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Government Affairs Service Platform for Smart City

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***Abstract*—Using a 3D geographical information system (GIS) and cloud computing, a new government affairs service platform is presented. To manage and use the city's data efficiently, the 3D analysis and visualization of the city's information are held on the platform of the smart city. With the new platform, a series of e-government services can be conducted to manage the makers and operation supervisors in the government agencies and other smart city industries, such as urban disaster and environmental protection, intelligent transportation, monitoring and evaluation of the urban resource centers. All services presented on the platform are extracted from the government departments' practical demand.**

Keywords: WebVRGIS, Smart City, GIS, e-Government, Cloud Computing

I. INTRODUCTION

THE cities' growth provides a new dimension in the city management.[1] The e-government can help bridge the gap between the government and the citizens, which can reduce the conflict between both parties.[2] The municipal applications of geographic information system (GIS) across the different countries showcase the potential use of GIS in the e-government agencies such as property management, traffic, and transportation, urban planning, waste management, urban design and renewal, financial resource mobilization, etc.[2] The territory plays a decisive role in the allocation of the financial, technological, and human resources. With this, the optimization of the infrastructure planning and health resources and the combination knowledge is important [3]. The GIS uses can provide the urban services and identify the related solutions.[4] GIS, apart from contributing to data integration from the different data sources, enables data visualization using the maps, which enhances the system usability and assists in the decision-making process [5]. In GIS tool presentation, it involves a new spatial visibility into the transparency of state activities, makes the activities of the public administration transparent to all citizens, and contributes the e-democracy evolution.[7] The web and GIS technologies-based e-government system can promote the dissemination of urban information and enable the citizens to register objections to the land use plan during the different phases of the planning process, along with responding to those objections.[6] Public Participation GIS (PPGIS), which broadly refers to the citizen participation in enhancing the public services and decision-making using the GIS, is a main theme of GIS research [7]. Although e-government scholars are centrally interested in enabling e-democracy, there is a dearth of public administration literature on allowing public participation using GIS technology [8]. The advancements have widened GIS' accessibility from the domain of the expert users to the lay citizens [9]. Some cases that employ GIS for urban planning have been shown, e.g. Sweden [10], Italy [11], UK [12], Canada [13], USA [14], and so on [15]. The 3D GIS provides a visual presentation and is used as a real 3D tool -for both queries by using a 3D model and visualizing geoinformation in 3D [16]. Our previous work based on WebVRGIS engine [17], which is WebGIS, 3D GIS and PPGIS, have proved the usability of 3D GIS for information management of e-government [18], including 3D interactive system for transportation [19], underground [20], water resources [21], virtual community [22]. By integrating the friendly interactive interface of Virtual Reality System and spatial analysis specialty of GIS, WebVRGIS is preferred in practical applications, especially in the geographical and urban planning. The contribution of this paper is proposing top design of a government affairs service platform which sufficiently uses GIS and cloud computing technologies to provide a service for facilitating and handling government affairs of a smart city.

The urban areas are in good position to avail the services of e-governance as they all have the required infrastructure. While in rural areas, the biggest problem is the non-availability of the necessary infrastructure and the lack of computer awareness among the citizens. Cloud computing can be an effective solution in the future to fulfill those needs, [23] which would be intelligent and accessible to all. [24] Also, e-government must be built on a fluid and constantly adapt to the collaborative governance systems that respond to the twin challenges of external alignment and internal integration and cooperation [25], and a cloud context is a good solution for this demand. So far, implementation of cloud computing based e-governance is still a challenge that needs to be given emphasis by the government. [26] All kinds of city devices and sensors are considered as part of the e-governance system [27].

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Cloud computing and Internet of Things (IoT) have led the urban management into the intelligent stage from the digital stage. As a functional core of the future city, cloud data centers have been constructed on large scales in different regions. Also, in view of the emphasis on hardware, the neglect of software, and the deficiency of application, it is urgent to develop the products in the field of cloud computing, cloud storage, and cloud service with the independent property, establishing specialized urban cloud platform, and carrying out industrialized applications. Based on the previous research and developments, this platform has created a smart city with 3D management service software platform based on cloud architecture. Focused on different fields such as public transportation, municipal pipe network, environmental protection, disaster prevention, and public information, the platform is applied through productization and industrialization.

The cloud data center of smart city space integrates facilities, platforms, and applications. It is aimed at comprehensive, practical, and integrated solutions for urban planning, construction, and management services. Compared with the other cloud architectures in the past, its unique characteristics and advanced nature are mainly embodied in the earth's 3D space cloud government affairs platform development (multisource data acquisition, cloud computing, and cloud services) similar to Google Earth, including the items as follows. The platform architecture is in Figure 1.

a) The advantage in the integration of software, hardware, and application. The super cloud is taken as the core for GIS, GPS, RS (3S), IoTs, video data, and data mining.
b) The multi-access method of spatial data (3S, surface live-action scanning, underground acoustic detection, sensor networks, and IoTs).
c) 3D visualization system.
d) Autonomous and open spatial cloud application system.
e) Excellent data mining and spatial analysis function.
f) Electronic government affair functions and the leading end customization aimed at the demands of the different industries.

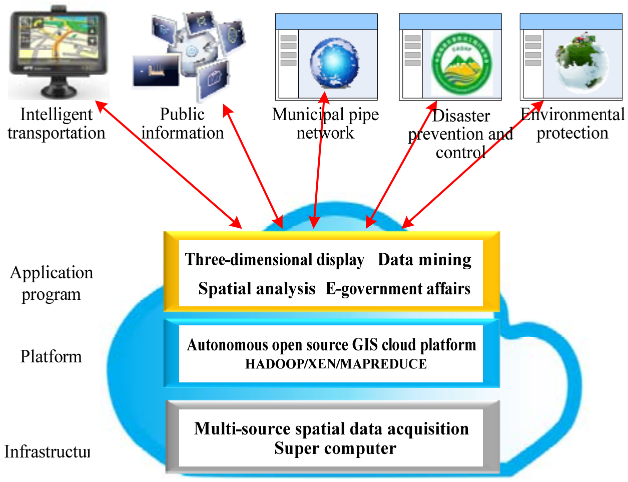

Figure 1. Platform architecture

II. SIGNIFICANCE

A. Background

1) Digital city is the spatial support of the smart city.

About 80% of the development of the modern cities is related to the geographical space location. The spatial support of the smart city is the digital city. For a city, a digital city is a geographical environment, the commanding system of the efficient operation, the infrastructure, and the simulation system. Some cities began to transit from digital city to smart city. For example, the transition from the e-government affair management to the government affair IoTs' application management should take advantage of the constructing and constructed resources of IoTs, promoting the popularization and application of government affairs, and improving the administrative efficiency of the government. This includes integrating the existing and upcoming construction sensor network and information network data of the urban operation and management, achieving the automatic data exchange and sharing of the government investment facilities and information system, relying on the e-government, enhancing the official urban management and service, and achieving data sharing, collaboration, and openness. The transition from digital city to smart city is also an inevitable choice to solve the global sustainable development crisis.

2) Significance of 3S technology

3S technology refers to the general term of GIS, global positioning system (GPS), remote sensing (RS) technology. The construction of the digital city and smart city need the support of the urban basic geographic information database based on 3S technology. In the different fields of the smart city, 3S technology makes the intelligent applications in traffic, urban management, and other related fields. This makes 3S technology to be widely used in public and professional applications.

3) Smart city is an inevitable development

In the past 20 years, the city information construction has experienced two stages of information port and digital city. Currently, it is being developed toward the stage of a smart city. These stages serve as a link between the past and future as they go forward one at a time. At the stage of information port, the main resources of city information construction are used in the construction of macro information infrastructure, such as bandwidth expansion and network construction. At the stage of a digital city, the main resources of the construction of city information are used in the database development and the internet application. Digital city is aimed at attaining numerous works in the real world through the computer network. At the stage of a smart city, the main resources are used in making the urban information network to achieve automatic monitoring, information collection, analysis and processing, and decision-making response. A smart city is derived from and surpasses the digital city.

4) Smart city = Digital city + Internet of things

A new round of information technology revolution represented by IoTs and cloud computing provided an important technical basis for the development of information technology toward intelligence. The smart city refers to making full use of the information technology through the construction of information and communication technology (ICT) infrastructure, certification, security platform and to accelerate tackling problems in key technologies, constructing the intelligent environment for urban development, and forming new modes of life, industrial development, and social management based on the mass information and intelligent filtering processing, and establishing new urban form. Digital city is a 3D description of the city with multi-resolution, multi-scale, multi-space time and multi-species. The IoTs connect any items with the internet through the information sensing equipment based on the agreed protocol to achieve information exchange and communication and realize intelligent identification, positioning, tracking, monitoring, and management. A smart city could be achieved by combining digital city and IoTs.

5) Cloud computing

Cloud computing and IoTs are the foundations of the smart city. The former takes charge of the storage, operation, decision-making, and command, while the latter assumes the function of information collection and automatic control. A smart city is bound to take the cloud computing center as the core and carrier. Cloud computing determines the urban construction and management capability and regional competitiveness in the future. The design of cloud computing based on the e-government platform is in Figure 2.

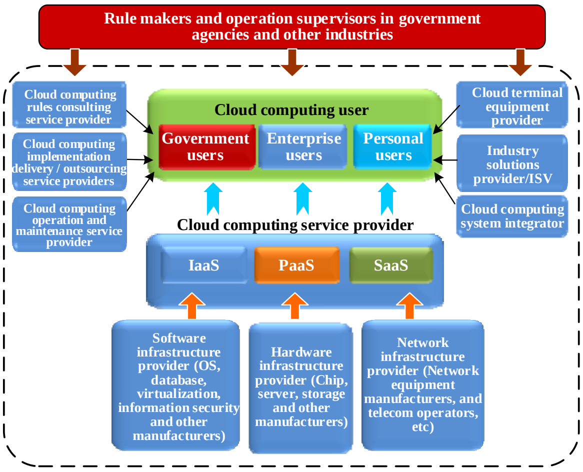

Figure 2. Cloud computing based e-government platform

B. Significant issues

Many cities have faced many problems in building a smart city. These are mainly manifested as follows. (i) Currently, the establishment of various types of urban basic database lacks effective organization and management, which leads to a serious information isolated island. Also, each application system needs to access the heterogeneous data and other non-spatial data distributed in multiple data sources. These have become serious obstacles to the construction of a smart city. (2) Various types of urban business system software and hardware platforms are not uniform and need further integration. (3) It is difficult to reuse the heterogeneous resources of the application system. The realization cost of city business logic function is large, which gives rise to the serious resource waste.

Cloud computing technology uniformly manages and schedules a great number of computing resources of network connections, which simplify the application deployment and management effectively. With the continuous deepening of the construction of a smart city, cloud computing service technology has been introduced. It is necessary to establish basic information supporting the platform which could efficiently manage urban information resources and meet the demands of all kinds of applications and services. It is the development trend to construct a smart city that is dependent on the cloud computing service technology. The existing support tools of a smart city include the information acquisition terminals, network infrastructure, and information processing, which have the following three major advantages:

1) Realize data sharing, establish multi-source, multi-temporal, and multi-scale 3D digital city cloud services platform, achieve data information sharing, information exchange, and refrain from repeated data collection.

2) Be conducive to the popularization and development of a digital city. After the adoption of cloud computing service platform, small and medium cities only need to rent the appropriate services, rather than buying the hardware and software facilities.

3) Achieve open innovation effects. Cloud service platform enables the system to provide services through the internet. The low cost and scale effect of the cloud service platform have increased the popularization of the system, expanded the source of information, and innovatively create more abundant applications of a smart city.

The use of 3D smart city cloud service platform has changed the traditional management and decision-making methods and promoted the harmonious development of the city.

1) Establish, improve, and integrate the dynamic and efficient spatial basic data frame system of a digital city to meet the needs of integrated storage and management of urban mass spatial information.

2) Realize the dynamic scheduling, real-time visualization, retrieval of temporal and spatial information, and the analysis of spatial data model in the cloud service environment, so as to provide data sharing and service interface for other applications.

3) Establish 3D digital city network information system, fire protection information system, tax information system, public information system, and other demonstration applications in the cloud service environment.

C. Related work

1) Smart city

Many different countries and governments worldwide have put forward a plan to change the urban future development by relying on the internet and IT. The United States has proposed the national information infrastructure (NII) and the global information infrastructure (GII) programs. Dubuque of Iowa in Middle West and IBM will jointly establish Dubuque into the first smart city in the United States, which could connect all the city resources. It can detect, analyze, and integrate all kinds of data, make intelligent responses, and serve the demands of the public and EU Committee incorporating information and communications technology into the focus of strategic development in Europe in 2020, and formulate *Internet of Things Strategic Research Roadmap*. The smart city's construction in Sweden has been significantly embodied on the transport system. It reduces traffic stream, lower traffic congestion and queuing time, and decrease exhaust emissions by charging "road congestion tax." In the Smart Bay project in Galway Bay of Ireland, the system gets information from the sensors mounted on hundreds of buoys to avoid the wreckage of fishing boat crash, sending flood warnings and carrying out C2B sales.

In Asia, Japan launched, "The I-Japan (wisdom Japan) strategy 2015," integrating digital information technology in every corner of the production and life and focus on the three major public utilities of the e–government's governance, health information services, and education and personnel training. Inchon of South Korea collaborated with the United States CISCO Systems, Inc. Through the integrated public communication platform, consumers can easily realize the remote education, medical treatment, and tax administration. Singapore introduced, "The Smart Country 2015" program, which would last for 10 years. It strives to realize the transition from the supply side leading to the two-way interaction between supply side and demand side in some public service areas through IoTs and other information technology in the smart process. In China, the construction of smart city initially analyzes the top-level design such as standard specification and related solutions of the city. Then, the application is developed based on the needs of the various industries and conduct studies in the major cities such as Beijing, Shanghai, Shenzhen, and Wuhan.

2) Cloud computing

Cloud computing has led to the transformation of the traditional e-government. The United States' federal government CIO set up a working group of cloud computing and appointed a cloud computing CTO to coordinate the cloud computing industry and the government's IT services. British Digital UK Report proposed to "Raise government cloud G-Cloud". In the past, the government has gained many benefits from the ICT service. Cloud computing will become part of the ICT industrial policy in various countries in the future.

III. TECHNOLOGY FOUNDATION

Based on GIS, RS, GPS, Digital Terrain Model (DTM), virtual reality, 3D modeling, large spatial database and other key technologies, the platform makes full use of the existing information infrastructure conditions and geographically spatial data resources. It integrates the urban natural resources and spatial geographic information and the related economic and social information to set up a multi-scale and multi-resolution spatial foundation database with timely updates, and construct a spatial information exchange and sharing online service system. With this, a 3D GIS scene within the scope of an urban area is established. Based on the 3D GIS, the business system of relevant industry application sector is developed to make it the basic information platform of digital city space, and integrate the core professional application system of the spatial information resources.

Based on this platform, the high-performance spatial information cloud computing and analysis mining are taken as the means to carry out basic application studies and application engineering construction related to digital city and smart city. This could provide the spatial information technology support for urban safety, environment, transportation, health and other livelihood areas and promote the development of the new social space information services industry.

A. 3D smart city cloud platform

As a multi-source, multi-space time and multi-scale urban spatial data management platform, it establishes a new cross-industry, cross-department, and cross-platform data sharing mode to achieve the information exchange and sharing among the multiple fields. Aside from the city pipe network, fire protection, and taxation, the platform can also be applied in the urban facilities supervision, urban traffic regulation, and the social public service so as to enhance the urban management and service functions.

The previous 3D digital city system has the problems of data dispersion, difficulty in effective data integration and reuse, which leads to serious resource waste. Depending on IoTs, cloud computing and other new technologies, this platform effectively integrate with 3D digital city service platform based on 3D GIS technology. It effectively integrates the basic information of all kinds of urban resources and spatial geography, establishes the multi-source, multi-space time and multi-scale information database, and develops the business application in related industry. Also, a reliable, efficient and shared 3D smart city cloud service platform is established to effectively integrate data resources and functional resources, serve the governments, enterprises, and the public, and guide the sustainable development of population, resources, and environment, economy and society. The platform has achieved favorable test application effect in the digital city, as shown in Figure 3.

Figure 3. 3D city interface

The bottom layer of the cloud platform includes Xen and PowerVM virtual Linux operating system mapping and Hadoop parallel workload arrangement, which are different from the previously distributed platform. It could ensure the best performance based on the demand through the management server. The cloud computing, including the ability of cloud application, is adequately used by means of software that can allocate resources in real time across multiple servers. Through the Web services based on SOA, it could integrate with their existing IT infrastructure, as shown in Figure 4. The 3D GIS provides a friendly and intuitive interface, as shown in Figure 5.

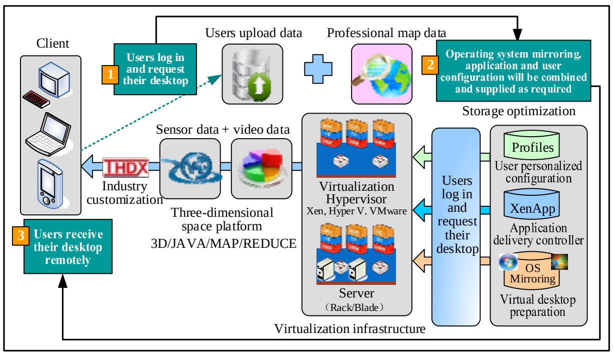

Figure 4. City data flow in cloud computing

Favorable performances can be obtained by applying virtualization technology to the cloud computing platform, including (1) It can dynamically locate the computing platform to the needed physical platform. (2) Computational nodes of the multiple virtual machines with light weight could be merged into the same physical node. (3) Through the dynamic migration of the virtual machine on the different physical nodes, the load balancing performance irrelevant with the application can be taken. (4) The deployment is more flexible, namely: the virtual machine can be deployed directly to the physical computing platform.

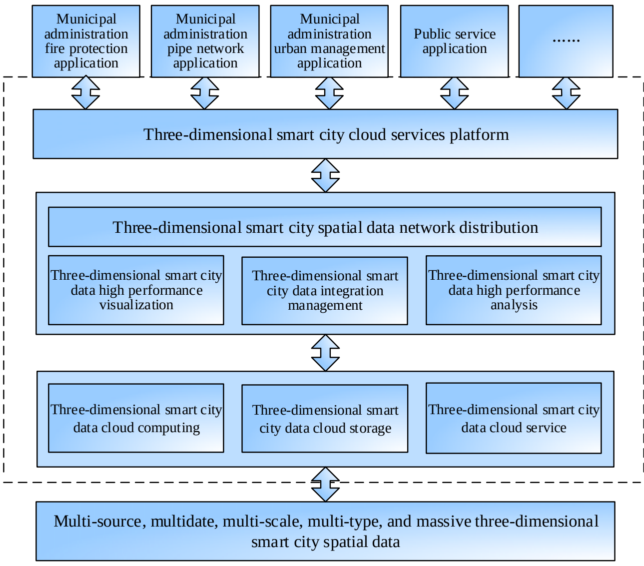

Figure 5. 3D GIS-based smart city cloud computing platform

B. Urban disaster and environmental protection

The platform carries out research and development, and practice that focus on the demands of urban environmental monitoring, planning and early warning of the natural disasters. Based on the extensive observations, analyses and abstractions of a huge number of geographical phenomena and processes, it solves the mathematical expression and scale theory of the process numerical analog computation. According to different types of geosciences, the basic theory of process numerical analog computation model construction and "data－model－system－expression" integrated urban resources and environment monitoring and disaster early warning methods. With the support of the high-performance computing environment, the solution to the process numerical analog computation is realized.

1) Data assimilation and integration of resources and environment

Multi-source data acquisition equipment provides abundant data for environmental monitoring and disaster warning. However, the information provided by the data is redundant, complementary and cooperative. Data integration is an effective method for the collection of multi-source data, which processes the information from different data sources in the same area as multi-source data complementarily. Effective data integration technology can reduce the data redundancy and improve the data reliability, which is of great importance for the government's data analysis, mining, and management.

2) Research on numerical prediction technique for parallel computation of disaster process

The space-time process model is the core of the disaster simulation. It can improve the accuracy of the monitoring model in the evolution process of the earth's surface to develop assimilation method for the development of space, sky and earth observation data, introduce space-time process model, and study the assimilation of the multi-source data and space-time process model of disaster. Cloud computing can effectively reduce the time of disaster simulation and forecasting process and make it possible to forecast the disaster timely and accurately.

C. Intelligent transportation

3S technology provides the necessary theoretical and technical support of acquisition, processing, analysis and visualization of the spatial data and traffic information for Intelligent Transportation System (ITS). GIS for Transportation (GIS-T) is the expansion of geographic information system technology in transportation. It is also an important foundation to build the intelligent transportation system.

By the advantages of 3S technology in the processing and analyzing basic geographic data, network data, and other spatial data, reasonable organization, management and release of traffic information will be conducive to improving the operational efficiency of the traffic system and reducing the incidence of traffic accidents. The people's trip rules in different periods and regions could be obtained by analyzing traffic information and traffic data mining. This provides support for traffic management department in traffic planning, guidance and flow forecasting, and theoretical basis for relieving traffic congestion.

RS is applied in the acquisition and update of the traffic data. The real-time geographic data could be acquired through feature extraction, change detection, target recognition and multi-source data integration of high resolution and large scale images, which are also used for updating basic geographic information, including road network. By combining GIS and network technology, the dynamic monitoring of vehicles and road network, the rapid response and processing of emergency events are realized. Relying on road network information, traffic flow is predicted, and combined with the historical and real-time dynamic traffic information.

The vehicle locations are obtained in real time by vehicle terminal and wireless network to provide traffic information service related to the locations or implement decision support based on the user demands. The traffic information service could provide service for the vehicle terminal users. Also, with the integration of the commercial network information, traffic information, atmospheric information and other spatial information, it will provide more powerful, comprehensive, and user-friendly information services for all users.

D. Monitoring and analysis of urban resource change

RS technology is used to study the dynamic monitoring of urban expansion and the urbanization process. The comprehensive application of RS and GIS will effectively monitor the illegal construction behaviors. In the typical architectural change, the Interferometry Synthetic Aperture Radar (InSAR) technology is used to describe the characteristics of back-scattering and interference of the object-oriented architecture. Then, a multi-date SAR urban change detection is established to efficiently and reliably extract urban land use/coverage change information. Finally, according to the urban planning map and the vector change classification map generated from the change detection, GIS technology data processing function and spatial analysis ability, and the attribute information inquiry method are employed to analyze, identify, and eliminate the false of the changed targets so as to determine the illegal buildings.

E. Dynamic monitoring and early warning of urban environment

The data of different resources and environment on the ground collected by the automatic monitoring system and various RS monitoring data are integrated to form the sky-earth integration monitoring means. In this way, a variety of resources and environmental issues could be conducted with multi-scale and multi-angle integrated analysis and monitoring, which ensure the effectiveness and accuracy of the monitoring results. Based on the distributed computing technology, the real-time processing of large data will be solved effectively to ensure the timely discovery of the relevant environment and resource problems, form a fast and effective solution, and reduce the impacts and losses. The resource and environment status display technology based on GIS 3D expresses relevant resources and environmental issues more vividly, and provides a more intuitive interactive interface for the relevant analysis of the personnel and decision makers, as shown in Figure 6.

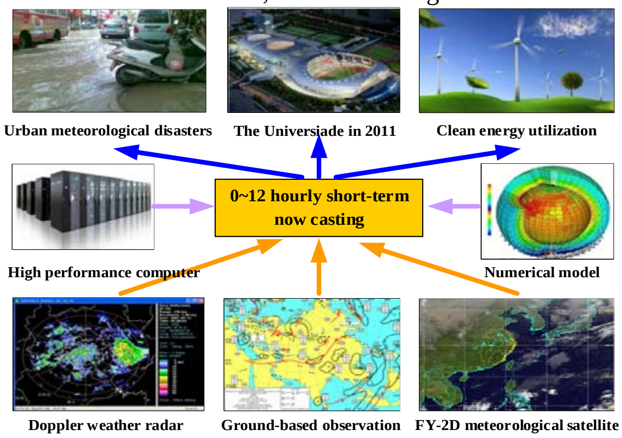

Figure 6. Urban meteorological monitoring

F. Marine environmental monitoring

The small unmanned aircraft is used to establish a professional multi-spectral monitoring system, unmanned aerial vehicle ocean remote sensing data transmission system and RS data processing system. Also, technology and modular application software are developed for real-time and long-term monitoring of marine disasters, such as red tide and oil spilling. RS technology monitors the condition of the coastal zone and the ocean. In the meantime, the information such as ocean surface temperature, surface height, and wind currents will be used in the spatial database. Once the oil spills, red tide, and other disasters can occur, and experts can predict the movement direction, development trend and damage degree of oil spilling and red tide. Also, it could provide information services for urban marine resources, meteorology, environmental monitoring, management, and decision-making.

G. Urban geological hazard monitoring and early warning

In monitoring and early warning of urban geological disaster and linear features and large area surface deformation, it is planned to use satellite remote sensing, satellite positioning, and optical fiber sensing network technology to achieve multi-scale, 3D (surface and subsurface), high precision, real-time, and dynamic monitoring, safety assessment and early warning for the earth's surface deformation. In a total of six major geological disasters of the two types, namely: displacement of rock and soil, including collapse, landslide, and debris flow, and ground deformation, including ground subsidence, and ground fissure, research and development are carried out for the different models of pressure sensors and displacement sensors. Monitoring and early warnings are conducted for the urban geological hazards and linear surface features and the large area surface deformation, which could provide information services for urban survey and design, construction planning, disaster reduction and disaster prevention, management, and decision-making departments, as shown in Figure 7.

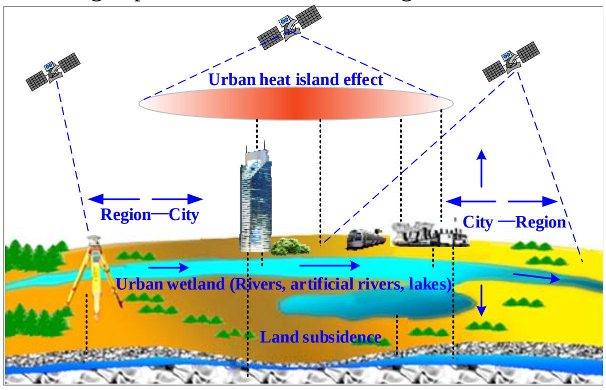

Figure 7. Space, sky, and earth integrated environmental monitoring

H. Numerical simulation of water disaster

The integrated disaster calculation and analysis platform based on IoTs and cloud services attain the collection and processing of multi-source data (high-performance physical information extraction). These provide information services for urban water resources, water conservancy, disaster reduction and disaster prevention, management and decision-making departments, as shown in Figure 8. Also, to carry out short-term, and objective forecast, the mesoscale numerical values such as Weather Research and Forecasting (WRF), Global/Regional Assimilation Prediction System (GRAPES), and Local Analysis and Prediction System (LAPS), and the analytical prediction mode are run on a high- performance computer to evaluate the quality of each model forecast based on several numerical tests.

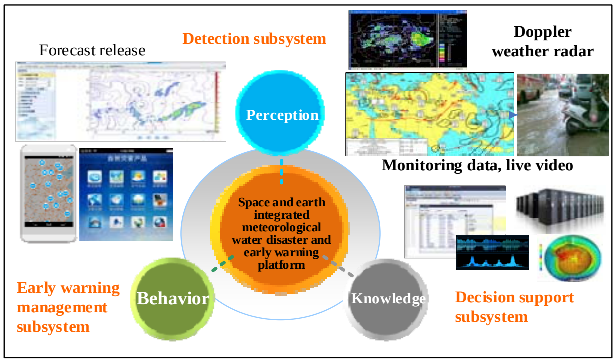

Figure 8. Space and earth integrated meteorological water disaster and early warning systems

I. Emergency evacuation simulation

The cross-sectoral, cross-regional, and cross-disciplinary professional data sources distributed in each institution, organization, and individuals are collected and integrated. Also, the main database is constructed for these discretely distributed data resources to form the physically distributed rescue resource GIS database and rescue service database integrating relevant field resource information through the internet. A simulation model of population evacuation based on 3D expression and a full range of emergency evacuation simulation platform are established to further calculate rescue resource allocation scheduling.

IV. CONCLUSION

A smart city is a new round of the informatization in the current world [28]. The sensors are installed in the urban power grid, roads, buildings, pipelines, and other infrastructure to connect into IoTs and combine with the internet. In this way, the interconnection between human society and an urban physical system could be realized. Also, through the establishment of cloud computing center, the personnel, machines, and devices are efficiently managed and controlled to subtly and dynamically manage the urban production and life, and achieve the wisdom state. As a result, it could enhance resource utilization and productivity quality, improve the urban environment and promote the global sustainable development. This paper proposed a government affairs service platform which sufficiently uses GIS and cloud computing technologies to provide a service for facilitating and handling government affairs of a smart city. In future, the system will be implemented according to the top design.

REFERENCES

[1] Nikolova, M., "Spatial Information and GIS for Smart City," in *Conference for E-Democracy and Open Government*, may. 2014, pp. 585.

[2] Lewis, M. P., Ogra, A., "An approach of Geographic Information System (GIS) for Good Urban Governance," in *2010 18th International Conference on Geoinformatics*, IEEE, June. 2010, pp. 1-6.

[3] Jim, A. F., Rosas, J. D. C., & Mar, J., "Geospatial model e-health planning collective intelligence," in *2016 Third International Conference on eDemocracy & eGovernment (ICEDEG)*, IEEE, March. 2016, pp. 121-125.

[4] González-Jaramillo, V. H., "Use of Geographic Information Systems with open source solutions, an approach to access eDemocracy & eGovernment," in *eDemocracy & eGovernment (ICEDEG), 2015 Second International Conference on IEEE*, April. 2015, pp. 7-8.

[5] De Souza Baptista, C., Leite Jr, F. L., da Silva, E. R., Etal, "Using open source GIS in e-government applications," in *International Conference on Electronic Government*, Springer Berlin Heidelberg, August. 2004, pp. 418-421.

[6] Díaz, P., Parapar, J., Touriño, J., Et al. "Web-GIS based system for the management of objections to a comprehensive municipal land use plan," in *Proceedings of the 7th International Conference on Politics and Information Systems, Technologies and Applications, PISTA*, 2009, pp. 145-150.

[7] Ganapati, S, "Using geographic information systems to increase citizen engagement," *IBM Center for the Business of Government*, 2010.

[8] Ganapati, S, "Uses of Public Participation Geographic Information Systems Applications in E ‐ Government," *Public Administration Review*, Vol. 71, no.3, pp. 425-434, 2011

[9] Ganapati, S, "Public participation geographic information systems: a literature survey," in *Comparative e-government*, *Springer New York*, pp. 449-466, 2010.

[10] Narooie, M, "Boosting Public Participation in Urban Planning Through the Use of Web GIS Technology: A Case Study of Stockholm County," *KTH ROYAL INSTITUTE OF TECHNOLOGY*, 2014.

[11] Selicato, F., Maggio, G., & Mancini, F,. "GIS to support environmental sustainability in manufacturing areas. case study of the apulian region in southern italy," In *International Conference on Computational Science and Its Applications*, Springer Berlin Heidelberg, March. 2010, pp. 210-223.

[12] Beaumont, P., Longley, P. A., & Maguire, D. J., "Geographic information portals—a UK perspective," *Computers, environment and urban systems*, vol. 29, no. 1, pp. 49-69 , 2005.

[13] Johnson, P. A., & Sieber, R. E., "Motivations driving government adoption of the Geoweb," *GeoJournal*, vol. 77, no. 5, pp. 667-680, 2012.

[14] Cavallo, S., Lynch, J., & Scull, P., "The digital divide in citizen-initiated government contacts: A GIS approach," *Journal of Urban Technology*, vol.21, no.4, pp. 77-93, 2014.

[15] Ricker, B. A., Johnson, P. A., & Sieber, R. E., "Tourism and environmental change in Barbados: gathering citizen perspectives with volunteered geographic information (VGI)," *Journal of Sustainable Tourism*, vol. 21, no. 2, pp. 212-228, 2013.

[16] Bodum, L., & Jernes, N., "Design of a 3D virtual geographic interface for access to geoinformation in real time," *CORP 2004: Treffpunkt der plannerinnen: 9. internationales Symposion zur Rolle der IT in der und für die Planung sowie zu den Wechselwirkungen zwischen realem und virtuellem Raum*, 2004, pp. 351-357.

[17] Lv, Z., Yin, T., Song, H., & Chen, G., "Virtual Reality Smart City Based on WebVRGIS," *IEEE Internet of Things Journal*, 2016.

[18] Lv, Z., Li, X., Zhang, B., Etal, "Managing big city information based on WebVRGIS," *IEEE Access*, vol. 4, pp. 407-415, 2016.

[19] Li, X., Lv, Z., Wang, W., Etal, "WebVRGIS based traffic analysis and visualization system," *Advances in Engineering Software*, vol. *93*, pp. 1-8, 2016.

[20] Zhang, X., Han, Y., Hao, D., Etal, "ARGIS-based Outdoor Underground Pipeline Information System," *Journal of Visual Communication and Image Representation*, 2016.

[21] Su, T., Cao, Z., Lv, Z., Etal, "Multi-dimensional visualization of large-scale marine hydrological environmental data," *Advances in Engineering Software*, vol. *95*, pp. 7-15, 2016.

[22] Lu, Z., Réhman, S. U., & Chen, G., "Webvrgis: Webgis based interactive online 3d virtual community," in *Virtual Reality and Visualization (ICVRV), 2013 International Conference on IEEE*, September. 2013, pp. 94-99.

[23] Khare, A. B., Raghav, V., & Sharma, P., "Cloud computing based rural e-governance model," *Journal of Information and Operations Management*, vol.3, no.1, pp. 89, 2012.

[24] Mukherjee, K., & Sahoo, G., "Cloud computing: future framework for e-Governance," *International Journal of Computer Applications*, vol. 7, no. 7, pp. 31-34, 2010.

[25] Allen, B. A., Juilett, L., Paquet, G., Etal, "E-government as collaborative governance: structural, accountability and cultural reform. Practicing E-Government: A Global Perspective," Hershey, PA, USA: Idea Group Publishing, 2005, pp. 1-15.

[26] Aziz, M. A., Abawajy, J., & Chowdhury, M., "The Challenges of Cloud Technology Adoption in E-government," in *Advanced Computer Science Applications and Technologies (ACSAT), 2013 International Conference on IEEE*, December. 2013, pp. 470-474.

[27] Kleanthis, D., Aristeidis, C., & Despoina, P., "Transforming Vehicles into e-government'Cloud Computing'Nodes," in *Global Security, Safety and Sustainability & e-Democracy*, Springer Berlin Heidelberg, 2012, pp. 1-8.

[28] Latre, M. Á., Lopez-Pellicer, F. J., Nogueras-Iso, J., Et al, "Spatial Data Infrastructures for environmental e-government services: The case of water abstractions authorizations," *Environmental modelling & software*, vol. 48, pp. 81-92, 2013.

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Shengzhong Feng

- Using a 3D geographical information system (GIS) and cloud computing.
- The 3D analysis and visualization of the city's information are held on the platform of the smart city.
- With the new platform, a series of e-government services can be conducted to manage the makers and operation supervisors in the government agencies and other smart city industries.