# Application Model for the Internet of Things in Government Statistics

**Lianli Guo***

Shaanxi Radio and Television University, Xi'an, Shaanxi, China

*Corresponding Author

**Keywords:** Internet of Things, Government Statistics, Application Mode, Architecture

**Abstract:** as an Important Part of the Emerging Information Technology, the Internet of Things (Iot) Integrates Information, Communication, Sensors, Automatic Control and Other Technologies. At Present, the Internet of Things Technology Has Been Successfully Applied to a Variety of Service, Industrial and Consumer Markets, and Gradually Extended to the Field of Government Statistics, Bringing Innovative Opportunities for Collection Means and Processing Methods during Operations. Aiming At the Integration of the Internet of Things and Government Statistics, Starting from Analysis on Basic Framework of Iot, This Paper Generalizes about Perception Layer, Transmission Layer, Support Layer and Application Layer of the Internet of Things, and Puts Forward the Application Mode of the Internet of Things for Data Collection, Aggregation, Processing and Services in Government Statistics. Consequently, a Government Statistical Architecture Integrating Technical Features of the Internet of Things, Application of Massive Data and Operation of Government Statistics is Formed.

## 1. Introduction

Internet of Things/Iot is an Intelligent Network with Network Technology as Its Core, Which Integrates Radio Frequency Identification, Wireless Sensor Network, Artificial Intelligence, Pattern Recognition, Automatic Control, Mechanical Engineering and Other Technologies, and Connects All Kinds of Objects in Accordance with Certain Protocols and Rules to Exchange Information. Since *Itu Internet Report 2005: the Internet of Things* Was Published by Itu, the Internet of Things Has Come into people's View. It Has Been Called the Third Wave of Information Industry after Computer and Mobile Communication Network, Which Has Attracted Enough Attention from All Countries in the World. in 2009, under the Initiative of Barack Obama, the United States Officially Launched the Development Strategy of the National Internet of Things, and Its National Science Foundation Also Formulated the Research Plan of Sensor Networks, Namely the Core Component of the Internet of Things. in 2015, the European Union Established the Alliance for Internet of Things Innovation, Which Brought Together the Internet of Things Technology and Resources of Eu Member States to Create the European Internet of Things Ecosystem, and Proposed 12 Key Technologies and 18 Key Application Areas of the Internet of Things. in the Same Year, Japan Also Established the Internet of Things Acceleration Consortium, Focusing on Solving the Problems during Technology Development and Application in the Internet of Things. in Addition, the United Kingdom, France, South Korea and Other Countries Have Also Incorporated the Internet of Things into the Scope of the Information Industry, and Established an Intelligent Network [1]. China Started Early in the Development of the Internet of Things. the National Natural Science Foundation of China, the 863 Program (National High-Tech r&d Program) and the 973 Program (National Basic Research Program of China) All Fully Supported the Internet of Things Technology. the Development of Technology and Standards Basically Synchronized with the International Development. in Addition to the Establishment of Sensor Information Centers, China Has Also Written the Internet of Things into the 13th Five-Year Plan, the Strategic Emerging Industry Development Plan and the Report on the Work of Government. Premier Li Keqiang of the State Council Emphasized the Extensive Application of Large Data, Cloud Computing and the Internet of Things in the Report on the

  DOI: 10.25236/ISMHI.2019.096

Work of Government 2016. in Recent Years, the National Development and Reform Commission Has Supported 28 National Demonstration Projects of Major Applications of the Internet of Things. the Industry of the Internet of Things Has Achieved the Scale of about 750 Billion Yuan in Wuxi, Hangzhou, Chongqing and Fujian. Relevant Scientific Research Institutions Have Also Made Great Progress in Wireless Intelligent Sensors, Network Communication Technology and Mobile Base Station Services.

At Present, Iot Has Entered the Public Management and Service Market Dominated by Government Public Services, the Industry Market Dominated by Enterprises and the Consumer Market Dominated by Individuals and Families. It Has Been Successfully Applied to Civil Aviation, Transportation, Agriculture, Environmental Monitoring, Smart Grid and Other Fields [2]. Also, Its Acquisition Means, Processing Methods and Data Results Have Brought New Opportunities for the Improvement of Government Statistical Ability, and Strongly Promoted Experts and Scholars to Study Subjects Related to Internet of Things and Government Statistics. in Foreign Countries, Researches Are Mainly Focused on Data Quality, Security, Aggregation and So on. Considering the Issue of Equipment Vulnerability and Data Anomaly, Mäkinen (2015) [3] and Karkouch (2016) [4] Respectively Discussed the Quality of Data Acquisition in the Internet of Things. Zimos (2016) [5] Used Compressed Sensing and Edge Information to Present the Data Aggregation Mechanism of the Internet of Things. Aiming At the Practical Application, Aljubairy (2016) [6] Carried out a Real-Time Investigation and Study of Aircraft Flight Delay Based on the Internet of Things. in Addition, Riga (2017) [7] Also Discussed Data Security from the Perspective of Network Attacks. Compared with Foreign Research, Domestic Research is More Closely Related to Government Statistics, Mainly from the Impact of the Internet of Things on Government Statistics, the Improvement of the Collection Process, the Rich Data Resources and Other Aspects. Shortly after the Rise of Internet of Things Technology, Ma Jiantang (2012) [8], Director-General of the National Bureau of Statistics, Put Forward the Guideline on Strengthening the Innovation of Government Statistics by Internet of Things Technology. Cong Yajing (2014) [9] Believed That the Rapid Development of Modern Information Technology Such as the Internet of Things Had Made Data Grow in Geometric Series, Resulting in the Continual Extension of Data Connotation. Thereafter, Starting from Data Characteristics of the Internet of Things, he Qiang (2015) [10] Studied Application Fields and Existing Problems of the Internet of Things in Government Statistics. Xin Jinguo (2015) [11] Pointed out through Analysis That the Openness and Standardization Level of the Internet of Things Were the Main Factors Affecting the Quality of Data Acquisition. in Addition, Xue Jie (2016) [12] Also Discussed the Trend of Statistical Information under the Background of the Internet of Things. Aiming At the Potential Security Problems of Statistical Data Acquisition in Enterprises and Institutions, Xiong Shuming (2016) [13] Also Put Forward the Idea of Building a Statistical Big Data Security Acquisition System Based on Internet of Things Technology.

Based on Existing Research, Preliminary Progress Has Been Made in the Application of the Internet of Things on Government Statistics. Experts and Scholars Fully Realize That the Internet of Things Will Become an Important Part of Statistical Informatization. This Paper Analyses the Innovation of Data Category, Collection Method and Processing Process Brought about by the Internet of Things, Puts Forward Some Suggestions for the Application of the Internet of Things in Government Statistics, and Analyses the Factors Affecting the Application of Government Statistics. However, Because the Internet of Things is a New Technology and a Unified System Framework is Not Available Yet, Relevant Research is Not Thorough Enough. Therefore, It is Urgent to Explore Ways to Apply the Internet of Things to Government Statistics from the Perspective of Operations. Based on the Analysis of System Structure of the Internet of Things, This Paper Discusses the Application Mode of the Internet of Things from Four Aspects: Government Statistical Data Collection, Aggregation, Processing and Service.

## 2. Architecture of Internet of Things for Government Statistics

According to the Coverage of Government Statistics, from the Data Point of View, Typical

Operations Include Data Collection, Aggregation, Processing and Services. Therefore, in Order to Establish a Government Statistical Model Based on the Internet of Things, It is Necessary to Sort out the Framework of the Internet of Things and Form a Hierarchical Structure Based on Government Statistics First. Then Technical Characteristics and Method System Should Be Extracted Corresponding to Government Statistics, So as to Support Smooth Operations. At Present, the Mainstream Internet of Things Frameworks Are Network Automatic Identification Architecture, Ubiquitous Sensor Network Architecture, Uid-Based Internet of Things Architecture, as Well as M2m, Iot-a, Sensei, Cps and Aoa, Etc., Which Are of Great Differences. However, It is Relatively Simple to Categorize Them According to the Abstraction Level. There Are Three Layers of Architecture Composed of Perception Layer, Network Layer and Application Layer, and Four Layers of Architecture Composed of Perception and Identification Layer, Network Construction Layer, Management and Service Layer and Integrated Application Layer. the Three-Tier Architecture Depicts the Main Characteristics of the Internet of Things and Centralizes the Core Technologies and Functions of the Internet of Things. However, in This Architecture, Data Processing, Computing Services, Storage Management and Other Links Are Integrated into the Application Layer or Part of the Links Are Placed in the Network Layer, Which Have Made the Transmission Process, with the Goal of Information Processing and Data Aggregation in Government Statistics, Unclear. Four-Tier Architecture Clarifies More about the Emphasis of Network Transmission Layer and Management Service Layer. However, as There Are Usually Certain Application Characteristics in Management Service, Confusion Exists in Terms of the Integrated Application Layer, Which Leads to Different Relationship between the Data Processing in the Architecture of the Internet of Things and Data Service Links in Government Statistics. Consequently, It is Difficult to Integrate the Internet of Things with Government Statistics.

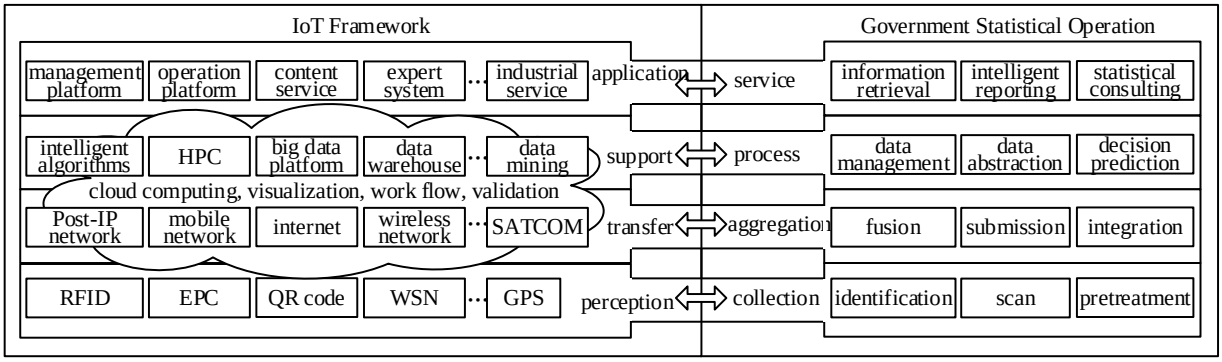


Fig.1 Architecture of Internet of Things Architecture for Government Statistics

To Address This Difficulty, According to Technical Characteristics of the Internet of Things and Needs of Government Statistics, This Paper Adopts the Principle of “Clear Structure, Progressive Hierarchy and Close Connection”, and Categorizes the Internet of Things Architecture into Four Levels: Perception Layer, Transfer Layer, Support Layer and Application Layer. as Shown in Figure 1, Each Level Corresponds to a Specific Government Statistical Task. the Perception Layer Includes Sensor Network, Reader, Camera, Gps, M2m Terminal, Rfid Equipment and Coding Technology, Mainly Responsible of Identification and Collection of All Kinds of Information in the Internet of Things, Acquiring Government Statistical Data, and Transmitting Data to the Gateway through Wireless Network and Fieldbus of This Layer. the Transport Layer Includes Basic Network Facilities Such as Mobile Network, Internet, Wireless Network, Satellite System and Post-Ip Network. by Using Wired Communication or Wireless Communication Technology, Objects Are Connected to the Internet According to the Agreed Protocol, and Data Resources Gathered in the Gateway Are Transferred to the Processing Service Center to Exchange Government Statistical Information. the Support Layer Includes Intelligent Processing, Parallel Computing, Large Data, Data Warehouse, Comprehensive Verification, Etc., Which Plays a Connecting Role [14] in Computing, Storage, Decision-Making, Support and Verification Powers for Government Statistics, and Supporting the Formation of Various Application Services. Thus, in the Environment of High-Performance Network Computer, It Will

Be Able to Integrate Massive Information Resources in the Network into an Interconnected Large-Scale Intelligent System to Support Statistical Data Storage, Data Retrieval, Data Mining, Machine Learning, Data Security, Privacy Protection and So on. the Application Layer Includes Management Platform, Operation Platform, Content Service, Expert System, Industrial Service and So on. as the User Interface of the Internet of Things, It Relies on the Support Layer to Provide Diversified and Specific Services, and Operates and Manages the Entire Internet of Things System. Various Government Statistical Applications Are Completely Based on the Application Layer of the Internet of Things to Form Processing Results of Applications.

## 3. Application Model of Internet of Things in Government Statistics

According to the hierarchical structure of the Internet of Things and the operational requirements of government statistics, the government statistical mode supported by the Internet of Things consists of four parts: data collection, aggregation, processing and services. During data collection process, data information is gained while during data aggregation, all kinds of resources are transmitted and gathered. During data processing, data analysis and processing methods can be gained, while during data service, service interface is provided for terminal. Compared with the traditional mode, this government statistical system based on the Internet of Things can provide data and communication solutions in a more convenient manner, support complex, fast and efficient processing rules, and provide comprehensive visual and diversified application services.

### 3.1 Collection Model of Government Statistical Data

Statistics reflect universality, while quantity is the basic feature of statistics. However, due to the limitation of collection technology and time, it is often impossible to carry out frequent surveys of a large number of statistical groups. In terms of identification through electronic tags and sensor technology in the perception layer of the Internet of Things, readers are used to transform all kinds of features and attributes into data resources, so that a large number of data objects can be counted in a very short time. Specifically, the following three modes are used to collect data. (1) A variety of sensors (physical, chemical, biological sensors, etc.) are used to collect data that cannot be obtained by manual collection, such as light, heat, electricity and other data, and convert them into indirect quantities used to represent prosperity, wealth index and so on. At the same time, based on the collection frequency cycle of the sensor and the function of data format conversion for the captured original information, in the case of a large number of government statistical indicators and more complex statistical objects, the sensor network is used to pre-process the collected data, explore data anomalies, eliminate data errors, and ensure the collected data quality. (2) Radio Frequency Identification (RFID) technology is applied when collecting government statistical data. Handheld electronic data collection equipment is used to collect and track large-scale statistical objects through non-contact scanning without geographical and time constraints, so as to improve efficiency and sustainability of government statistical data collection. (3) In the Internet of Things era, government statistics not only refer to text information, but also include image, video and audios. In order to enrich the content of data collection, video capture card and multi-functional TV card are used to extract key data content from media information, expand the scope of data collection, improve the comprehensiveness of data collection, and promote the realization of “big statistics” strategy.

### 3.2 Aggregation Model of Government Statistical Data

Under the Internet of Things, the government and enterprises will use statistical data for management and decision-making more frequently. How to aggregate massive and scattered statistical data and manage them together has become a major problem for decision-makers. The traditional way of aggregating government statistical data is to collect and report the survey data step by step from bottom to top until the highest body. However, this process is very time-consuming due to incomplete data collection. Even if the “super collecting” method is used (all survey data are collected to a certain institution for one-time collection), it is difficult to

realize rapid data collection and synchronous entry. Based on the Internet of Things technology, the collected statistical data will be transmitted through wireless communication or wired communication in the transfer layer, and statistical resources will be integrated by data fusion technology. The data will further be integrated into the data warehouse of the central information system. The accuracy, security and consistency of the data will be guaranteed by the communication protocol. Data transmission is realized in many kinds of communication networks, and data processing departments at all levels are used as receivers to collect data directly from the data warehouse. In addition, the control strategy of Internet of Things communication is used to add early warning mechanism for statistical data aggregation. When data upload is abnormal due to transmission failure, the statistical data management system realizes automatic early warning, puts forward the possible causes of failure, ensures the stability of communication channel, and automatically controls repeated sampling or re-sampling to supplement the missing data. In this way, interference caused by the system destruction can be eliminated, and timeliness and reliability of statistical data aggregation improved, further making the system rapidly adapt to changes of social and economic phenomena data, and better serve the government decision-making and social production.

### 3.3 Processing Model of Government Statistical Data

The data resources collected through the Internet of Things are diversified and thus should be standardized to support government statistics. Therefore, the primary task of data processing is to use the data warehouse of the Internet of Things for normalized data processing and management, and to standardize different data codes, acquisition frequency, measurement units and so on, and then integrate them. The integrated verification technology based on the support layer of the Internet of Things is used to check the data format, completion of information, consistency of data package address, and legitimacy of collection time. In order to make sure the data is correct, different types of statistical data received are sliced, the metadata information is abstracted, and the large data platform is called to coordinate the allocation of data resources to prepare for the next statistical analysis. In addition, considering the limitations of traditional government statistics in intelligent processing, cloud computing, big data, intelligent algorithms and other technologies provided by the Internet of Things are used to transform statistical data processing mode from a single statistical analysis to a supporting component for complex tasks. Under distributed data management and access mechanism provided by the big data platform, data mining technology is used to detect the implicit law of connotation in the massive statistical data. With the help of high-performance computing, computing tasks are decomposed and computing resources are allocated. Data processing workflow is dynamically established in a graphical way, and swarm intelligence and optimization are adopted. The algorithm supports the development of various deep-seated government statistical tasks such as prediction and decision-making, and constructs analysis service in the way of Web Service for special assignments to support the description and sharing of results information. At the same time, based on the diversified visual display platform provided by visualization technology, an efficient, intelligent, shared and visual data processing model of government statistics is formed.

### 3.4 Service Model of Government Statistical Data

The ultimate goal of government statistics is to serve national decision-making and social production. With the refinement and diversification of people’s demand for statistical information, the information service capacity of statistical information institutions is gradually strengthened. The government statistical information service under the environment of the Internet of Things mainly takes the statistical information portal as the carrier, and is divided into information retrieval, statistical consultation, information service, decision analysis, intelligent report forms and other parts. Among them, information retrieval is based on the Internet of Things operation platform, during which comprehensive inquiries of statistical data can be provided by time, region and topic in plug-in mode; during statistical consultation, the achievements of the Internet of Things expert system are displayed, providing technical guidance and professional consultation;

during information services supported by the Internet of Things management platform, information resources are integrated for information, and management and control services of distributed data information are provided; during decision analysis, IOT support layer is integrated to produce statistical information products for macro-control, economic prediction and management decision-making on the basis of processing and analysis of statistical data; and during intelligent reporting based on Internet of Things expert system and industry service system, according to personalized needs, the statistical results of various industries and departments are intelligently displayed through tables. In addition, the service model of government statistical data also adopts the computing power and decision-making power provided by the support layer of the Internet of Things to carry out association, clustering, classification and deviation analyses after intelligent data extraction, and then reveals the relevant implicit relationship information between data and establishes a model [15]. It further extracts the potential and valuable data results out of massive information resources, and summarizes them from the perspective of data generalization to meet people's needs of understanding and in-depth statistical analysis from a higher-level view.

## 4. Conclusions

Internet of Things (IOT) technology is the representative of modern sensor technology. It develops and extends the application of Internet, and realizes the interconnection of goods and real-time sharing of information through radio frequency identification and wireless data communication technologies. Considering the enormous application potential of the Internet of Things in government statistics, this paper, based on the analysis of the architecture of the Internet of Things, puts forward the application mode of government statistics from the aspects of collection model, aggregation model, processing model and service model, which provides some reference for the development of government statistics services under the Internet of Things. However, because the Internet of Things is still being developed, especially in its technical standards, the lack of privacy security and other issues have brought some obstacles to government statistics. Therefore, the practical application of the Internet of Things in government statistics should be further supported technically, which requires further exploration of standard specifications of the Internet of Things. Specifically, it should start from standardizing hardware equipment and unifying software systems to eliminating inconsistency of data mapping, improving stability of the system and the reliability of data transmission, enhancing data quality, and exploring the role control method in depth to protect privacy and ensure the security of data application and services. In this way, solutions can be provided for government statistics with extensive data collection, efficient information processing, deep resource mining and domain sharing services.

## Acknowledgement

This research has been financed by The Shaanxi Statistical Science Research Project "Research on the development status and trend of statistical informatization" (2014LX02).

## References

[1] Zhou J. The Internet of Things development status of the world's major developed countries [J]. Technological Development of Enterprise, 2012,(28):92-93+95.

[2] Jia X L. A brief analysis of the development status and trend of the Internet of things [J]. Journal of ShanXi Finance and Economics University, 2012, (S1):105+107.

[3] Mäkinen J. Data quality, sensitive data and joint controllership as examples of grey areas in the existing data protection framework for the Internet of Things [J]. Information & Communications Technology Law,2015,24(3):262-277

[4] Karkouch A, Mousannif H, Moatassime H. Data quality in internet of things: A state-of-the-art

survey [J]. Journal of Network & Computer Applications, 2016, 73,:57-81.

[5] Zimos E,Mota J,Rodrigues M,etal. Internet-of-Things data aggregation using compressed sensing with side information[C]. 23rd International Conference on Telecommunications (ICT) Telecommunications (ICT), 2016:1-5

[6] Aljubairy A, Shemshadi A, Sheng Q Z. Real-time investigation of flight delays based on the internet of things data[C]. Advanced Data Mining and Applications - 12th International Conference, ADMA Proceedings, 2016, 10086:788-800

[7] Riga S. Data Security and the rise of the internet of things [J]. Journal of Internet Law. 2017, 20(9):3-7.

[8] Ma J T. The statistics bureau will intensify reform and innovation from four aspects, including Internet of things technology [J]. Golden Card Project, 2012, (09):7.

[9] Cong Y J, Cai N. Informatization construction of government statistics under the background of big data [J]. China Statistics, 2014,(06):19-21.

[10] He Q. The Internet of things helps build the government's big data strategy [J]. China Statistics, 2015, (04):14-15.

[11] Xin J G, Gong K. Influence factors of statistical data collection based on Internet of things technology [J]. Statistics & Decision, 2015,(23):34-37.

[12] Xue J, Zhao Z F. The development trend of statistical informatization under the background of Internet of things [J]. Statistics & Decision, 2016, (09):75-78.

[13] Xiong S M, Wang Q, Wu J Y. Exploration on the construction of statistical big data security collection system based on the Internet of things [J]. Statistics and Consulting, 2016, (02):20-22.

[14] Xin J G, Gong K, Wang Y. Exploration on the construction of statistical data collection system based on Internet of things technology [J]. Statistics and Consulting, 2013, (06):31-32.

[15] Dai L L. On statistical data mining technology [J]. Statistics and Consulting, 2011, (05):55-56.