs of error will also be rapidly changing depending on the level, however, in a reverse order than the obsolescence time.

Control automation problems in organizational and technical systems, and modern megapolis could be considered among such systems, had been studied over 40 years ago, at the beginning of the seventies of the last century. The given idea was well formulated by D. A. Pospelov [17] and is known since as "situational control". The above mention approach had specifically emphasized the fact that well developed mathematical apparatus and automatic control theory techniques are not applicable to for the case of organizational and technical systems. The ideas proposed by D. A. Pospelov were somewhat extended by the concept of "network centric war" formed in the USA at the end of the twentieth century and in the beginning of the twenty first [18].

The existing body of network centric ideas allow for forming an integral concept that regards the made decisions' realization process at various levels in control and management hierarchy, particularly, at the level of the modern megapolis resident as the very essence of the modern megapolis.

In the nearest future the main features of the decisions' realization in NCC will be as follows:

- high rate of decision-making as well as high rate of its realization;

- high degree of decentralization in decision-realization, and consequently, high level of self-dependence in decision-making at various hierarchical levels;

- adaptability of the made decisions under rapidly changing situation's conditions;

- reasoning ability at the "situation" level rather than at "data and facts" level;

- common introduction of the artificial intellectuality means and techniques destined to avoid critical errors and obvious misoperations under rapidly changing situation's conditions and source data deficiency. Potential advantages as stipulated by NCC concept realization cannot be implemented automatically, so, consolidation of the skilled professionals from many subject areas .as well as engagement of citizens and governments will be required.

6 CONCLUSION

Modern city is a global information system where the modern citizen plays a key role as a user and as an active participant. NCC concept assumes considering the urbanization problem from computer point of view, at that, not neglecting conventional approaches.

Under the ICT rapid development the role of computer sciences and professionals is expected to continuously grow. At that, ICT will be rapidly introduced to all spheres somehow related to the modern individual activities.

At arranging for planning and development of the projects for the new city's districts or remodeling the old ones it seems reasonable enough to invite professionals developing global computer networks and large-scale information systems. Modern society cannot advance without paying a close attention to developing in all spheres of modern megapolis life the information networks and decision-making support facilities and systems.

It looks like that the NCC concept would inspire the development and practical realization of modern megapolises structuring and development tasks.

It might be quite reasonable to represent the CNN concept by three basic subsystems.

Decision-making system and management (NCDMS). Legislative and executive authorities are ascribed to this system.

System realizing the passed laws and managerial decisions (NCDRS). Here the immediate performers who realize the made decisions and acts of law in practice are meant; first of all they include police, emergency services, medical care, economic subsystem, etc.

System of the two first systems information support (NCIS).

7 REFERENCES

[1] DREWE, Paul: What about time in urban planning & design in the ICT age? Vienna, CORP2005, 2005.
[2] FERNANDEZ-MALDONADO, Ana Maria: Macro-spatial aspects of the digital backbones network in Latin America. Vienna, CORP2005, 2005.
[3] ACHATSCHITZ, Claudia: Identifying the necessary information for a spatial decision: Camping for Beginners. Vienna, CORP2005, 2005.
[4] ARANYA, Roleer: Intra-metropolitan location for global production: Case of the IT Industry in Bangalore City. Vienna, CORP2005, 2005.
[5] FAHMI, Wael Salah: City of Pixels experimental imaging of postmodern other urban spaces. Vienna, CORP2005, 2005.
[6] PHYSENTZIDES, Kostas: From the vertical city to the virtual-city: the rise of the cyber-city. Vienna, CORP2005, 2005.

[7] DREWE, Paul: What about time in urban planning & design in the ICT age? Urban competitiveness and ICT Vienna, CORP2006, 2006.
[8] LACONTE Pierre: Urban planning in the global economy:what can be done? Vienna, CORP2006, 2006.
[9] WOLFRAM, Marc: The politics of spatial data infrastructures: State transformation, urban governance and the instrumentation of electronic territories. Vienna, CORP2007, 2007.
[10] FARKAS, Andor: Where are the planners in Municipal Wireless deployments? Vienna, CORP2007, 2007.
[11] BENNER, Joachim, et all: Public Participation and Urban Planning supported by OGC Web Services. Vienna, CORP2009, 2009.
[12] APOSTOL, Ileana, ANTONIADIS, Panayotis, BANERJEE, Tridib: Places on the Net. Vienna, CORP2009, 2009.
[13] ZEILE, Peter, HÖFFKEN, Stefan, PAPASTEFANOU, Georgios: Mapping people? – The measurement of physiological data in city areas and the potential benefit for urban planning. Vienna, CORP2009, 2009.
[14] WASSERBURGER W. Wolfgang: OpenStreetMap.org - Community game or real geo-data? And the role of data donations. Vienna, CORP2009, 2009.
[15] SCHRENK, Manfred et all: Bus Stop 3.0 – Multifunctional Centers for Regional Development. Vienna, CORP2009, 2009.
[16] POPOVICH, Vasily, VORONIN, Mareng: Data Harmonization, Integration and Fusion: three sources and three major components of Geoinformation Technologies.//Proceedings of IF&GIS, September 25-27, 2005, St. Petersburg.
[17] POSPELOV D.A: Situational Control. Theory & Practice. M.: Nauka, 1986, 288pp in Russian.
[18] ALBERTS, D.S., GARSTKA, J.J., STEIN, F.P., (2000) Network Centric Warfare: Developing and Leveraging Information Superiority, CCRP Publ., 2nd Edition (Revised). Aug 1999, Second Print Feb 2000.
http://www.networkcity.bk.tudelft.nl/