# RESEARCH ON GEOGRAPHIC INFORMATION DATA CIRCULATION SUPPORTS THE CONSTRUCTION OF DIGITAL CHINA

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**KEY WORDS:** Geographic information, Spatio-temporal information, Data circulation, Data sharing and exchange, Digital China.

**ABSTRACT:**

Accelerating digital development and building a Digital China is an important engine for promoting Chinese-style modernization, which has become the development tone of the 14th Five-Year Plan period. The Overall Layout Plan for the Construction of Digital China clearly requires the improvement of the three-dimensional "One Map" of natural resources and the basic information platform of land and space, and the transformation of governance mode driven by digitalization. Giving full play to the value of geographic information data elements and comprehensively and effectively supporting national and local high-quality development has become an important topic for the construction of Digital China. Firstly, this paper expounds the connotation and application of geographic information data circulation. Secondly, it proposed the construction of geographic information data circulation system, designed the overall framework, basic requirements and technical indicators of geographic information data infrastructure and geographic information resource database, in order to better support the construction of Digital China. Thirdly, other aspects of geographic information data circulation that need to be paid attention to are given. It mainly includes geographic information data security and user location privacy issues aspects. Finally, the opportunities and challenges of geographic information data circulation are summarized.

## 1. INTRODUCTION

Geographic information refers to the collection of spatial data, non-spatial data, and metadata related to the Earth's surface. They not only include basic information such as geographic coordinates, attributes, relationships, etc., but also extend to the application data of Geographic Information System (GIS) technology in natural, human and economic fields. Geographic information resources are mainly composed of geospatial and remote sensing data. The circulation of geospatial and remote sensing data is of great significance in improving decision-making efficiency, promoting economic growth, improving public services, ensuring national security and sustainable environmental development, and there are mainly ways to share, exchange, trade, etc.

The Digital China is a strategic plan to comprehensively advance China's digital transformation, promote the deep integration of information technology and the real economy, and realize digital economic and social development. The Overall Layout Plan for the construction of the Digital China recently issued by the Central Committee of the Communist Party of China and the State Council, which clearly points out that digital infrastructure and data resource system are the "two foundations" for the construction of the Digital China. As an important basic and strategic resource of the country, geographic information is the "base" of digital infrastructure and data resource system. With the deep cross-integration of geographic information resources, artificial intelligence, Internet and other fields, various spatio-temporal information products, applications and services have been formed. Using geographic information to help digital development and enable high-quality development is of great significance and has a long way to go. From a technical point of view, this involves the whole chain of geographic information data acquisition, information processing, knowledge generation, and intelligent application. The key technical problems in spatiotemporal connectivity, spatiotemporal computing, and spatiotemporal intelligence should be overcome. A new generation of spatiotemporal data products represented by real scene 3D China should be developed, and the infrastructure of spatiotemporal computing power should be built. Multi-level spatiotemporal knowledge engineering should be implemented to provide high-quality spatiotemporal information and support high-level spatiotemporal analysis. We will carry out high-level spatio-temporal empowerment. By providing "ubiquitous spatio-temporal connectivity, ubiquitous spatio-temporal computing, and omnipotent spatio-temporal intelligence ", we can effectively promote the enabling applications of digital economy, digital life, and digital governance, and realize the high-quality development of geographic information empowerment.

This paper first gives expounds the connotation and application of geographic information data circulation, such as the National Geographic Information Resources Directory Service System, the National Natural Resources and Geospatial basic information database, the Data Sharing and Service Portal by CASEarth, the National Platform for Common Geospatial Information Services (TIANDITU), and the Real 3D China. Secondly, on the basis of enumerating and summarizing the current situation of the construction and data circulation of the Digital China, it is proposed to build a geographic information data circulation system to better support the construction of the Digital China, and designed the overall framework, basic requirements and technical indicators of geographic information data infrastructure and geographic information resource database. And taking construction of geographic information resource directory as an example, the detailed contents of data

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source, data resource organization and management, network and platform construction and data directory service are given. Thirdly, other aspects of geographic information data circulation that need to be paid attention to are given, which including geographic information data security and user location privacy issues. Finally, the opportunities and challenges of geographic information data circulation are summarized.

## 2. RELATED WORK

The research methods of scholars at home and abroad mainly focus on the establishment of the Digital China "base" through geographic information sharing and exchange.

**Geographic Information Resources Directory System.** When Ted Codd of the Bell LABS proposed the theory of relational databases in 1970, it provided the theoretical foundation for the construction of detailed and complete resource catalogs. Relational databases make storing, managing and retrieving data more efficient and maintainable. Subsequently, many practitioners, scholars, and companies have actively participated and promoted the work in the construction of resource catalogs.

**Geographic Information Resource Database and Mining Analysis.** In the mid-1980s, spatio-temporal databases and their query languages appeared. Since the 21st century, with the proposal of the concept of "spatio-temporal big data", Li Deren, Wang Jiayao and other academicians have used spatio-temporal big data to mine, analyze and visualize. Harvey et al. proposed Geographic Data Mining and Knowledge Discovery, 2015. Academician Li Deren first proposed the realization of global socio-economic dynamic monitoring supported by night-light remote sensing marketing based on remote sensing big data.

**Construction of Geographic Information Data Infrastructure.** The United States first signed the National Spatial Data Infrastructure (NSDI) presidential decree in 1994. The National Strategic Plan for Spatial Data Infrastructure (2014-2016) was released in 2013. In 2018, the Geographic Information Data Act was promulgated, which for the first time codified the role orientation, construction content, and main responsibility department of NSDI into federal law. In November 2020, the Federal GeoData Council (FGDC) released the Strategic Plan for Spatial Data Infrastructure in the United States (2021-2024). in addition, the European Union, the United Kingdom and other regions and countries also started the Infrastructure for Spatial Information in the European Community (INSPIRE) construction in the early 21st century.

**Geographic Information Public Service Platform Portal.** The United States first signed a memorandum of Understanding on Transparent and Open Government in 2009, and released the Open Government Project website (data.gov). In 2011, the Geospatial Platform project was launched. The UK launched the Federal Government Data Sharing website (data.gov.uk) in 2010. China launched the National Platform for Common Geospatial Information Services (TIANDITU) (tianditu.gov.cn) in 2010. In addition, Canada, Australia, Japan, South Korea, Singapore and other countries have initially built a series of platform websites.

**Smart City Construction.** In the early 1990s, the then US Vice President Al Gore proposed the concept of "Digital Earth", which can be regarded as the beginning of the embryonic concept of smart cities. Then, around 2000, many cities began to explore the use of information and communication technology (ICT) to improve the level of urban management, a phase known as digital city. The concept of smart city began to receive extensive international attention and research around 2008. That's when IBM came up with the "Smarter Planet" concept.

## 3. THE CONNOTATION AND APPLICATIONS OF GEOGRAPHIC INFORMATION DATA CIRCULATION

### 3.1 The Connotation of Geographic Information Data Circulation

The connotation of geographic information data circulation is the sharing and exchange of geographic information data resources.

Geographic information data resources sharing is composed of three parts: shared data provider, shared data exchange service and shared data user. It consists of three stages: shared data preparation, shared data exchange and shared data use. The geographic information data resources sharing and exchange business model is shown in Figure 1. The shared data provider is the subject of shared data rights and interests, the shared data exchange service is the subject of the construction and operation of the geographic information resource sharing exchange platform, and the shared data user is the responsible subject of the use of shared data.

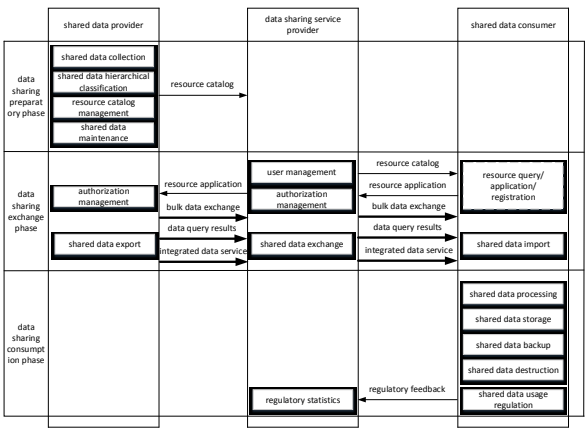


**Figure 1**. The geographic information sharing and exchange business model.

In the shared data preparation stage, the shared data provider completes the shared data collection and data classification according to the sharing business requirements, forms the geographic information resource directory and manages the data sharing mode, continues to maintain the shared data, and is ready to provide the shared data to the outside by batch exchange of data, providing data query services, and providing comprehensive data services such as verification, statistics and analysis According to the data, a shared data update and failure recall mechanism is constructed to recall the failed data in time. The shared data provider adopts the technical means of data source identification, data classification, resource directory management and shared data maintenance to complete the shared data preparation, so as to ensure the accuracy, integrity, availability and authenticity of the shared data.

In the stage of shared data exchange, users of shared data use the geographic information resource sharing and exchange platform to query shared data, apply for and register shared data. After the shared data exchange service examines and authorizes the resource access application, or the shared data provider examines and authorizes the resource access application as needed, the shared data provider exports the prepared shared data. The shared data exchange service party provides data exchange service according to the need, and the shared data user obtains and guides the data. The service provider of shared data exchange adopts identity authentication, access control, secure transmission, process traceability and other technical means to ensure the credibility of exchange entities, the security of data transmission, and the traceability of exchange behavior records in the process of geographic information resource sharing exchange.

In the use stage of shared data, users of shared data can further build a government big data resource system through data processing, data storage, data backup and other data service mechanisms after completing data acquisition. Provide integrated data sharing services for other departments, destroy expired and recalled shared data according to management requirements, and monitor and feedback the data usage process according to the requirements of the shared data provider. According to the security requirements of the shared data, the user of the shared data shall adopt technical means such as access control, data encryption, secure storage, and secure destruction to ensure the security of data use. The shared data exchange service shall supervise and count the system, business, security, data usage monitoring feedback and other contents of the data sharing business carried out through the geographic information resource sharing and exchange platform, so as to ensure the continuous, stable and reliable operation of the sharing and exchange service.

### 3.2 The Applications of Geographic Information Data Circulation

**3.2.1 National Geographic Information Resources Directory Service System**: an authoritative network query and service platform covering the whole country, providing geographic information resources searching, sharing and service for the public, as shown in Figure 2. It is an important part of the public service platform of geographic information, which gathers the catalogue of basic surveying and mapping results at all levels across regions and industries.


**Figure 2**. The National Geographic Information Resources Directory Service System portal website. (https://www.webmap.cn/)

**3.2.2 The National Natural Resources and Geospatial Basic Information Database**: one of the four basic information databases of national e-government determined by the state. It has formed a basic and strategic geospatial information resource database with standardization, scale and sustainable renewal. A nationwide network service system for geospatial information sharing and exchange, an information resource directory service system, and a mode for large-scale and rapid integration and sharing of multi-source geospatial information have been established. A government information sharing service support system composed of one data master center and 11 data sub-centers was formed. A work system that combines military and civil forces and cross-departmental collaboration and a mechanism for sharing natural resources and geospatial information have been established, as shown in Figure 3.


**Figure 3**. The National Natural Resources and Geospatial Basic Information Database Portal website. (https://sgic.net.cn/portal/index.html)

**3.2.3 Data Sharing and Service Portal by CASEarth**: is built for the release and sharing of data resources of "Big Earth Data Science Engineering Project" launched by the Chinese Academy of Sciences, as shown in Figure 4.


**Figure 4**. Data Sharing and Service Portal by CASEarth portal website. (https://data.casearth.cn/en/)

**3.2.4 The National Platform for Common Geospatial Information Services (TIANDITU)**: an open and shared service portal of networked geographic information built by National Geomatics Center of China (NGCC), as shown in Figure 5. It integrates geographic information public service resources from national, provincial, city (county) surveying and mapping departments at all levels, as well as relevant government departments, enterprises and institutions, social organizations, and the public to provide authoritative, standard, and unified online comprehensive geographic information services to all kinds of users.


**Figure 5**. The National Platform for Common Geospatial Information Services (TIANDITU) portal website. (https://www.tianditu.gov.cn)

**3.2.5 Real 3D China**: As a real, three-dimensional, temporal and spatial information reflecting human production, life and ecological space, real 3D is an important new national infrastructure. It can realize the real-time correlation and interconnection between digital space and real space through "human-machine compatibility, perception of things, ubiquitous services", and provide a unified spatial positioning framework and analysis basis for Digital China. It is an important strategic data resource and production factor for digital government and digital economy. The real 3D China construction is oriented to the new positioning and new demand of surveying, mapping and geographic information service for economic and social development and ecological civilization construction in the new era. The transformation and upgrading of traditional basic surveying and mapping business is the development direction and basic mode of surveying, mapping and geographic information service, which has been included in the 14th Five-Year Plan for natural resources protection and utilization.

The construction of real 3D China mainly includes five major construction tasks. The first is terrain level real scene 3D construction. Second, the city-level three-dimensional construction of real scene. The third is component level real scene 3D construction. Fourth, IoT sensing data access and fusion. Fifth, the construction of online system and supporting environment.

## 4. CONSTRUCTION AND DESIGN OF GEOGRAPHIC INFORMATION DIGITAL INFRASTRUCTURE AND DATA RESOURCE SYSTEM

The first task of Digital China is to build the geographic information digital infrastructure and data resource system. The core of geographic information data to support the construction of Digital China is to create a unified spatio-temporal basis for it, as is shown in Figure 6. We will build a Beidou-based national satellite navigation and positioning reference station "One Network", accelerate the construction of a real 3D China and spatio-temporal big data platform, and realize the interconnection between digital space and real space.

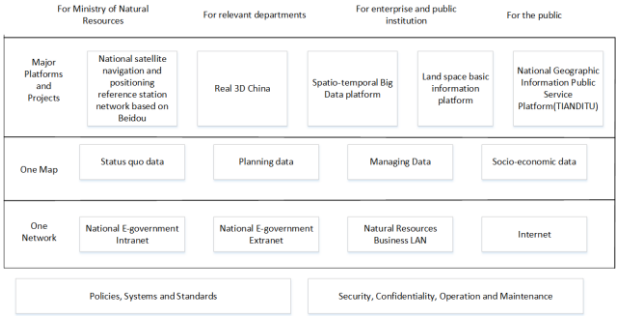


**Figure 6**. The overall framework of Digital China development in natural resources and territorial space.

### 4.1 Design of Geographic Information Digital Infrastructure

A detailed and complete geographic information data infrastructure should cover data acquisition, storage, integration, processing, analysis, and presentation so that organizations can make full use of their data assets and enable data-driven decisions. A comprehensive and complete geographic information data infrastructure should include the following components, as is shown in Table 1.

| Systems | Core Components | Instances |
|---|---|---|
| Data Storage and Management | Database Management System (DBMS) | Relational (MySQL, Oracle, and SQL Server), non-relational (MongoDB and Cassandra), and newer databases (Time-series databases and Graph databases) |
| | Big Data Storage | Hadoop, HBase, and Bigtable |
| | Data Warehouse | Amazon Redshift, Google BigQuery, and Snowflake |
| | Data Lake | Amazon S3, Google Cloud Storage, and Azure Data Lake |
| | Content Management System (CMS) | WordPress, Drupal, and SharePoint |
| | Extract, Transform, and Load (ETL) Tools | Informatica, Talend, and Apache NiFi for Data Migration |
| | Application Programming Interfaces(APIs) | RESTful API, JSON API |
| | Data Virtualization | Consolidate multiple data sources into a |

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|---|---|---|
| | | unified view (Denodo) |
| Data Processing and Analysis | Data Cleaning Tools | Handle missing values, outliers, duplicates, etc. ( OpenRefine, Trifacta) |
| | Data Mining and Analysis Tools | Structured queries (SQL), statistical analysis (Pandas for R and Python), and machine learning (TensorFlow and scikit-learn) |
| | Real-time Data Processing Framework | Apache Kafka, Apache Flink, Apache Storm |
| | Big Data Processing Framework | Apache Spark, Apache Hadoop |
| Data Visualization and Reporting | Data Visualization Tools | Tableau, Power BI, D3.js |
| | Report Generation Tools | Crystal Reports, JasperReports, Microsoft SQL Server Reporting Services |

**Table 1**. The Table of Geospatial Data Infrastructure Components.

### 4.2 Construction of Geographic Information Data Resource System

A sound data resource system can help organizations better manage data, enhance data value, and provide strong support for business decision-making, thereby improving market competitiveness and profitability. A detailed and complete geographic information data resource system usually includes the following key parts, as is shown in Table 2.

| Key Parts | Contents |
|---|---|
| Data Source | This includes both internal and external data sources. Internal data sources include business systems, business personnel, etc. External data sources may come from government agencies, partners, data vendors, etc. |
| Data Acquisition and Integration | Through data scraping, API, ETL and other ways to collect potentially valuable data from different systems, and perform data cleaning, format conversion, deduplication, data fusion, etc., to form integrated data resources such as data warehouse and data lake. |
| Data Quality and Governance | Data quality and governance ensure data accuracy, consistency, and timeliness. It involves data quality monitoring, data auditing, data governance policies, etc., to ensure the integrity and reliability of data resources. |
| Data Storage and Management | According to the business requirements and data types, choose the appropriate data storage mode, including relational database, non-relational database, data warehouse, etc. At the same time, it is necessary to manage the life cycle of data, backup policies, data encryption, etc. |
| Data Security and Privacy | Protect data from unauthorized access, tampering, disclosure, etc., comply with data protection regulations and ensure that user privacy is not violated. These include access control, data encryption, data desensitization, audit trail, etc. |
| Data Modeling and Analysis | Through data modeling and analysis, we can gain insights into the business logic and relationships behind the data, such as data mining, data analysis, machine learning, etc., and build valuable internal information. |
| Data Visualization and Reporting | The data is displayed on the visualization platform through graphs, tables and other forms to help users quickly understand the industry trends and performance indicators behind the data. This can be achieved with the help of BI tools, dashboards, etc. |
| Data Applications and Decision Support | The results of data analysis are applied to business scenarios to support business decision making and optimization. These include recommendation engines, predictive analytics, risk assessment, and more. |
| Data Culture and Governance Organization | Cultivate data culture, enhance data awareness, and establish a data-driven strategy. Set up data governance organizations and roles such as data steward, data analyst, data scientist, etc. |
| Data Value Discovery and Optimization | Continuously excavate the potential value from data resources, discover new business models and opportunities, and improve the efficiency and effectiveness of existing data resources. |

**Table 2**. The Table of Key Parts of Geographic Information Data Resource System.

### 4.3 Construction of Geographic Information Resource Directory

Geographic information resource directory integrates digital infrastructure and data resource system, which is the data sharing and exchange foundation of the construction of Digital China base. It aims to integrate all kinds of geographic information resources at home and abroad, realize the efficient management, utilization and sharing of geographic information resources, and provide convenient, fast and accurate geographic information services for national government decision-making, enterprise management and public life.

**4.3.1 Data Source**: contains the following five types of data resources.

**Basic Geographic Information:** including maps, remote sensing images, digital elevation, place names and addresses, administrative divisions and other basic geographic information data.

**Thematic Geographic Information:** including land use, water resources, mineral resources, geological disasters, ecological environment, meteorology, Marine, forestry and other thematic geographic information data.

**Industrial Geographic Information:** including transportation, energy, communications, national defence, public security, civil

administration, education, health, real estate, agriculture and other industrial geographic information data.

**Historical Geographic Information:** including historical maps, historical remote sensing images, historical place names, historical administrative divisions and other historical geographic information data.

**International Geographic Information:** including world maps, remote sensing images, geographic coordinate systems, place names and addresses, administrative divisions and other national thematic geographic information data.

**4.3.2 Data Resource Organization and Management**: contains the following four parts.

**Resource Directory:** The resource directory management mode of multi-level, in charge and integration is adopted to realize the unified classification, standardized description and fast retrieval of geographic information resources.

**Metadata:** According to the International geographic Information Metadata Standard (ISO19115), formulate and implement geographic information resource metadata standards.

**Data Sharing:** realize the sharing of geographic information resources across departments, regions and industries to avoid repeated construction and waste of resources.

**Data Security:** Establish and improve the geographic information resources confidentiality, review, supervision mechanism, to ensure national geographic information security.

**4.3.3 Network and Platform Construction:** contains the following four types of network and platform.

**Information System Platform:** The core information system platform of geographic information resource directory service system is constructed by using Service-oriented Architecture (SOA) and cloud computing technology.

**Application System Platform:** Based on the core information system platform, it develops various application service systems of geographic information resources for the government, enterprises and the public.

**Portal and Navigation Platform:** to build a portal website and navigation system for geographic information resource directory service, providing unified retrieval, display, download, interaction and application service functions.

**Network and Communication Platform:** Relying on the national information infrastructure, build a broadband network and communication platform for geographic information resources directory service.

**4.3.4 Data Directory Service**: contains the following four types of data resources.

**Resource Retrieval:** It supports fast retrieval of geographic information resources based on map, keyword, time, scope and other conditions.

**Resource Browsing:** Support online browsing, zooming, roaming, downloading and other functions of geographic information resources.

**Resource Sharing:** realize the sharing and exchange of geographic information resources across departments, regions and industries.

**Resource Application:** Develop various application service systems of geographic information resources to support government decision-making, enterprise management and public life.

## 5. OTHER ASPECTS OF GEOGRAPHIC INFORMATION DATA CIRCULATION THAT NEED ATTENTION

Building a Digital China, data security and privacy protection are important issues that cannot be ignored.

### 5.1 Geographic Information Data Security

It refers to the protection of the confidentiality, integrity and availability of geographic information data against unauthorized access, tampering, loss or destruction. At present, an appeal for geographic information data confidentiality is to change the traditional way of classification by scale, to determine the classification by geographic entity, that is, according to the attribute, value and importance of geographic information to determine whether it is classified and delimit the classification level. In this way, more accurate geographic data can be mapped for non-classified applications, thus meeting the needs of the public. The main means of data security processing of surveying and mapping geographic information are coordinate encryption and element deletion. For confidential geographic information such as vector data, raster data, three-dimensional models, real data and navigation electronic maps (including the basic map of intelligent vehicles), we will accelerate the development of technical methods for confidential processing of all or part of their spatial location, accuracy, attribute content and their interrelations. The main technical means include the following.

**Data Classification:** Data classification is a common method of data security management, which classifies data according to its sensitivity and importance, and develops corresponding security measures for each level of data. Identify and classify data, and determine the level of data according to its sensitivity and importance, such as public data, internal data, confidential data, etc.

**Data Access Control:** According to the level of data, set different access permissions to ensure that only authorized personnel can access and process the corresponding level of data.

**Data Encryption:** For high-level sensitive data, encryption technology is used to protect it to ensure the security of data during transmission and storage.

**Data Backup and Recovery:** For important data, make regular backups and establish a reliable recovery mechanism to prevent data loss or corruption.

**Data Auditing and Monitoring:** Audit and monitor the access and use of data, discover abnormal behaviors and security risks in time, and take appropriate measures to deal with them.

### 5.2 User Location Privacy Issues

With the emergence and rapid development of Location-Based Services (LBS), it has become normal for massive user personal location information to interact across systems, ecosystems and even cross-border. User location information will inevitably be retained in different information systems during the whole life cycle of collection, storage, processing, release (including exchange) and destruction. As a result, the right of ownership, management and use of location information are separated, which seriously threatens the user's right to know, right to delete/be forgotten, and extended authorization, resulting in many security problems. As shown in Table 3, it mainly includes personal privacy information such as user location information stipulated in GDPR and Chinese privacy protection laws and regulations.

| Categories | Contents |
|---|---|
| Basic Personal Information | Personal name, birth date, gender, ethnicity, nationality, family relationship, address, personal telephone number, E-mail address, etc |
| Personally Identifiable Information | Id card, military card, passport, driving license, work permit, access card, social security card, residence permit, etc |
| Personal Biometric Information | Personal genes, fingerprints, voiceprint, palmprint, ear pinna, iris, facial recognition features, etc |
| Network Identity Information | Personal information subject account number, IP address, personal digital certificate, etc |
| Personal Health Physiological Information | Records related to personal illness and treatment, such as symptoms, hospitalization records, wills, examination reports, surgery and anesthesia records, nursing records, medication records, drug and food allergy information, fertility information, past medical history, diagnosis and treatment, family history, present history, infection history, etc., and information related to personal physical health status, such as weight, height, vital capacity, etc |
| Personal Education Work Information | Personal occupation, position, work unit, education, degree, education experience, work experience, training records, transcripts, etc |
| Personal Property Information | Bank account, identification information (password), deposit information (including the amount of funds, payment and collection records, etc.), real estate information, credit records, credit information, transaction and consumption records, flow records, etc., as well as virtual currency, virtual transaction, game exchange code and other virtual property information |
| Personal Correspondence Information | Communication records and contents, text messages, MMS, emails, and data describing personal communications (often called metadata) |
| Contact Information | Address book, friend list, group list, email address list, etc |
| Personal Internet Record | Refers to the operation records of personal information subjects stored through logs, including website browsing records, software usage records, click records, favorite lists, etc |
| Personal Commonly Used Device Information | Devices include hardware serial number, MAC address, software list, the only equipment identification number (such as IMEI/Android ID/IDFA/OpenUDID/GUID/SIM card IMSI information, etc.), a description of the basic conditions of personal common equipment information |
| Personal Location Information | Including the trajectory, precise positioning information, accommodation information, latitude and longitude |
| Other Information | Marriage history, religious belief, sexual orientation, undisclosed criminal records, etc |

**Table 3**. The Content of Personal Privacy Information Stipulated by GDPR and Chinese Privacy Protection Laws and Regulations.

**Personal Location Security:** Safe and reliable high-precision seamless positioning is the basis for obtaining high-quality location information. However, all kinds of positioning facilities do not have the ability of self-protection from the beginning of design. In fact, satellite positioning, network-based positioning, sensing positioning and other positioning technologies are facing different degrees of positioning security threats. Regardless of network-based localization or perception localization, according to the probability distribution relationship between wireless sensor Received Signal Strength (RSS) and location distance, there are malicious attacks such as attackers intercept and forge beacon phase data packets at different locations, and change the signal value of beacon nodes, which leads to positioning errors.

**Location Privacy Protection:** Location privacy security is an inevitable problem in the process of LBS. While enjoying the convenience brought by LBS, users should consider the privacy leakage problem caused by exposing location information to untrusted third parties. Location privacy includes single user's fixed Point of Interest (POI) privacy, continuous location trajectory privacy, and multi-user location big data privacy. LBS uses effective spatio-temporal indexing technology to efficiently process service query requests, and adopts different privacy protection strategies to effectively protect users' location privacy. The risk points of location privacy leakage include intelligent terminals that collect location information due to excessive or illegal collection, third-party agents of background servers, collusion between users and operator servers, association analysis, and ecosystem sharing.

## 6. CHALLENGES AND OPPORTUNITIES OF GEOGRAPHIC INFORMATION DATA CIRCULATION

The core of "Data 20" is to put forward four data basic systems, including the data property rights system, the data factor circulation and transaction system, the data factor income distribution system, and the data factor governance system.

Among these four systems, the data property rights system is the foundation, the circulation and transaction system is the core, the income distribution system is the driving force, and the governance system is the guarantee. The "Data 20" has initially set up our country's data basic institutional system, fully activate the value of data elements, empower the development of the real economy, activate the vitality of market players, promote the construction of a new development pattern, and promote high-quality development. With the establishment of the National Data Bureau and the release of the national data foundation system, it is bound to further stimulate the advantages of data elements.

The Overall Layout Plan for the construction of Digital China clearly points out that building a green and intelligent digital ecological civilization is the fifth important task of the construction of Digital China. Specifically, we should promote smart governance of the ecological environment, accelerate the construction of a smart and efficient ecological environment information system, use digital technology to promote the integrated protection and systematic management of mountains, rivers, forests, fields, lakes, grass and sand, improve the three-dimensional "one picture" of natural resources and the basic information platform of territorial space, and build a smart water conservancy system with digital twin river basins as the core. We will accelerate digital and green collaborative transformation. Advocating green and smart lifestyles.

Geographic information has important application scenarios in digital economy, digital society and digital government. In particular, spatio-temporal information empowers high-quality development, which mainly includes building a real 3D China, building a spatio-temporal computing power infrastructure, and building a spatio-temporal knowledge service infrastructure. Geographic information data circulation will certainly play a central role in supporting the construction of Digital China.

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