A Framework of Integrating Digital City and Eco-city[*]

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ABSTRACT

The nature of mankind is longing for better residential environments. City, as a major living style, has never stopped exploring more comfortable urban modes. The main stream of city development theory resulted in 'eco-city'. Recently a new concept, digital city, was push forward with the hot tides of IT technologies. However there is few research linking these two concepts together.

This paper tried to explicit the affiliation and comparable elements between these two concepts. It overviewed the recent research achievements on both eco-city and digital city. It pictured an integrative prospect of digital city and eco-city on the point of view from urban sustainable development with IT technologies widely applied. It proposed a fundamental technological framework of the integration of digital city and eco-city. It finally concluded that the integration of eco-city and digital city is the future of sustainable urban development.

KEY WORDS: Digital city; Eco-city; Urban sustainable development

1. INTRODUCTION

Mankind has never stopped the endeavor of exploring the best urban mode. As a major style of residential environment, city, has been endowed new contents by new ideas ever emerged in the history. 'Garden City' in the *Athinai Charte* in 1933, 'eco-city' of sustainable development proposed in *Machu Pichu Declaration* in 1977 and the latest conception "digital city" in later 20th century, all these ideas enriched the contents of modern city and significantly affected the development direction of urban mode.

The theory of eco-city views city from the point of ecosystem. It pursues high efficiency and sufficient harmony for living in modern city and investigates urban problems under the guidance of ecological ideology. Digital city is a technical framework attempts to offer a totally new and information-ready living space. The feature of digital city is the overwhelming convenience of accessing all kinds of information for living in a city. The background of digital city is that information becomes more and more important in modern city lives.

Eco-city and digital city are two faces of a modern city. Eco-city is the physical face of real daily living styles and digital city is the spiritual face of virtual, sensible information world supporting daily living styles. The integration of eco-city and digital city is the un-reversible trend of human living style in the future. From the point of this integration view, the traditional ideology of urban planning 'man-architecture-city-society' will naturally evolve to 'man-architecture-digit-city-society', where information will plays a key role in a modern city. This paper tries to explicit the affiliation and comparable elements between these two concepts. It reflects our efforts to picture the integrative

prospect of digital city and eco-city on the point of urban sustainable development view with IT technologies ubiquitously applied. A fundamental technological framework of the integration of digital city and eco-city is proposed in this paper.

The rest of this paper is organized in 5 sections. Section 2 reviews the conceptions and technological frameworks of eco-city and digital city. Section 3 discusses problems emerged during the building of eco-city when information becomes more and more important in a modern city. Section 4 explores the theoretical aspects of integration of eco-city and digital city and Section 5 proposed a framework of integrating eco-city and digital city. Finally a brief conclusion was given at section 6.

2. DIGITAL CITY AND ECO-CITY

2.1. Digital City

The past ten years witnessed great achievements in the technology of the Internet and Cyberspace. This offered a unique opportunity to break through the bounds of time-space and explore our planet from a totally new start point. The former US vice-president Al Gore propose the concept "digital earth" on January 31, 1998 and he further pushed the concept "digital city" in September 1998. As one of the main applied fields and key nodes of digital earth, digital city drew more and more attention from countries all over the world. Singapore proposed the plan of "Intelligent City". The US and Japan respectively established some examples of "Intelligent Digital Community". Digital city is now part of the main stream of planning a modern city.

Digital city is an information service system that supports city decisions by continuous collection of city information and dynamically monitoring all possible aspects of the city. The key feature of digital city is that information and its transmission become the most important part of the city and an intelligent network is addressed to collect, store, transfer, retrieve and make use of all these information. Besides the up-to-date city model as its skeleton, other information such as financial, communication, transportation, tourism, shopping etc., work together to form a cyberspace serving urban livings. Realized on the Internet, digital city needs multi-disciplinary supports, especially information science technologies. The key technologies of digital city include high-speed network, high-resolution earth observation technology, GIS, GPS, and Virtual Reality (VR) etc.

Digital city is built with the physical city with enormous buildings and other man-made geomorphological objects. This physical city is, however, an ecosystem that provides the residents with living resources and living environment. The only purpose of digital city should be parallel to the ideology of eco-city.

2.2. Eco-city

Modern eco-city ideology directly originates from Howard's theory of Garden City. The theory of Garden City reveals the ecological charms of harmonious development of city and nature. Letchworth is a widely recognized Garden City in England designed by Edenezer Howard and built in 1903. After nearly one century, it still remains one of the most desirable living environments.

Urban planners have absorbed big ecology ideologies and principles in urban research, and considered city as an artificial ecosystem. Considered by the former Soviet Union ecologist O.Yanitsky (1987), eco-city should be an ideal pattern and living place. Roseland (1997) proposed the idea that eco-city ideology coexists with and contains others, rather than exists independently.

Eco-city theory views city from the point of ecosystem interactivity. Its basic opinion of city development is to fully exploit the potentials of ecological construction under the present resource environment for the purpose of building up a efficient, harmonious, health and wealth city. It rejects the traditional way of low productivity and the modern way of resource-consuming. Thus the eco-city ideology solves urban problems from the point of ecology. It modifies the city into a low-entropy regular structure with perfect functionalities, sustainable efficiency and better environmental quality. The eco-city process benefits the ecological, environmental and social systems. Therefore, eco-city is a sustainable developing city with harmony between man and nature. It is a city based on the improvement of productivity, using modern science and technologies such as eco-engineering, system engineering and information technology including the technological system of digital city.

3. IT PROBLEMS ARISING IN ECO-CITY

3.1. Building Database for Ecological Elements of a City
For planning and building eco-city, it is essential to obtain various types of ecological data about a city. At current stage, the major problems are deficiency and obsolescence of data, lack of data standards and open management systems. Most researchers on eco-city are from urban planning, geography with some backgrounds in ecology. They need more cooperation with those computer talents to deal with these IT issues. Digital city, as it relies mainly on latest information technology, provides a just-in-need account for eco-city.

3.2. Decision Information System for Eco-city
With the fast development of a city, eco-city, as a complicated system of nature and community, are evolving. A city's fragile ecosystem will gradually shrink under the impaction of urban activities. As a strategic control meaning, new technologies must be applied to dynamically analysis and monitor each eco-elements. The result is a decision support system to direct urban planning officers and experts to draw up specific measure for eco-city. Currently, there are GIS-based dynamic systems such as urban green land system, urban environment monitor models, urban land use information system, and so forth. However, most of them are stand along systems and are not networked. Sharing information is almost impossible. What is more, a lot of important issues are not considered in these systems. These problems include data error and uncertainty, concurrency, consistency, data standards, technical specifications and data sharing issues etc.

3.3. Public Participation
Eco-city planning not only includes physical environment such as housing area, green land, roads, plants and public facilities, but also includes humanity value, ecological effect, cultural context, historical features etc. With the development of modern city, man-centered idea becomes more important and the public is the main point of urban planning. Thus, people should actively participate the planning of eco-city and eco-city should ultimately serves the people.

However, at current stage, public participation is only realized through the form of questionnaire and creative motion of the public. The public is not comprehensively informed and does not understand the materials about urban planning. The administrative departments also do not have rational mechanism of making use of public participation. To bring public participation into full play, it is necessary to strengthen the construction of

eco-city information platform, comprehensively utilizing relevant technologies of digital city, such as GIS, Remote Sensing (RS), network and Virtual Reality (VR).

4. INTEGRATION OF DIGITAL CITY AND ECO-CITY

4.1. Possibility and Necessity

The fast pace of urbanization and IT infrastructure makes it possible to study digital city technologies for urban development. Furthermore, future research will focus on city ecology and sustainable development. Thus, technologies of digital city will cause drastic change in the fields of the collecting, analyzing and processing information for urban planning. It will improve the exchange and feedback mechanism of information process in urban planning. However, the development of eco-city will also adopt urban planning mode in IT-age, and seeks the best integration of ecology and technologies to plan eco-city on digital platform.

It is obvious that the integration of eco-city and digital city is the un-revertible trend of urban planning in the information age. And this new planning idea will change human settlement in deep. On one hand, human's real living environment is pushed to the road of ecology with much rationality; on the other hand, the networked, intelligent and visualized informational environment meets more and wide variety demands of urban residents. In this way, the living space of human being is stretched from 3D space to a multi-dimensional space. The living style is also changed from material existing to digital existing, and the whole city becomes a sustainable developing living space with more rational structure and higher living quality.

4.2. Technological integration of digital city and eco-city

According to Roseland's (1997) explanation, eco-city should be a healthy community with wonderful technologies including automatic data collection, dynamic monitor & management, and auxiliary decision technologies, which are relevant technologies of digital city. These technologies are accessible to eco-city, and make the integration possible.

(1) The digital city network and GIS technologies make it easier to collect data of eco-city
    Cyberspace built on the WWW (World Wide Web) breaks through some of the "bottlenecks" of traditional GIS. Web-GIS running over the Internet extends functions of GIS to a popular toy. Meanwhile, online data release and interoperation, based on open standards, support multi-data sources, multi-resolution, multi-scale and multi-media data. Urban planners can browse and consume geographic and other information through Web-GIS online.

(2) Virtual Reality and 3D technologies improve eco-city planning and public participating.
    Taking advantage of Virtual Reality and 3D technologies, urban planners can virtually plan the city in the virtual environment modeled by computer. The public can acquire the same planning experience through the web.

(3) Digital city technologies offer IT support for eco-city management and decision-making.

### 4.3. Aim of this Integration—Urban Sustainable Development

Urban sustainable development is a newly urban development mode [7]. In this mode, a city develops in a certain spatial-temporal scale, and grows harmony with external regions of the city. It optimizes internal organization structure and running mechanism,

manages urban and environmental resources in balance, and promotes the harmonious development of urban resources, economy, society and environment.

The integration of digital city and eco-city makes it possible to realize this new urban developing mode. With the Internet, digital city technologies build up the data sharing system and technological platform for urban sustainable development. Supported by the urban basic database, it keeps a virtual reproduction of real city. This helps to achieve the effective integration of the subsystems of urban population, resources and environment. This also optimizes the allocation and effective utilization of urban resources in space and time. It also assists to form decisions of the urban sustainable development.

5. A TECHNOLOGICAL FRAMEWORK OF THIS INTEGRATION

Table.1 A technological framework of the integration of digital city and eco-city
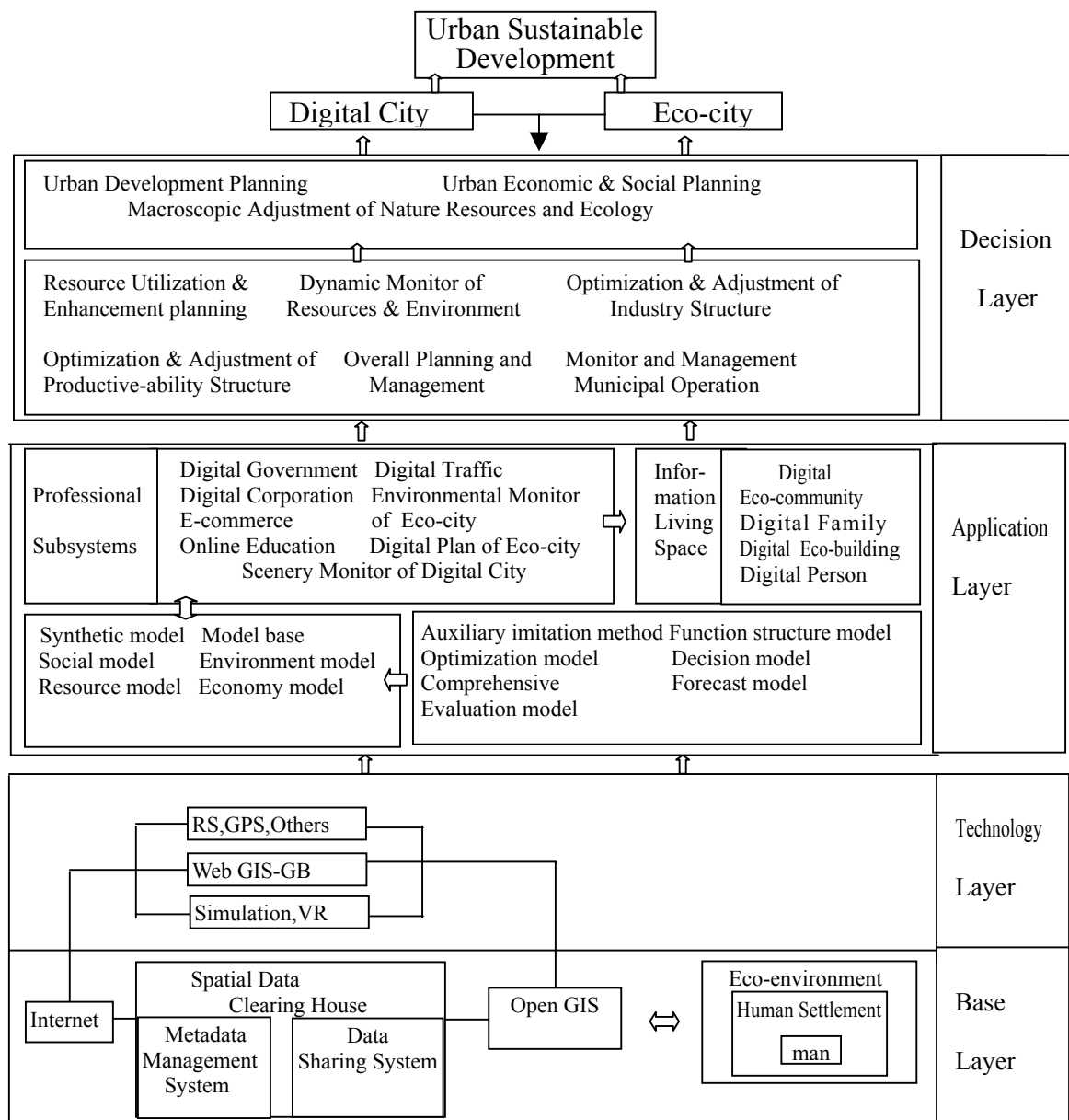
We propose a technological framework of this integration in Table 1. This integration is in four layers. They are the data layer, the technology layer, the application layer and the decision support layer.

(1) Data layer

This layer collects and manages all data including urban digital information infrastructure and human settlement of eco-city.

(2) Technology layer

This layer implements the basic and abstracted functions on data layer. Technological components such as RS, GIS, the Internet, VR and 3D interaction are running as kernel of the integration.

(3) Application layer

Supported by data layer and technology layer, this layer implements sub-system of different functions on the digital platform. Some of these sub-systems support the management and operation of eco-city. Examples of these sub-systems are digital government, digital corporation, digital transportation, digital community, digital ecological building, digital family and digital person.

(4) Decision Support layer

Supported by the integrated decision support systems, this layer will bring about the dynamic supervision, monitoring, simulation and assist to carry out sustainable development decision and provide services to the scientific decision and management of sustainable development for the whole city.

6. CONCLUSION

With the further development of IT and digital city technologies, information, as a virtual but valuable substance, will penetrate to the daily physical living of urban life. The integration of digital city and eco-city is the un-reversible trend of future urban sustainable development. The living space of city will extend gradually from pure social space to the integrated space of social and information life. The human settlement environment will keep on optimized and further fulfilled the demands of human being through this integration.

The IT and digital city technologies are now able to provide the technological supporting the integration in all four layers from data to decision. They will even better service the urban sustainable development with achievements in technologies. The future of urban life is beautiful and sustainable.

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