One Digital Blueprint: A Unified Architecture for Organizing Territorial Space Information and Innovations in Governance Practice

ZUO Wei, LIU Jinqiu, ZENG Peng

Abstract. The One Digital Blueprint is the essential embodiment of the Territorial Information Model (TIM) and a critical foundation for the implementation and management of territorial spatial planning. Its core lies in establishing a unified architecture for information organization around a fundamental logic: the grid-based, fully traceable lifecycle management of information concerning any territorial-space triad of land, entities, and people. Building on a mathematical model of multidimensional information vectors, this study formalizes a theoretical system for spatiotemporal information grids and derives the basic architecture and defining characteristics of digital territorial-space information organization. It further uses the logic of the information lifecycle to construct a fully traceable account of territorial-space information processes and governance. Taking the territorial-space digital governance platform of Tianjin Binhai New Area as a practical case, the paper presents the dataset architecture of the spatiotemporal information grid and representative operational scenarios of the platform. The study offers both theoretical insight and practical guidance for the digital governance of territorial space.

Keywords: one digital blueprint; Territorial Information Model (TIM); territorial-space governance; information grid; information lifecycle; spatial intervention.

Chinese Library Classification: TU984. Document Code: A. DOI: 10.16361/j.upf.202503010. Article No.: 1000-3363 (2025) 03-0079-08.

* Supported by the National Natural Science Foundation of China project "Boundaries of County-Level Territorial-Space Intervention: An Empirical Study Based on Multi-Source Data" (No. 52308074); the Ministry-Province Collaborative Pilot Project "Research, Development, and Demonstration of Key Technologies for the China Spatial Planning Observation Network (CSPON) in Xiong'an New Area" (No. 2023ZRBSHZ068); and the special project under the pilot reform of the delegated-agent mechanism for ownership of state-owned natural-resource assets, "Research on Advancing Integrated Land-Sea Development in Binhai New Area" (No. 2024GFW-0029).

1 Background

1.1 Vision and objective: digital national governance calls for a One Digital Blueprint

The digital transformation of national governance has long formed part of China's top-level institutional design, and territorial spatial planning and governance have now entered a comprehensively digital stage. Theoretical and methodological work in this field increasingly emphasizes digitalization, informatization, and intelligent technologies [1-2]. The Outline of the National Territorial Spatial Planning (2021-2035) called for the establishment of the China Spatial Planning Observation Network (CSPON), while the Work Plan for Building the National Territorial Spatial Planning Implementation and Monitoring Network (2023-2027) proposed lifecycle management of territorial spatial planning and an overarching Territorial Information Model (TIM). In recent years, emerging digital technologies have greatly expanded the technical possibilities for digital territorial space, and several pioneering regions have begun experimenting with CSPON-oriented systems [3-4]. Territorial spatial planning and governance have thus entered a new phase of comprehensive digitalization [5-6].

The One Digital Blueprint represents the overarching vision for digitizing territorial-space governance through TIM. By dismantling information silos among spatial-governance agencies and enabling the integration and normalization of management information, it supports the modernization of the territorial-space governance system and governance capacity.

1.2 Pressing constraints: the underlying logic of the One Digital Blueprint requires clarification and standardization

A review of current practice shows that the fundamental logic of the One Digital Blueprint remains insufficiently clarified and standardized.

(1) Clarifying its essential role: a unified digital foundation. In theoretical terms, the One Digital Blueprint has moved beyond a specific planning map or a simple overlay of sectoral layers [7-8]. The digital system for territorial-space governance likewise cannot be reduced to new technologies for plan preparation and decision-making [9], or to application-style innovation. It must advance toward systematic empowerment of digital management [2, 4] through a unified digital spatiotemporal foundation.

(2) Resolving the core challenge: a normalized logic of information organization. The One Digital Blueprint is not merely an aggregation of basemaps, baseline data, and spatial datasets. The urgent challenge is to establish, through a foundational logic of information organization, a unified mechanism for identifying, collecting, exchanging, and managing information of any scale, hierarchy, granularity, or category, thereby enabling intelligent territorial-space governance. Current research and practice on smart territorial-space platforms [10], digital-twin platforms [11-12], and big-data “one-map” platforms [13] appear to be approaching this objective. The unresolved bottleneck, however, is the need to fully address the horizontal coverage of all spatial elements in spatial intervention [14], the vertical effectiveness of full-cycle planning implementation and supervision [4, 15-16], and overall coordination.

(3) Providing a systematic theoretical foundation: mathematical standardization and a comprehensive framework. Some studies of digital territorial-space information platforms remain primarily practice-oriented introductions [17-18] and lack broadly applicable theoretical inquiry. Other studies have offered valuable conceptual advances, including spatiotemporal information foundations as an enabling infrastructure [6], the concept of a fully event-based spatial-planning management platform [5], and digital territorial-space governance built around unique spatial genes [19]. Yet systematic mathematical formalization and framework construction remain inadequate. The One Digital Blueprint therefore requires a normalized logical architecture with a transparent underlying logic, rigorous mathematical derivation, and comprehensive theoretical coverage, so that it can remain extensible and sustainable in practice.

2 Underlying logic and unified architecture of the spatiotemporal information grid

2.1 Basic characteristics

The One Digital Blueprint should exhibit four defining characteristics. First, information dimensions must be fully extensible: a dataset can be established for any object of spatial intervention according to management needs. Second, information content must be comprehensively interconnected: an intervention object’s spatial, temporal, and attribute dimensions should be organically linked. Third, the information architecture must be fully unified: information on every object should be incorporated into a normalized, integrated information-grid system. Fourth, object identification must be entirely unique: each object must correspond to a unique dataset that is clearly searchable and traceable.

Accordingly, every territorial-space object should be assigned a unique identifier and information chain. Information on land, entities, and people should be managed across scales and throughout the process, making grid-based, lifecycle-traceable territorial-space information the logical starting point of the One Digital Blueprint.

2.2 Underlying logic: constructing a spatiotemporal information grid from multidimensional vector theory

The spatiotemporal information grid is a digital grid in an abstract sense and comprises both a spatial grid and an information grid. For any real-world object, a multidimensional information vector can be constructed within a defined spatiotemporal context.

2.2.1 A multidimensional vector of spatial, temporal, identity, and attribute information forms a basic grid

In theory, the information associated with any entity may be represented as a multidimensional vector P. Spatial information (S), temporal information (T), and identity information (I) form the foundational dimensions of the grid system. On this basis, N categories of attribute information (V) may be added and extended according to practical needs for information recording, identification, and management. The mathematical mapping is:

$$P = \{S, T, I, V1, V2, V3, ..., Vi, ..., VN\} \quad (1)$$

In Equation (1), S records the object's position, orientation, scale, hierarchy, granularity, and other spatial states; T indicates the time or stage at which the object is recorded, transformed, or extinguished; and Vi denotes multidimensional territorial-space information beyond space and time, including land/entity type, economic attributes, and social attributes.

2.2.2 Existence and uniqueness of the object-identity vector in the spatiotemporal information grid

Within the basic information grid, the identity vector (I) has a distinctive role: it expresses the object's existence and uniqueness and establishes a one-to-one mapping between the object and its identity information. Important objects are generally assigned unique identification systems or codes. Examples include personal identity numbers, taxpayer identification numbers for enterprises, and patch identification codes in basic land surveys. From the perspective of information management, identity information makes the existence of an object unique; a patch identification code, for example, gives a spatial patch a unique identity. Accordingly, under a spatiotemporal information-grid system, the identity information of digital territorial-space objects commonly includes associated personal identity, spatial identity, and entity identity.

To provide a comprehensive account of the existence and uniqueness of identity information, the following meta-rules are also required for grid-based information governance:

(1) The existence and extinction of an object must themselves be recorded as information. For a spatial patch, one method is to reserve a specific digit in its identifier. For instance, the final digit of "BSM62***11" may be set to "1" to indicate existence and "0" to indicate extinction. Another method is to add a dedicated status field, with "E" representing the existence of the identity and "N" its extinction.

(2) Once an object has ceased to exist, its identity code must never be reassigned to another object. For example, because "BSM62***01" is bound to a particular patch, if that patch changes in extent or is merged into a new patch and thereby enters an extinct state, the code becomes invalid and a new identifier, such as "BSM62***02," must be assigned.

2.2.3 An important latent parameter in the grid: auxiliary management information attached to object attributes

In theory, each of the N categories of attribute information Vi (i = 1, 2, ..., N) should be accompanied by an auxiliary information unit that functions as an interface for identifying, transforming, and managing the information itself. The mapping is:

$$Vi = a_i^j \cdot v_i \quad (2)$$

In Equation (2), v_i denotes the object's pure attribute information for attribute i, while a_i^j denotes the corresponding auxiliary information. The latter is itself a multidimensional information sub-vector:

$$a_i^j = \{a_i^1, a_i^2, ..., a_i^j, ..., a_i^M\} \quad (3)$$

In Equation (3), if the subscript i denotes the land-use category, the superscript j denotes multidimensional auxiliary management information associated with that category, such as the code of a relevant spatial-control rule.

Auxiliary management information associated with the same attribute may therefore be multidimensional. Once such multidimensional auxiliary information is comprehensively implemented in digital territorial space, it can both identify and integrate complex attribute information within the same space and improve the efficiency of spatiotemporal information management by eliminating redundant components.

2.2.4 Full grid extension of the temporal dimension: the information lifecycle

Information is characterized by processes of creation, acquisition, indexing, storage, retrieval, distribution, presentation, migration, exchange, protection, and disposal, collectively described as the information lifecycle①. This lifecycle reflects the general law governing the transmission and movement of information [20-22]. It is evident not only in the dynamic change of territorial-space elements but also throughout every stage of spatial intervention. The underlying logic of the information lifecycle can therefore be understood as the longitudinal grid extension of temporal information (T). For any territorial-space object, provided that its identity information (Ir) remains unchanged, its information vector (Pr) can be treated as a function - or discrete sequence - of T:

$$Pr = fr(T) \quad (4)$$

Equation (4) is a general conceptual expression of the mechanism of temporal change. As Equation (1) shows, the information vector is a multivariate set; fr(T) is therefore a combination of functional relationships for multiple set elements, including S, T, and Vi. Two points deserve particular attention. First, the functional relationships of the object's attribute vectors Vi are the most dynamic and information-rich components and therefore require close observation. Second, temporal information T should itself be expressed as a function T(t) of a basic time sequence, whether in years, months, weeks, days, hours, minutes, or seconds, or as discrete time nodes composed of significant stages. Equation (4) can thus be expanded as follows:

$$fr(T) = \{S(t), T(t), Ir, Vi(t)\} = \{S(t), T(t), Ir, a_i^{j(t)} \cdot v_i(t)\} \quad (5)$$

In Equation (5), $S(t)$ indicates that the object's spatial information changes with the periodic variable t; $Vi(t)$ captures the change of any attribute i over time; and $Vi(t)$ can be further decomposed into the function of pure attribute information $vi(t)$ and the function of auxiliary management information, where $j(t)$ denotes the function of a specific management-information category j with respect to t. The information lifecycle of any territorial-space object can therefore be translated into an analytical function in which multiple factors and elements vary over a time sequence.

Equations (1) through (5) thus extend the information-vector set of any object both horizontally, in a static sense, and vertically, in a dynamic sense, forming a multidimensional and three-dimensional information-grid system.

2.3 Basic architecture: an integrated structure of space, object, and information

On the basis of the preceding logic, the spatiotemporal information grid can be translated into several concrete grid systems for digital territorial space and its governance: a foundational spatial-grid system, a foundational object-grid system, and an information-grid system for attributes and administrative events.

2.3.1 A foundational spatial grid subdivided to atomic units

The spatial grid provides the basic order for dividing and organizing space. It may be subdivided vertically as required until a spatial patch becomes an atomic unit② that is no longer suitable for further subdivision and instead corresponds to a specific physical entity, such as a building, facility, tree, or body of water. For any territorial-space entity, the spatial-grid system can therefore be represented by S_grid in the information-vector set:

$$P = \{S\_grid, T, I, V1, V2, V3, ..., Vi, ..., VN\} \quad (6)$$

The foundational spatial-grid system can precisely identify a region, extent, and location and is therefore the most fundamental component of a vertically integrated digital territorial-space governance system.

On the one hand, administrative units should serve as the basis for fully exploring the granularity of grassroots spatial units. Administrative divisions are among the most universally applicable and compatible forms of spatial hierarchy and are closely aligned with the requirements of geographic information management, urban-rural construction management, land administration, and forestry administration. On the other hand, administrative divisions extend only to the village level. Taking a prefecture-level city as an example, they can be refined vertically only to a four-level grid: city -> county/district -> township/subdistrict -> village/community. This remains insufficient for refined spatial governance.

As capabilities improve in grid-based governance, basic investigation of spatial entities, boundary delineation, and rights confirmation, the system may be subdivided into fifth- and lower-level grids. First, the fifth-level grid may be divided into villagers' groups/teams③ in rural areas and community grid units in urban areas. Second, the sixth-level grid approaches the theoretical atomic unit and may be specified differently according to territorial conditions and governance tasks. In urban areas, it may be subdivided into planning or construction blocks and cadastral parcels; in agricultural areas, according to the logic of agricultural operation and production organization, it may be subdivided into contracted-management-right plots④ or even cultivated fields; and in forest areas, forest compartments⑤ may serve as basic grid units. These together form a foundational spatial grid covering the entire territory. For convenience, the sixth-level grid may be collectively termed the parcel grid. At the municipal scale, the foundational spatial grid of the One Digital Blueprint can therefore form a six-level hierarchy: city -> county/district -> township/subdistrict -> village/community -> villagers' group/community grid -> parcel.

2.3.2 A foundational object grid centered on land, entities, and people

Attributes can be assigned only after real-world entities have been identified. Land, entities, and people should therefore serve as the basic physical objects of the system (Figure 1), forming a foundational object-grid architecture centered on the land-entity-people triad.

Land is the foundational spatial carrier. It generally comprises basic plots where rights have not yet been confirmed or cadastral parcels where rights have been confirmed, as the smallest grid units. The aggregate of numerous land-patch polygons forms the basic grid whose core is land. Following the general principle of Equation (1), the information-vector set of any land-based entity P_{land} can be expressed as:

$$P_{land} = \{S_{land}, T_{land}, I_{land}, V1, V2, V3, ..., Vi, ..., VN\} \quad (7)$$

Entity refers to the broad range of intervention elements based on spatial carriers. These include not only fixed objects on the land but also underground objects. They encompass natural resources and physical features above and below ground, agricultural and forestry features, production and living facilities, buildings and structures, and regional environmental elements. Any object that can be incorporated into an information-identification, binding, and lifecycle-management system becomes part of the foundational grid centered on entities.

People refers to stakeholders. The significance of a people-centered information grid lies in linking the socioeconomic relationships between stakeholders and the associated land and entities, thereby creating explicit information mappings and chains of spatial intervention.

Taken together, land, entities, and people provide a comprehensive account of the foundational information of territorial space. More importantly, these three information categories serve as anchor information in the regional spatiotemporal information-grid system. Because each has unique spatial, locational, and identity information, they provide essential reference points for organizing massive volumes of entity and attribute information and can mutually connect and support one another. The foundational object-grid system serving the One Digital Blueprint is therefore built around three core information sets: land, entities, and people (Figure 1). When spatial-grid information is incorporated, the information-vector set for any governance object in territorial space can be expressed as:

$$Pr = \{S_{grid}, T, Ir, V_{land}, V_{people}, V_{entity}, ..., Vi, ..., VN\} \quad (8)$$

Here, S_{grid} provides the basic spatial reference; V_{land}, V_{people}, and V_{entity} carry the object's foundational land, people, and entity information; and together with other attributes Vi they form a rich information-vector set subject to grid-based information capture, tracking, dispatch, and management.

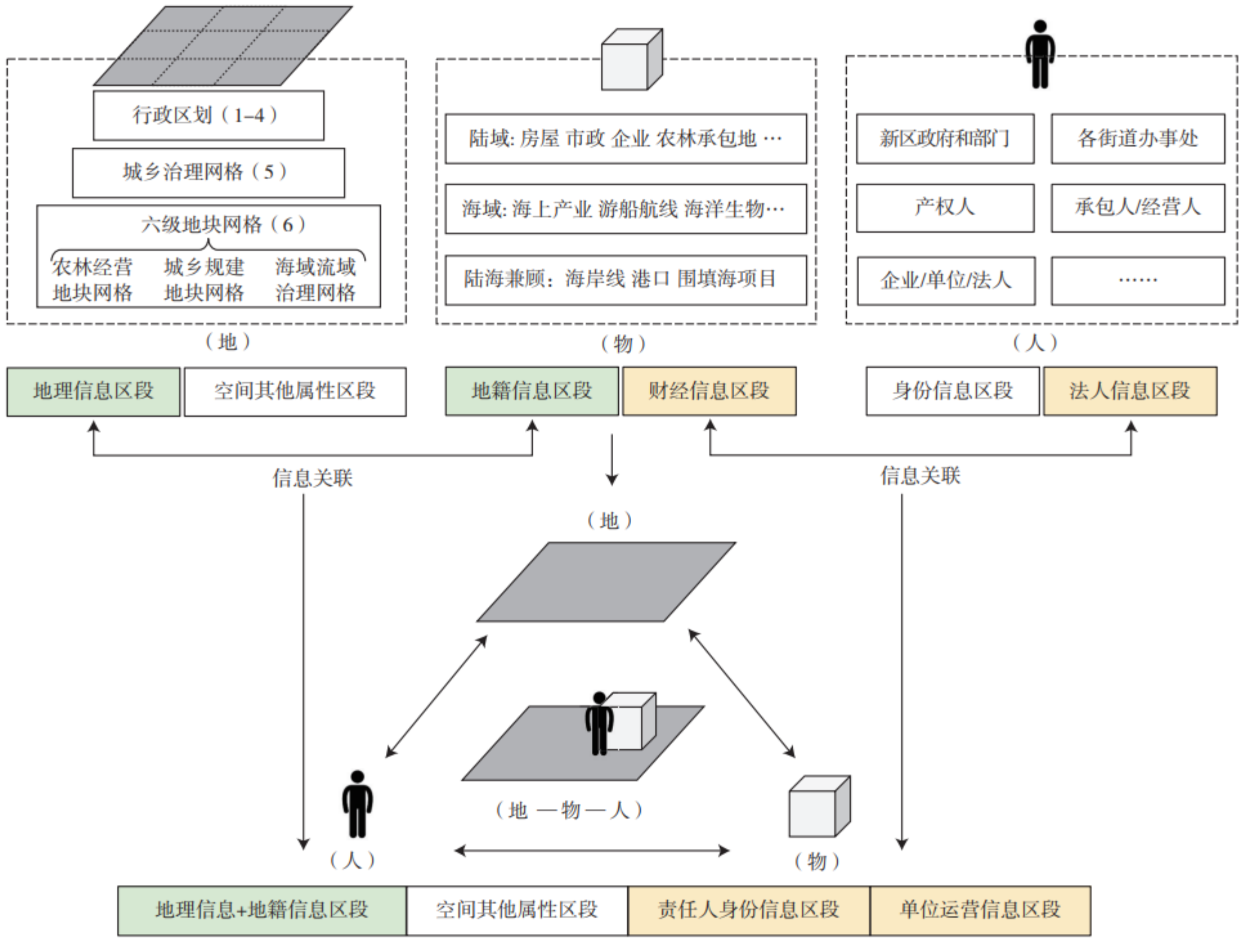

Figure 1. Information-linkage structure of the foundational object system centered on the "land-entity-people" triad in Binhai New Area

2.3.3 Mapping attributes and administrative events to auxiliary management-information units

How can the relationships among land, entities, and people be represented in sufficient depth to produce more explicit operational effects? The key is to comprehensively link, map, and integrate important information dimensions, including the attributes of intervention objects and the administrative events generated by spatial-intervention activities.

Attribute refers specifically to characteristics of an intervention object other than land, entities, and people. In the multidimensional information vector, these are the extensible information matrices represented by Vi, including categories, properties, functions, and detailed parameters. Under a grid-based information architecture, the One Digital Blueprint must first achieve comprehensive linkage among land, entities, people, and attributes. Its central principle is to assign normalized cataloguing rules to all attribute information. Although standards already exist for cataloguing feature attributes in geographic information, territorial surveys, land and sea use, forestry, grassland, water and soil resources, and environmental-factor management⑥, they have never been fully integrated into a genuinely unified format. This is the critical technical issue in linking land, entities, people, and attributes.

Event information refers to recordable factual information generated in the dynamic evolution of territorial-space objects, with particular emphasis on administrative events arising from spatial intervention.

It is a concrete manifestation of the auxiliary management information described above. In e-government systems, the processing and completion of administrative matters generate event records, including the responsible department, legal or policy basis, stage, opinion, and timestamp. Because event information is dynamic, it helps capture cyclical and stage-based changes in spatial governance. Its administrative scope should cover planning, land, forestry and grassland, resources, environment, construction, housing, transport, agriculture and forestry, water affairs, landscaping, urban management, and other necessary fields. All actions, stages, and outcomes of planning intervention should therefore be incorporated into a unified information-grid system. The relationship between the dynamic development of intervention events and the attributes of the object can be translated into the mapping structure of auxiliary management-information units described in Equations (2) and (3). In short, the linkage among land, entities, people, attributes, and events is always based on a deeply grid-based mechanism.

2.3.4 Embedding the information lifecycle into the grid to enable whole-process governance

Change in territorial-space systems and spatial intervention are always integrated systemic processes [23], and the large volumes of information they generate exist throughout the process. One of the most important foundations of lifecycle territorial-space governance is therefore lifecycle information management. Without continuous information capture, lifecycle spatial intervention cannot be achieved.

A lifecycle mechanism should therefore be established for identifying and capturing information attached to each object, covering the entire process from information creation to extinction and all other change events, including changes or transformations in every category of information generated by the object's evolution within the system. In the context of spatial governance, each specific action or implementation process - process A -> process B -> ... - can be represented within spatial grids and object grids at every level (Figure 2).

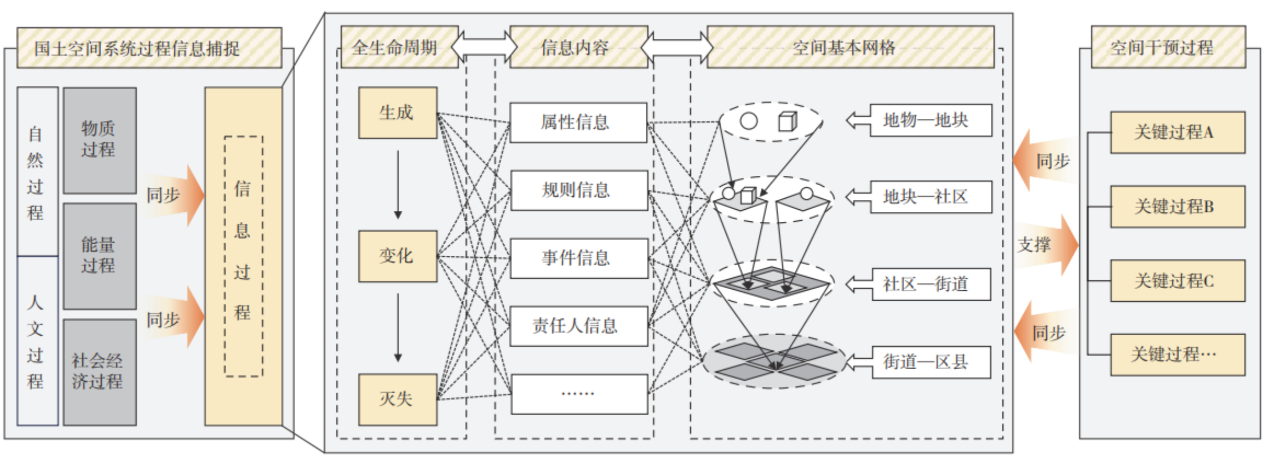

Figure 2. Full-lifecycle coupling of territorial-space system processes and information processes

3 Concept and practice of the One Digital Blueprint digital-governance platform for Binhai New Area

Since 2022, Binhai New Area (hereafter, the New Area) has implemented a pilot reform of the delegated-agent mechanism for ownership of state-owned natural-resource assets. Building on the State-Owned Natural-Resource Asset Management Information System and Supervision Platform, the authors explored the development and application of a One Digital Blueprint digital-governance platform for territorial space. The platform is designed to create a digital application environment in which spatiotemporal information is comprehensively grid-based, fully traceable throughout the lifecycle, and interactively connected across multiple information layers, thereby enabling multi-party coordination, cross-element collaboration, and comprehensive, refined territorial-space governance.

3.1 Basic principles for building the One Digital Blueprint digital-governance platform

3.1.1 Comprehensive identification of object information and organic linkage among land, entities, and people

Based on the organic land-entity-people framework, information should be identified and incorporated into the spatiotemporal information-grid system according to governance needs and within feasible technical conditions.

Identification of land-object information. Given the combined land-sea character of the New Area, data should be sampled from different periods, including land-use data, land and marine cadastral surveys, planning-zone data, sea-area-use zoning, thematic coastline survey data, administrative units, and urban-rural grassroots governance grids, thereby forming a six-level spatial-grid dataset.

Identification of entity-object information. Composite data-acquisition technologies should be used to obtain information on the full range of entity elements that can be incorporated into the New Area's spatiotemporal information grid, including land and marine objects, moving elements, functions, facilities, and landscape points, thus achieving full territorial and full-element coverage of land and sea use.

Identification of people-object information. Governance actors involved in territorial-space governance in the New Area should be clearly identified, together with the functions and powers of relevant Tianjin municipal departments, New Area departments, subordinate administrative committees, social organizations, and the public. The socioeconomic relationships between these actors and the corresponding land and entities should then be linked to create information mappings and chains of spatial intervention.

Land, entities, and people are organically integrated through the information sections they carry. As Figure 1 shows, the geospatial information section of a land object is linked to the cadastral information section of an entity object; the legal-person information section of a people object is linked to the financial-information section of an entity object, connecting each element with its stakeholders. Attribute information for land, entities, and people is organized through different attachment mechanisms, integrating the object's own attributes, the scope of spatial control, management actors, and other attributes into complete information sections.

3.1.2 Capturing the information lifecycle and fully coupling the temporal and spatial dimensions

On the basis of the theoretical model of full-lifecycle information, the platform dynamically captures information on spatial interventions undertaken by all departments in planning, land, forestry and grassland, resources, environment, construction, housing, transport, agriculture and forestry, water affairs, landscaping, urban management, marine affairs, and fisheries. It extracts temporal information T, identity and ownership information I, event-related attributes of land, entities, and people (V_land, V_entity, V_people), and linked auxiliary management information a_i^j, and integrates them into the New Area's spatiotemporal information-grid set fr(T), fully coupling the temporal and spatial dimensions.

3.1.3 Aggregating multi-source heterogeneous data and integrating composite information-acquisition technologies

Information sources and providers are distributed across multiple departments, actors, channels, and networks [7]. The institutional mechanism for information management in the New Area should therefore be optimized through centralized coordination and multi-departmental collaboration, establishing both vertical and horizontal connectivity. By combining composite spatial and information technologies⑦, the system can collect, capture, store, and transform diverse information forms beyond documents, maps, and numerical data - including on-site photographs, video and multimedia, and virtual-reality content - into a multi-source heterogeneous database.

3.2 Spatiotemporal information-grid architecture of the One Digital Blueprint digital-governance platform

According to the actual conditions and management needs of the New Area, the platform uses the foundational grid as its spatial carrier, enabling accurate and effective linkage among land, entities, and people and dynamic lifecycle management of information (Figure 3).

3.2.1 Unified architecture and transmission of the foundational spatial grid

A six-level spatial grid is progressively established according to the New Area's administrative divisions and practical management requirements across urban-rural areas, agriculture and forestry, and land and sea. Below the fourth-level grid, urban and village areas are refined into governance grids, including communities, villagers' groups, and industrial parks⑧, and ultimately into sixth-level parcels or plots. Agricultural areas are refined into contracted-management-right plots and then into individual cultivated fields; forest areas into forest compartments and then subcompartments; and watersheds and water areas into river-channel unit grids according to the functions of major water bodies and river sections, then further into river- or water-control patches in conjunction with shoreline controls and plot divisions. Marine areas are refined into functional sea-area zones and ultimately into specific mariculture units and marine production-control units.

3.2.2 Grid-based organization of stakeholder and intervention-element information

Stakeholders - the people objects - consist primarily of governments, departments, and other interested parties. They include Tianjin municipal agencies; departments under the New Area government, such as the planning and resources bureau, marine bureau, and ecology and environment bureau; administrative committees for designated areas such as the China-Singapore Tianjin Eco-City; all levels of governance bodies, including subdistrict offices and villagers' or residents' committees; and social organizations, key enterprises and public institutions, the general public, and property-right holders. Together they form a multi-party information-network architecture for intervention (Figure 3). All categories of intervention elements are incorporated into the grid under the principle of full-range inclusion and become elements carried by spatial grids. On this basis, stakeholder and intervention-element information is further organized into information grids, vertically and horizontally integrating the unified land-entity-people architecture.

3.2.3 Information chains and grid-based coding of spatial-intervention activities

Constructing the land-entity-people-attribute-event chain is one of the platform’s most difficult tasks because the types, processes, and components of spatial intervention are highly complex and require a cataloguing logic based on the grid framework.

On the one hand, theoretical synthesis shows that any spatial intervention can be structured as an actor-path-object system: an intervention actor affects an intervention object through a particular pathway [24]. A spatial-intervention activity can therefore be treated as an element within a specific intervention pathway. On the other hand, the generation of an intervention pathway is itself an information system organized around a spatial-intervention theme, such as planning, construction, or ecology, and its subthemes.

Accordingly, on the basis of the grid-based construction of stakeholder information V_people and intervention-element information V_entity, event information on spatial-intervention activities is catalogued according to the grid logic of auxiliary management information a_i^j. Let i denote a spatial-intervention theme corresponding to an object attribute, such as approval of marine reclamation, thereby defining the dominant intervention pathway. Let j denote an intervention event within that pathway. Grid-based cataloguing can then differentiate components such as event type, procedural stage, and technical or policy instrument.

3.2.4 Incorporating full-lifecycle information into the grid architecture

The integrated spatiotemporal information grid of the New Area forms a lifecycle information framework attached to objects across both land and sea. On the basis of intervention-process event information and information-operation records, all events involving the creation, modification, and extinction of each object are fully documented. This creates long-term, grid-based lifecycle chains for survey and statistics, assessment and evaluation, spatial planning, land and sea-use approval, certification and registration, change of use, implementation supervision, inspection, and law enforcement.

In addition to recording changes in the object’s own information, the platform simultaneously records responsible persons and operational logs associated with the change process, thereby improving the territorial-space governance network.

3.2.5 Establishing unique relationships through object identity codes

A unified code-management system is assigned to the preceding information architecture. Every object receives a unique identity code composed of a stakeholder code segment, foundational spatial-grid code segment, land or marine entity code segment, and event and auxiliary-information code segment. Each segment contains multiple code types, which together form the unique identity code of an object in the New Area’s spatiotemporal information grid (Figure 3), enabling deep grid-based organization and refined management of all territorial-space elements.

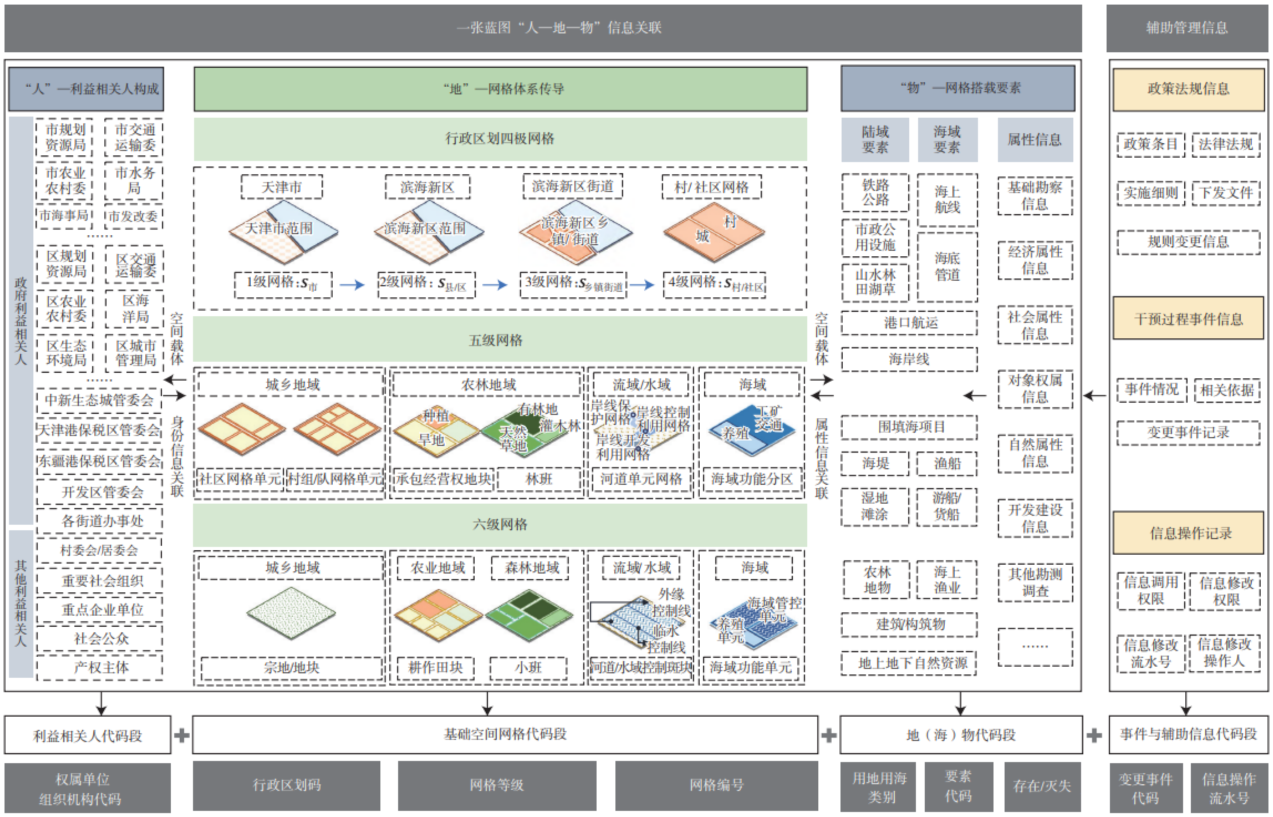

Figure 3. Spatiotemporal information-grid architecture of Binhai New Area

3.3 System development and application of the One Digital Blueprint digital-governance platform

3.3.1 Basic system characteristics and major functional modules

An open framework has been preliminarily established for the Binhai New Area Digital Territorial-Space One Digital Blueprint Information Platform. It comprehensively coordinates land-sea information on land, entities, and people throughout the New Area, accurately locates every object and its associated information in space, and enables timely retrieval of attributes and related change events. All recorded information can be clearly searched, traced, and managed. The functional structure is shown in Figure 4, which illustrates the platform interface with the Attribute Query and Administrative Query modules expanded.

3.3.2 Precise identification and object indexing through the six-level spatial grid

The six-level spatial-grid search enables precise spatial identification of objects. Users can then select Attribute Query through a right-click menu or navigation interface to display the object's full attribute information - V_land, V_entity, and V_people - as shown in Figure 4. This includes two modules: stakeholder information for spatial intervention and fixed-attribute information. The stakeholder module records in detail the organizations, departments, and individuals associated with the object and distinguishes such roles as principal responsible person, authorized person, and operator, forming an accurate and complete chain of administrative roles. The fixed-attribute module contains the basic information of the spatial object.

Taking a land-transfer event for a particular cadastral parcel as an example, when the original transfer application is entered into the platform as a change to transport-service-station land and public-utility land, the use-control information for the new land category and information on the responsible authorities change accordingly. The platform also displays in real time the prerequisite information for the change, records of the relevant processing workflow, and the information-operation log of the change process.

3.3.3 Management and presentation of each object's unique information code

The object's attribute and administrative-event information is fully represented in its unique code (Figure 4). The stakeholder code segment identifies the organization, such as the Binhai Power Supply Branch of State Grid Tianjin Electric Power Company. The foundational spatial-grid segment records the administrative-division code, grid level, parcel number, and related data. The land or marine entity segment identifies the code of elements carried by the spatial object and their existence or extinction status; the element code distinguishes the object's specific category. The event and auxiliary-information segment identifies related change events and the serial number of the information operation. If the object is currently at the planning-scheme review stage, for example, "07" is used to identify the operation serial number.

3.3.4 Presentation and sustained management of full-lifecycle information

By selecting the Administrative Query module, users can rapidly retrieve the current progress of an object's administrative process and records of related events. For the example spatial object, the Progress Query section consolidates processes and documents from earlier cadastral surveys, land-value calculation, applications for land-type changes, and other procedures, ensuring completeness of the materials required for administrative processing.

The Administrative Event Record section displays in real time planning information, meeting records, and notification documents associated with the object. The Historical Administrative Query section simultaneously archives past events related to the land-use change, including the administrative matter, implementing department, and execution time. When administrative information is adjusted, older archive versions remain effectively managed, enabling sustained whole-process management.

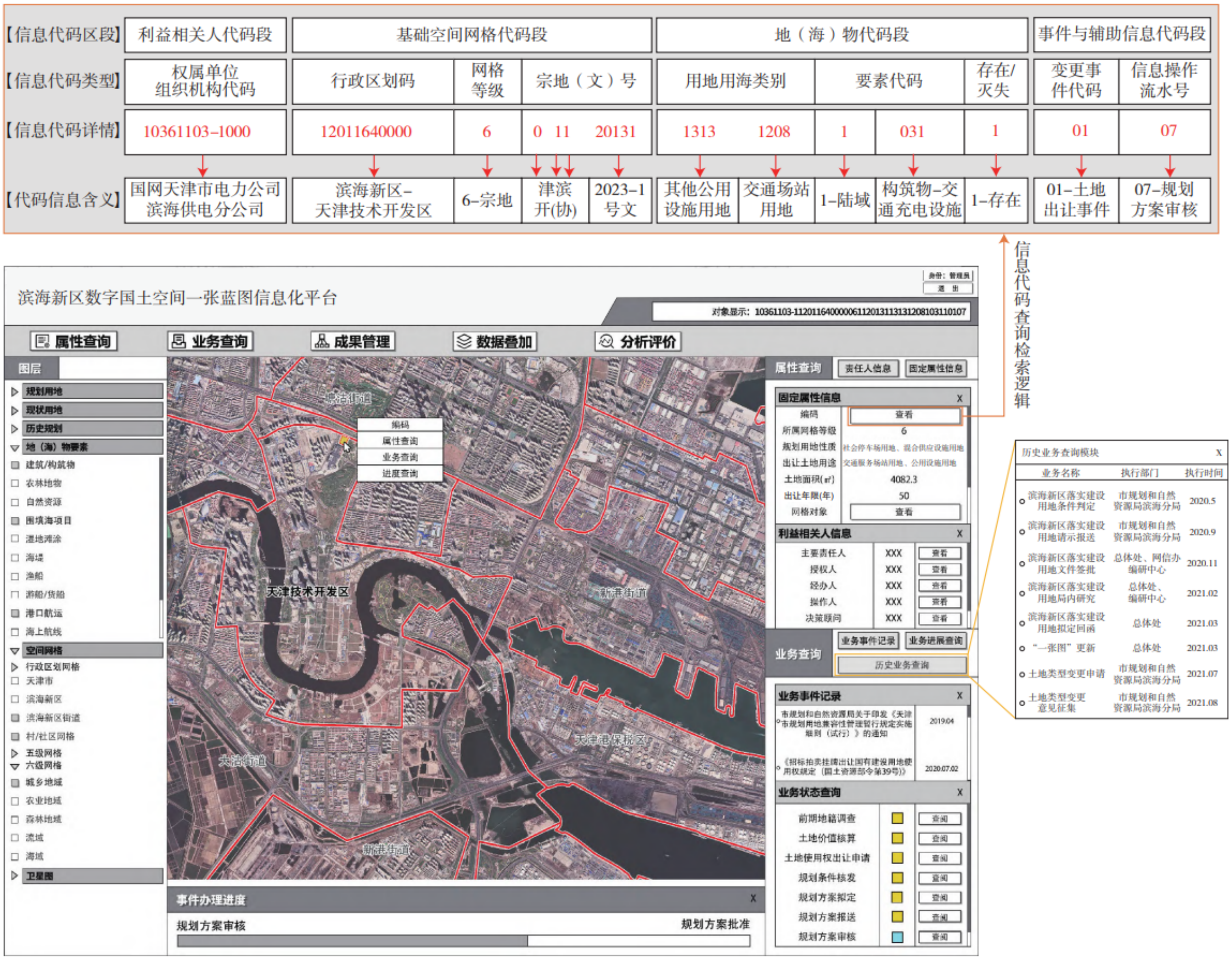

Figure 4. Operational schematic and functional layout of the One Digital Blueprint information platform for Binhai New Area

4 Conclusions and outlook

This study seeks to clarify the foundational logic required by the One Digital Blueprint for territorial spatial planning and governance in the digital era. Its key contribution is the formation of a spatiotemporal information-grid architecture and a traceable full information lifecycle. Through rigorous mathematical derivation, the paper explains these mechanisms and their correspondence with massive real-world spatiotemporal information on land, entities, and people. It then demonstrates their application scenarios and potential for broader implementation through the construction and operation of a specific One Digital Blueprint platform.

Two prospects can be anticipated. First, as China continues to deepen digital governance, the One Digital Blueprint architecture for digital territorial space proposed here has the potential to become a widely transferable digital platform for spatial governance. Second, as multidimensional information about diverse objects continues to expand, the platform's spatial-information system will also broaden, creating progressively greater capabilities and possibilities for spatial intervention.

Notes

① At the annual meeting of ISO/TC 171, Document Imaging Applications, held in London in October 2000, a broadly accepted proposition concerning the information lifecycle was articulated: whether information is managed in physical or digital form, its lifecycle includes creation, acquisition, indexing, storage, retrieval, distribution, presentation, migration, exchange, protection, and final disposition or disposal.

② The smallest spatial unit whose properties and characteristics are internally most similar.

③ An abbreviation for villagers' group/team. An administrative village is further divided into villagers' groups, which are the basic units of villagers' self-governance. During fieldwork conducted by the authors and the project team in 2022-2023 in City D in northwestern China and City Q on the coast, villagers' groups had already been incorporated into party-government governance grids. The community-grid division discussed below - dividing a community into several spatial-governance grids - is likely to be more broadly applicable.

④ Such information is generally held by the agricultural authority of the county-level government.

⑤ With reference to Terminology of Forest Resources (GB/T 26423-2010) and Technical Regulations for Forest-Land Boundary Delineation in Forest-Land Protection and Utilization Planning (LY/T 1955-2011), a forest compartment, or even a subcompartment, is a grid unit below the administrative-village level: county -> township -> village -> forest compartment.

⑥ Examples include Classification and Codes for Features of Fundamental Geographic Information (GB/T 13923-2006); Technical Regulations for the Third National Land Survey (TD/T 1055-2019); Guidelines for the Classification of Land and Sea Use in Territorial-Space Survey, Planning, and Use Control (Trial, 2020); Classification and Codes of Forestry Resources - Forest Types (GB/T 14721-2010); General Rules for Classification and Coding of Water-Conservancy Objects (SL/T 213-2020); Standards for Classification and Grading of Soil Erosion (SL 190-2007); Classification and Codes for Eco-Environmental Information (HJ 417-2025); and Codes for Wastewater Discharge Patterns (Trial) (HJ 521-2009).

⑦ Composite information technology refers to the use of digital communications and Internet of Things technologies to mobilize smart cards, sensors, and mobile communication networks for broad dynamic data acquisition, real-time communication, and two-way interaction, thereby supporting spatial-information cognition, analysis, and management.

⑧ This corresponds to the recent implementation of territory-wide grassroots grid governance in Binhai New Area, including 388 community grids, 135 rural grids, and 105 enterprise grids.

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Revised: April 2025.

AI-assisted translation