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Top-Level Design of Smart City Based on "Integration of Four Plans"

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Abstract

A smart city provides a new idea and model for urban construction, management, and development. This article proposes the concepts and methodology for top-level design of smart cities based on the "Integration of Four Plans", and the planning process and systems for implementing the top-level design of smart cities. This article discusses, from the perspective of a city, how to optimize resource allocation, coordinate the development of urban economy, society, resources, environment, and people's livelihood, and map out the blueprints for healthy and sustainable development of a smart city.

Keywords

smart city; top-level design, integration of Four Plans, ICT Benefiting People

1 Top-Level Design Guiding Smart City Construction

A city is composed of many ecosystems, which is called a "System of System". From the perspective of urban structure, a city is a combination of interactive elements, such as the economic structure, social structure, and spatial structure. From a technical perspective, a city is a complex system composed of multi-field, multi-class, multi-level, and multi-directional heterogeneous sub-systems for collaboratively processing different types of massive data in different areas. A city has the following features:

- Rapid changes in demands
- Technological diversity
- Complex internal structure
- Frequent external interactions
- Coexistence of old and new systems
- Needs for continuous improvement.

Evolving information technologies and requirements for urbanization are jointly spurring the development of smart cities. A smart city is a new idea and model for urban construction, management, and development to improve urban management efficiency, facilitate public life, and promote technological innovation using information and communications technologies (ICTs), such as high-speed Internet, big data, Internet of Things (IoT), and cloud computing. Smart cities have been witnessing rapid development in China since 2012. Statistics shows that national ministries have approved a total of 529 pilot smart cities in Eastern, Central and Western China [1].

However, in the existing administrative systems, due to a lack of experience in smart city construction, different understanding and organization of smart cities across regions, and absence of state-level standards and evaluation systems, if without overall planning and guidance, many existing and new issues, such as lack of coordination, information silos, the same picture of different cities, and low degree of smartness, may arise again during the implementation process, increasing the risks of failure.

In respect of the complexity of smart city construction, this article proposes the top-level design of smart city as well as its implications, scope of planning, key planning contents, implementation strategies, and typical cases, to provide a feasible way for smart city construction through coordination of all levels and elements.

Top-level design is a concept of system engineering, and embodies the "overall idea" of a project. In order to complete a large project, overall planning from a global perspective with "common ideas, functional coordination, unified structure, resource sharing, and standardized components" is needed. In addition, a smart city is a long-term and sustainable systems project to reform the urban management ideas and models of governments, and cannot be promoted effectively without an appropriate top-level design [2].

When the smart city construction is implemented all over China, the following common problems arise from the practice during the top-level design process:

1) Focus on technologies rather than services

Top-level design was driven by technologies, and is merely

in pursuit of application of hi-techs, such as the IoT, cloud computing, and mobile Internet. Without considering in-depth integration of ICTs with urban function modules or elimination of deep-seated contradictions, top-level design was always unattractive to the public. A smart city does not depend on advanced technologies but should properly tackle existing problems.

2) Focus on construction rather than management

The current smart city planning and design basically put emphasis on technical architecture and specific applications, but seldom take into account the closely-related operation management mechanisms, service models, policies, and measures, for example, how to build the libraries for information resource sharing, examination and approval lists, and public service lists, and how to implement dynamic management. Due to a lack of national standards, regulations, and procedures, and great differences in local circumstances, these are often difficult to achieve, and are usually the weaknesses of IT professionals. However, these are the basis and guarantee for achieving the goals of smart cities.

3) Focus on planning rather than implementation

Although a series of projects are planned in top-level design, local governments fail to implement these projects due to insufficient funding. The governments do not have constructive ideas on how to innovate in business models, attract social investments, involve financial institutions in smart city construction, and promote the development of the industry chain. Neither do the governments make clear plans for opening up the charged information resources of governmental departments or motivate the community through purchase of services, thereby prohibiting sustainable development of smart city construction.

The top-level design of smart cities is an innovative activity to promote urban development through research on urban planning, current urban situation, and urban economic and social development planning.

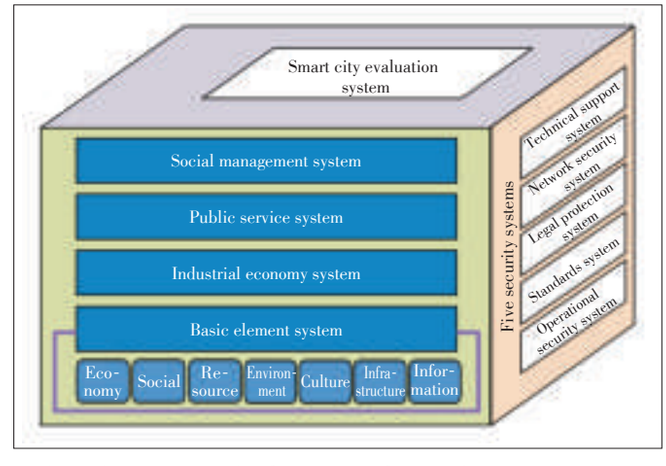
1) Future-proof plans, and practical and forward-looking blueprints can be formulated through the top-level design of smart city based on regional positioning and advantages of cities, and the requirements and trends for social, economic, and technological development in quite a long period of time.
2) Overall planning should be conducted from the perspectives of the demand framework, technological implementation, investment and financing modes, and industrial support, to improve organizational collaboration and achieve the highest efficiency and optimal resource allocation at the lowest costs.
3) Innovations should be made in IT project implementation, and the mechanisms and modes are designed deliberately to involve more enterprises in smart city construction, leveraging more social investments at a small amount of governmental expenses.
4) The core demands of governments, the public, and enterprises should be considered systematically to build a livable and sustainable smart city, and a convenient, fair, inclusive, high-quality, and efficient public service system, so that the public can enjoy the convenience and comfort of the smart city.

2 Implications of Top-Level Design of Smart City

Based on scientific methodologies, the top-level design of smart cities involves strategic planning and overall design of a city to optimize resource allocation, coordinate the development of urban economy, society, resources, environment, and people's livelihood, and map out the blueprints to guarantee healthy and sustainable development of a smart city. The top-level design of a smart city is not only for the city itself, but also for urban development and public experience. Urban development involves social, economic, and cultural value aspects, while public experience refers to an IT-based living environment that brings perceivable welfare to people.

From a different dimension, the top-level design framework of a smart city includes the basic element system, industrial economy system, public service system, social management system, evaluation system, as well as five security systems (technical support, security, legal protection, standards, and operational security), as shown in **Fig. 1**.

The basic element system, which is the foundation for operation and development of a smart city, improves efficiency, and facilitates innovation and coordination between urban operation lines and functional elements, including the economic, social, resources, environmental, cultural, infrastructure, and IT fields. The industrial economy system transforms and improves traditional industries through the new-generation information technologies to accelerate transformation and upgrade, and promote the rapid development of emerging strategic industries. The public service system is a comprehensive service system involving the public and enterprises to meet the main needs of the city. The social management system, which is at the core of the city's comprehensive regulations and management, imple-



▲**Figure 1. Top-level design framework of smart city.**

ments intelligent analysis and control of urban operations on the basis of efficient operations of the urban resource element system. The evaluation system guarantees that the city develops towards people - orientation, smart people, intelligent things, and optimal development of economic and social activities. The five security systems support and guarantee the operations, management, and services throughout the life cycle of the smart city.

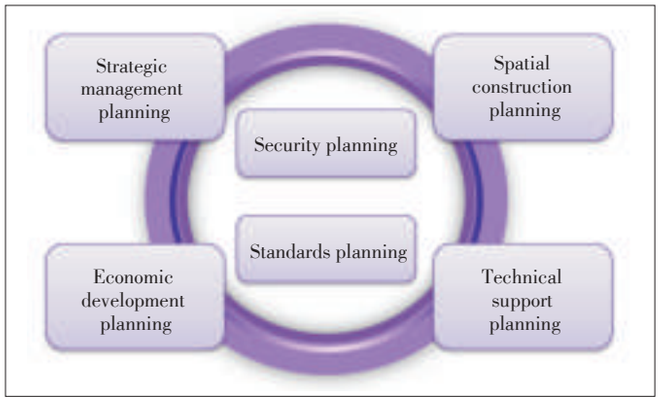
Having made lots of practices, ZTE proposes the top-level design methodology with "Integration of Four Plans". Namely, strategic management planning, spatial construction planning, economic development planning, and technical support planning are indispensable and their collaboration should be considered in the top-level design process of smart cities.

Based on strategic management planning, with the goal of economic development planning, guaranteed by technical planning, with overall spatial deployment, equal basic public services should be actively promoted to avoid redundant construction, and promote rational distribution and full use of resources to establish a unified smart city planning system with functional complementation. On this basis, a complete top-level design of smart cities can be formulated by involving security and standards planning (**Fig. 2**).

The key to top-level design is to develop a complete and feasible smart system. In this system, all parties can independently construct the system to build a sustainable framework for a smart city with a clear division of labor and joint efforts. Through the top-level design of smart cities, with unified strategic planning for urban development, the city positioning, and the contents, modes, and overall design of smart city construction should be identified to avoid decentralized investment and redundant construction, providing a feasible way of resolving the difficulties in the development of smart cities.

1) Strategic management planning

Strategic management planning, with the highest priority among the four plans, identifies urban development goals, regional planning, policy environment, and security systems based on the current status and typical features of the city, as well as makes reversal correction to city positioning.



▲**Figure 2. Top-level design of smart city based on "Integration of Four Plans".**

2) Spatial construction planning

Spatial construction planning includes urban spatial planning, land use planning, and municipal facilities planning based on the city positioning. It is a complicated systematic project involving the deployment and arrangements for political, economic, cultural, social, and land resources. Spatial construction planning is closely associated with the smart city to improve urban planning, promote the optimal design of public facilities, and achieve scientific and accurate urban planning using big data.

3) Economic development planning

Economic development planning includes planning for industrial development, economic environment, investment and financing, and financial services based on city positioning, in order to ensure sustainable construction and operation of a smart city. For example, industrial transformation and upgrade should be facilitated by planning the development paths for key industries, proposing recommendations for investment and financing models, and integrating information technologies, to ensure sustainable development of the smart city.

4) Technical support planning

Technical support planning is to achieve the strategic goals of a smart city by means of IT, where the difficulties include interconnection between systems, information mining, and mass data processing. With the development of the new-generation information technologies, such as the IoT, cloud computing, big data, and mobile Internet, data becomes ubiquitous, and is accumulating at any time. How to eliminate the long-existing information silos and conduct data mining to benefit people, promote business, and improve governance is key to the smart city construction, and needs to rely on technical support planning [3].

5) Security planning

Security planning is to build a unified information security system that involves security management, technical defense, secure operation and maintenance (O&M) capabilities, and unified management and control of the physical layer, sensor, network transmission, data, application, and O&M risks, to ensure data security and secure Internet access for a smart city.

6) Standards planning

A smart city involves a large number of areas, processes, systems, interfaces, as well as managers, constructors, and maintainers, and therefore needs to establish unified technical standards and regulations based on a sophisticated system for efficient collaboration, and standardize smart city construction projects through a unified, open, and operable construction standards system.

3 Contents of Top-Level Design of Smart City

In accordance with the planning concept of "Integration of

Four Plans" for top-level design, strategic management planning should be developed by analyzing the demands for smart cities. Strategic management planning for a smart city includes the following contents:

1) Guiding principle

Everything develops by following related principles, and the same is true for smart city construction, which also needs an appropriate guiding principle. In August 2014, the *Guiding Opinions on Promoting Healthy Development of Smart City* was officially released, clearly putting forward the guiding principle for smart cities: In accordance with the general requirements for following an intensive, intelligent, green, low-carbon road of urbanization, the market should play a decisive role in resource allocation, and governmental guidance should be strengthened and improved for coordination of materials, information, and intellectual resources, to promote the application of the new-generation IT innovations, strengthen construction of intelligent urban management and service systems, proactively develop intelligent applications for public services, and enhance network security, thereby improving the city's comprehensive capacity and residents' happiness, and enhancing the quality and level of urbanization.

2) Development goals

Construction will be in disorder without clear goals. Therefore, the social, economic, and livelihood goals of smart city construction should be determined in accordance with the city's regional positioning, strengths, development opportunities, and industry features. Social goals include caring public services, rational social management, optimal resource allocation, environmental improvement, effective economic development, people's welfare, and harmonious social trends. Economic goals include healthy development of industrial economy, continuous cost reduction, and increasing efficiency and benefits. Livelihood goals are to provide people with better living and guarantee services, such as basic housing, community, and public education services.

3) Key tasks

With adequate research on and analysis of demands, in accordance with smart city construction and development goals, key tasks and projects should be determined, target tasks and responsibilities should be specified, and construction requirements, leaders in charge, leading departments and accountable persons, and assistance departments and accountable persons should be identified for all construction projects. Key tasks should be prioritized in the planning process, highlighting priorities and implementation methods. For example, priorities for IT applications shall be specified in urban planning and management, public services, social management, infrastructure, and industrial development, and the issues constraining urban development should be addressed to explore and promote the sound development of information networks, technological innovations, industrial transformation, and social applications.

4) Strategic steps.

In accordance with the top-level design, a smart city should be conducted step by step by tackling easier issues first, focusing on usability, and launching pilot projects, to build, use, summarize, adjust, and improve the smart city simultaneously. For example, infrastructure should be improved with the guidance of "Broadband China", and big data centers should be built with the guidance of "ICT Benefiting People", including four basic databases for natural persons, legal persons, macroeconomics, and spatial geography. Furthermore, corresponding subsystems, such as smart transportation and smart tourism, should be built to meet different local needs. The smart city construction is in progress, and will never end.

Upon the completion of strategic management planning, further measures should be taken for the collection, integration, storage, mining, and sharing of information resources.

First, a technical support system should be developed for the smart city. A smart city has a long-term development process, and therefore needs a scalable, flexible, and evolving technical system. This system coordinates all project levels and elements from a global perspective, analyzes the current status, target architecture design, interconnection specifications, and comprehensive construction constraints in respect of services, data, systems, and technologies, and designs implementation path for the target architecture [3].

Second, a service application system should be developed for the smart city. With the goal of fully supporting government functions, the service application system is the infrastructure for planning and designing service functions of a smart city, breaking the limitations of specific department functions, and reviewing the services in respect of serving the public, in order to adapt to the changes in urban management, economic development, people's livelihood, and public services. This system better serves the general public, governmental departments, and enterprises by building related service application systems, such as urban planning, construction, operations, and management services.

Third, a policy and standards system should be developed for the smart city. Currently, the level of standardization has become an essential element of core competitiveness of all countries and regions in the world. In the top-level planning stage of smart cities, great importance should be attached to standardization. There must be guides for planning smart cities, standards for building shared platforms, and references for collaborative application and development, to achieve orderly, high-quality, and significant development.

Fourth, an evaluation system should be developed for the smart city. The evaluation system should be established for scientific measurement of smart city construction, and specifying and setting indicators for the smart city, to ensure rational urban investment, efficient management, livable environment, and happiness of residents. The evaluation system identifies the construction goals and standards of the smart city, to help smart city administrators make objective judgment on the con-

struction process and results, and qualitative and scientific evaluation of the construction achievements. This system has become an effective means for assessing smart city construction, and is of great significance and value for solving these problems. In accordance with the upcoming state-level evaluation indicators for a smart city, based on the actual conditions, detailed evaluation systems can be developed for all cities [1].

Fifth, an investment and financing system should be developed for the capital industry of a smart city. Smart city construction is a complicated systematic project that has wide coverage, and needs huge capital investments. It cannot be effectively supported by relying on only the public expenditure of a nation. It is an inevitable choice to meet the funding needs of smart city construction through various flexible investment and financing models. For example, the public-private partnership (PPP) model can be used to introduce market mechanisms into smart city construction projects. In this way, additional funding needs can be fulfilled by enterprises and financial institutions, achieving the goals of shared and win-win project construction involving multiple parties. This will become an inevitable choice for investment and financing models of smart city construction projects in China.

4 Cases of Top-Level Design of Smart City

Y City, located to the south of the Yangtze River and to the north of the Changsha-Zhuzhou-Xiangtan City Group, has rich natural and tourism resources, and is well-known as "a land flowing with milk and honey", the "Land of Black Tea", the "Land of Ramie", the "Land of Nan Bamboo", and the "Land of Culture" in China. With distinctive geographical advantages and rich element resources, Y City has witnessed the rapid development of various undertakings, increasing economic strength, improving information infrastructure, rapid development of the information industry, and better environment for IT-based development in recent years, laying a solid foundation for smart city construction. However, Y City also faces a series of problems and challenges:

- Closed platforms and imbalanced development result in information silos, and information sharing and opening up lack intrinsic motivation or external regulation mechanisms.
- Overall planning and construction should be further improved due to poor IT-based coordination.
- IT infrastructure does not meet the development requirements, with a low level of intensive development and weak information security capabilities.
- Due to low investment in IT, Y City suffers a severe shortage of talents.

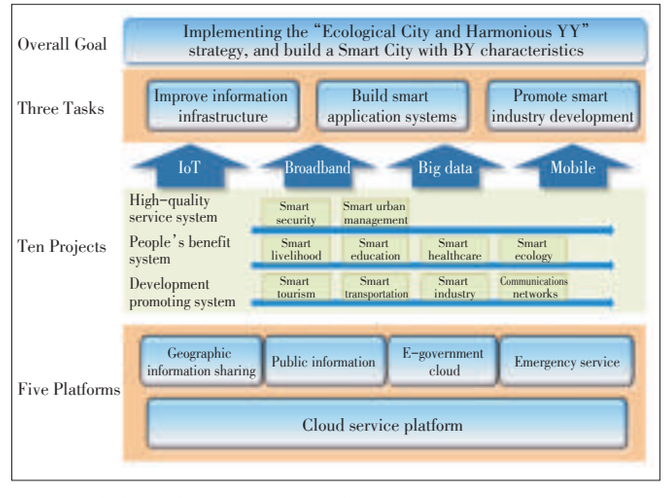
Based on its actual conditions and geographical advantages, with adequate research and demand analysis, Y City proposes the purposes of providing high-quality services, benefiting people, and promoting development, and the goal of enhancing the city's core competitiveness for smart city construction through "strategic management planning". Y City promotes the improvement and optimization of public infrastructure through spatial construction planning, determines to promote the transformation and upgrading of traditional industries and strategic development of the IT industry through economic development planning, and identifies to build an urban platforms for public services to achieve city-level information gathering and resource integration through technical support planning. In addition, Y city guarantees smooth implementation of the smart city through security planning and standards planning.

Y City uses the top-level design with "Integration of Four Plans", and formulates the framework of smart city construction, including three major tasks, ten major projects, and five key platforms (**Fig. 3**).

Based on the development strategy of "Ecological City, and Harmonious YY", in accordance with the general requirements for following an intensive, intelligent, green, low-carbon road of urbanization, with the goal of enhancing the city's core competitiveness, this top-level design promotes the application of the new-generation IT innovations, and boosts economy restructuring and social management innovation, providing important support and laying a solid foundation for build livable Y City with economic prosperity, social civilization, and beautiful environment.

To ensure the smooth implementation of the smart city, Y City starts from improving information infrastructure, building smart application systems, and promoting industrial development to lay a solid foundation for smart city construction, achieve standardized, accurate, and intelligent urban construction and management, and cultivate and develop emerging strategic industries, creating new economic growth poles.

To effectively promote citywide public resource sharing, achieve collaborative and efficient operations of people, logistics, information flow, and capital flow, and improve its operational efficiency and public services, by focusing on providing high-quality services, benefiting people, and promoting devel-



▲**Figure 3. Case of top-level design of a smart city.**

opment, Y City makes overall planning of ten projects, including smart security, smart urban management, smart livelihood, smart education, smart healthcare, smart ecology, smart tourism, smart transportation, smart industry, and smart communications networks.

To promote intensive construction of the smart city, and rational use of existing resources to avoid redundant construction, ZTE provides a full range of support for key projects of Y City through overall planning of five major platforms, such as the cloud service platform, geographic information sharing platform, the public information platform, e-government cloud platform, and emergency service platform, thereby raising the overall level of the smart city.

Through the top-level design of a smart city, starting from big data mining and applications, Y City implements online processing of all governmental activities, formulates citywide information resource data standards, launches information resource update, exchange, sharing, and opening-up policies and measures, and improves the governmental information resource catalog system and exchange system. In addition, Y City uses big data technologies for multi-dimensional analysis and judgment of economic and social development, to fully explore and enhance the value of data resources, and provide support for scientific prediction, correct decision-making, and quick processing. By improving appropriate security mechanisms for smart city development, such as accelerating urban information infrastructure and strengthening information security, Y City focuses on the construction of major smart application projects, and makes great breakthroughs in urban management and public services.

5 Summary

In general, smart city construction in China is still in the early and the exploratory stage. What is a smart city? How to build a smart city? Due to different understanding of these fundamental questions, many cities may encounter such problems as information silos, same images of different cities, and low degree of smartness during the smart city development. The root causes include management without collaboration due to lack of top-level design and overall planning, lack of innovations in systems and mechanisms, and potential network security risks. Some places even have the signs of muddy thinking and blind construction, and are therefore in urgent need of strengthening guidance. Based on overall needs for smart city development, through the top-level design concepts and methodology of smart city with "Integration of Four Plans", we should integrate and coordinate all resources from top to bottom, identify the relationships between all tasks, and design the implementation path systematically to ensure healthy and sustainable development of the smart city.

References

[1] B. Qiu, *Research Report on Development of Smart Cities in China (2012–2013)*. Beijing, China: China Architecture and Building Press, 2013.
[2] D. Cheng, *Introduction to the Top Design of Smart City*. Beijing, China: Science Press, 2012.
[3] J. Wang, C. Li, Z. Xiong, and Z. Shan, "survey of data-centric smart city," *Journal of Computer Research and Development*, vol. 51, no. 2, pp. 239–259, Feb. 2014.
[4] Y. Wang, "Smart city top-down design," *ZTE Technology Journal*, vol. 20, no. 4, Aug. 2014.

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