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Article

A Review of the Application of Industrial Internet Identifier Resolution in the Lifecycle Management of IT Assets in Group Enterprises

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Abstract: With the deepening of digital transformation in group enterprises, IT equipment assets generally face issues such as "multiple codes for one item", information silos, and difficulties in dynamic tracking. The industrial internet identification resolution system, as a national new infrastructure, provides standardized and interoperable underlying capabilities for "one item, one code, and full life cycle traceability" management by assigning a globally unique "digital identity" to physical entities. This paper systematically reviews the technical architecture, standardization progress, and research and application status of the identification resolution system in the field of asset management, and summarizes the key issues and research gaps in the intersection of identification resolution and IT asset full life cycle management. Based on this, a lightweight technical path with identification as the sole primary key and intelligent association with the enterprise's existing material master data is proposed, and its applicability and implementation architecture are demonstrated from aspects such as coding, system integration, process reengineering, and data application. Further, an effectiveness evaluation framework covering the entire life cycle is provided from the two dimensions of application scenario mapping and quantifiable results. Combined with the practice of a large energy enterprise leading the construction of the secondary node of the industrial internet identification resolution system in the petrochemical industry, the application prospects of this path in asset fine management, operation efficiency, data value mining, and ecological collaboration are illustrated. This paper provides a forward-looking and operational theoretical framework and practical reference for the digital and intelligent management of IT assets in large group enterprises.

Keywords: Industrial Internet; Identification Resolution; IT Asset Management; Full Life Cycle Management; One Item, One Code; Digital Mainline

1. Introduction

Information technology (IT) equipment - servers, network switches, storage devices, etc. - are the core production and operation support assets for large conglomerates. Their management has characteristics such as high value, rapid updates, decentralized deployment, complex configuration, and multiple lifecycle stages (planning, procurement, inventory, deployment, monitoring, maintenance, retirement) [1-2]. Currently, most conglomerates still adopt traditional management models, where asset identities are encoded differently in ERP, CMDB, financial fixed asset ledgers, and physical labels, resulting in widespread "multiple codes for one item" issues. This directly leads to "data islands" among procurement, finance, and operation and maintenance departments: the overall asset picture is difficult to visualize, status updates are lagging, and historical traceability is challenging, seriously damaging asset utilization, operation and maintenance efficiency, and the scientificity of management decisions [3-4].

"Unique item code" is the key to solving this problem. The core is to establish a unique digital identity for each physical asset throughout its entire lifecycle. However, the choice of implementation path is crucial. Although some solutions emphasize deep encapsulation of internal attributes (such as the idea of integrating "material gene code" for internal and external dual codes), for conglomerates with a mature material master data system, introducing a completely new closed coding system often leads to complex mapping relationships with existing systems and higher management costs. The industrial internet identification resolution system, as an open network infrastructure based on national standards, its core idea is to provide a unified network query entry for objects, without directly carrying or replacing enterprise internal data, and is more suitable for solving "data association and traceability" problems across systems and stages [4-5]. Therefore, this paper focuses on the feasibility, architecture, and value of implementing a unified lifecycle management of IT assets for conglomerates using the industrial internet identification resolution code as a single primary key and in coordination with the existing material master data.

The contributions of this paper can be summarized in four aspects: (1) Systematically reviewing the technical architecture and standardization progress of the industrial internet identification resolution system, as well as the research and application status of identification resolution in asset management, and pointing out the research gap of "unified identity across systems while data remains within the domain"; (2) Proposing a lightweight technical path of "single code + master data coordination", different from the dual code integration solution, to obtain the maximum data integration benefits with the minimum cost of modification; (3) Constructing a mapping of application scenarios (Table 1), a quantitative effectiveness framework (Table 2), and a four-layer implementation architecture (Figure 4) covering all stages of the IT asset lifecycle; (4) Using the practice of a large energy enterprise leading the construction of a secondary node of the identification resolution system in the petrochemical industry as an example, to illustrate the feasibility of the proposed path at the case level.

The remaining parts of this paper are organized as follows: Section 2 reviews related work and technical basis; Section 3 analyzes the adaptability of the single identification resolution code solution in the IT asset management of conglomerates, and presents the mapping of application scenarios and effectiveness framework; Section 4 provides the application architecture, implementation path, and security governance; Section 5 validates and discusses through a case of a large energy enterprise; Section 6 summarizes and looks forward.

2. Relevant Work and Technical Foundation

2.1. Industrial Internet Identifier Resolution System

The industrial internet identification resolution system is often compared to the domain name system (DNS) of the internet, but its resolution objects have expanded from websites to all physical or logical entities [4]. China has released a series of national standards such as GB/T 42569-2023 "Industrial Internet Identification Resolution System Architecture" [5], adopting a hierarchical system: international root node, national top-level node (including recursive resolution nodes), industry/enterprise secondary nodes, and enterprise nodes [5-8]. The core process includes three steps: identification encoding, identification registration, and identification resolution. Assign a unique identification code to each IT device; when users scan the device's QR code, the application queries layer by layer through the resolution network, ultimately locating the enterprise node or application system address that stores the detailed data of the device, and returning the information within the authorized scope (as shown in Figure 1). This "separation of encoding and data" design is the cornerstone that balances data sovereignty and information sharing [4-5].

From the technical lineage perspective, identification resolution is not a completely new concept: there are Handle systems (IETF RFC 3650-3652) [9-11], object identifiers (OID), GS1's EPCIS standard [18], and China's Ecode (GB/T 31804-2015) [12] among others. Different systems have different emphases in terms of resolution performance, security model, and applicable scenarios, while the distinct feature of the industrial internet identification resolution system is its national standard foundation and focus on large-scale industrial interconnection. At the policy level, the "Industrial Internet Identification Management Measures" (2020) [13] and the "Action Plan for 'Integration' of Industrial Internet Identification Resolution System (2024-2026)" [14] provide institutional guarantees for its large-scale application; according to a relevant report from the China Academy of Information and Communications Technology (CAICT), China's identification resolution system has covered all major industrial categories and has formed a number of typical applications in equipment manufacturing, petrochemicals, and power industries [15-16]. The Industrial Internet Industry Alliance (AII) has also released "Industry Application Guide for Identification (Petrochemical)" [16] and "Industrial Internet Identification Resolution Standard System" [36], and the "Industrial Internet Innovation and Development Action Plan (2021-2023)" [37] further solidifies the policy framework. Identification resolution has also been explored in discrete manufacturing [40] and supply chain traceability [41].

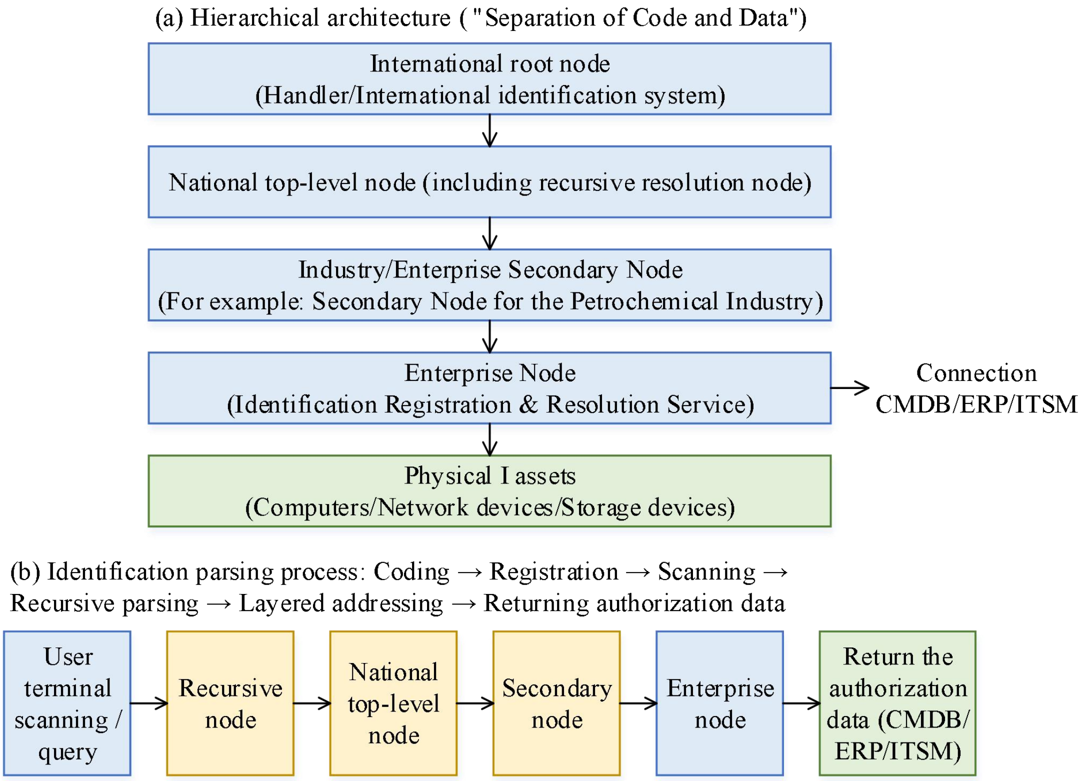

Figure 1. Industrial Internet Identifier Resolution: System Architecture and Resolution Process

2.2. Research Status of IT Asset Life Cycle Management

IT asset management (ITAM) aims to plan, control and optimize the entire lifecycle of IT assets from planning to disposal. ITIL 4 regards ITAM as a key practice, emphasizing the alignment of asset financial value with business goals [1]; the ISO/IEC 19770 series published by the International Organization for Standardization provides normative requirements for IT asset management systems and governance [2]. The CMDB, as the sole trusted source of configuration items (CI), is the factual foundation of operation management. However, in the practice of group enterprises, ERP material codes, asset card numbers, equipment serial numbers, CMDB configuration items and physical barcodes often operate independently, resulting in a typical "one item with multiple codes" predicament [3-4].

To address this predicament, existing research often starts from single-point technologies: Fixed asset management systems based on barcodes or RFID can significantly improve the efficiency of single-point inventory [19-20], but fail to fundamentally solve the identity unification and data integration across systems; Digital mainline and digital twin research provide theoretical tools for the data integration of the entire asset lifecycle [21-25, 27-28], and the ISO 23247 series provides a reference framework for manufacturing digital twins [28]. Overall, existing literature is relatively comprehensive in terms of identification resolution system architecture, resolution performance and security [4, 29-30], ITIL/CMDB/RFID asset management [1, 3, 19, 38-39], and product digital twins [21-25, 27, 35], but research on identifying resolution as the "identity layer" and lightweight integration with the enterprise's existing master data system is still relatively weak.

It is worth noting that barcode and RFID technologies only solve single-point automatic identification and do not define the semantic of cross-organizational and cross-system identification and resolution capabilities; Identification resolution precisely fills this gap, elevating "identification" to "addressable, associated, and collaborative" [4, 17]. This also explains why in group enterprises that have established CMDB/ERP, simply strengthening barcodes is difficult to eliminate "multiple codes for one item", and it is necessary to introduce an identification infrastructure with global addressing capabilities as the identity foundation.

2.3. Application of Digital Mainline and Digital Twin in Asset Management

The digital main thread emphasizes the data flow that runs through the entire life cycle of products/assets, enabling the correlation and traceability of data at each stage of design, manufacturing, operation, and decommissioning [21, 26]; digital twins construct real-time digital mirrors of physical assets in the virtual space [21-25]. Both have relatively rich practical applications in the manufacturing field, but the research on IT assets (servers, network devices, etc.) is relatively insufficient. Identifier resolution is regarded as a key enabling technology for building the digital main thread of assets due to its "unified identity anchor point" feature: using identifiers as an index, the dynamic data scattered in ERP, CMDB, monitoring systems, and operation work orders are associated into a continuous digital archive [4, 17]. This perspective expands the research object of this paper from "products" to "IT assets", which is a beneficial supplement to the existing research on digital main threads [26-27, 35].

2.4. Research Gaps and the Focus of This Study

Based on the above literature, three types of research gaps can be identified: Firstly, the research on identification and interpretation mostly focuses on the system architecture and interpretation performance, lacking specific scenario mapping for asset management (especially IT asset management); Secondly, the research on asset management mostly stays at single system or single-point technical improvement, lacking a lightweight integrated path for cross-system identity unification; Thirdly, the research on digital main thread/digital twin mainly focuses on manufacturing products, and the applicability demonstration for the high-value and highly controlled object of IT assets of group enterprises is insufficient. The starting point of this paper is: Using the industrial internet identification and interpretation code as the sole primary key, a collaborative method of "mapping rather than replacing" with the existing material master data is proposed, and an application scenario mapping covering the entire life cycle and an implementable architecture are provided to respond to the above research gaps [4, 29, 34, 42].

2.5. Theoretical Framework of This Paper: Identification as the Primary Key - Main Data Synergy - Digital Mainline Integrated into One

Based on the aforementioned research gaps and the adaptability analysis, this paper proposes a tripartite theoretical framework of "Identification as Primary Key - Main Data Synergy - Digital Main Line" (Figure 2) to integrate the application logic of identification analysis in the entire lifecycle management of IT assets.

The first pillar "Identification as Primary Key": Use a unified identification code as the unique digital identity primary key for the asset, replacing the heterogeneous codes scattered in various systems, fundamentally eliminating "multiple codes for one object". The second pillar "Main Data Synergy": Establish a mapping relationship rather than an alternative relationship between the identification code and the existing enterprise material main data, achieving cross-system identity unification with the minimum cost modification, following the principle of "data remaining within the domain". The third pillar "Digital Main Line": Use the identification as a link to connect the data of planning, procurement, deployment, operation and maintenance, and retirement in the five stages, forming a traceable and analyzable full lifecycle data chain.

The input layer of this framework is multi-source data of IT assets, enterprise main data and various business systems; the identity layer generates a unified identification; the three pillars constitute the capability hub; the effectiveness layer corresponds to the eight quantifiable effectiveness dimensions in Section 3.4. This framework emphasizes the two principles of "mapping rather than substitution" and "data remaining within the domain", taking into account both group control and cross-domain collaboration [43-45].

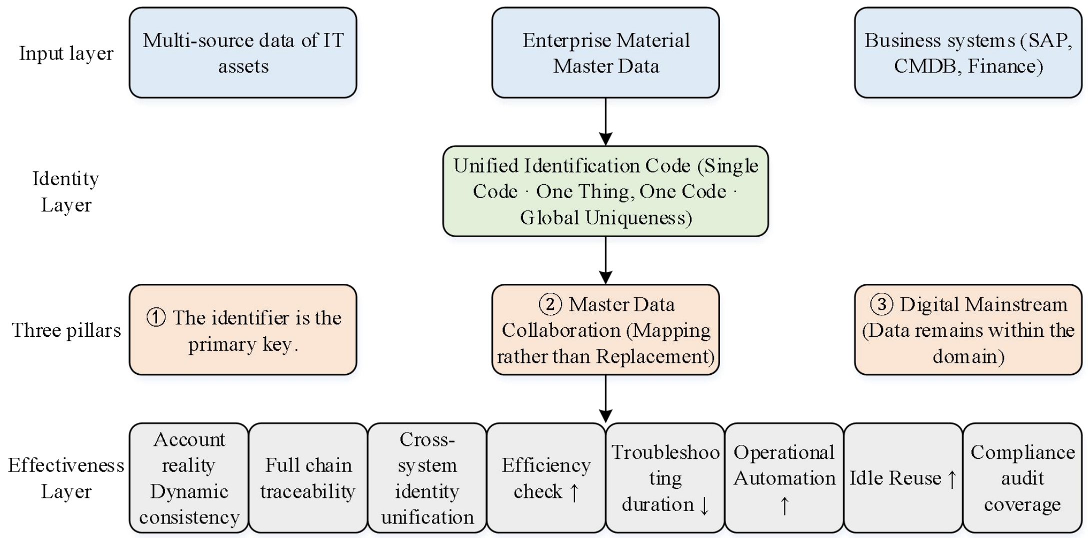

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Figure 2. The Tripartite Theory Framework: Identifier as Primary Key - Main Data Synergy - Digital Main Thread

3. Adaptability Analysis of the Single Identifier Decoding Scheme

3.1. Collaboration with the existing master data system for materials

The master data management system established by large-scale group enterprises (such as a major energy company) is a core data asset. The single identifier resolution code scheme does not overthrow or replace this system; instead, it serves as a "collaborative enhancement layer" and a unified "access point" (as shown in Figure 3). The relationship between the two can be summarized as "mapping rather than substitution": for each physical instance of the main data of a material (such as a certain model of server), a unique identifier resolution code is assigned, and this identifier code is established with a stable association mapping to the material code, asset card number, equipment serial number in the ERP system [4, 16].

In this relationship, the main data is responsible for "what it is" - defining the classification, standard names, technical parameters, etc. of the asset; the identifier code is responsible for "where it is, who is using it, and what the status is" - through dynamic association and presentation, the procurement information, storage location (data center/cabinet/U position), using department, current operation status, and historical work orders of this specific instance are presented as dynamic full life cycle data. This model maximally protects the existing IT investment and management inertia, and solves the fundamental problem of "data integration" through "a layer of lightweight identifier mapping".

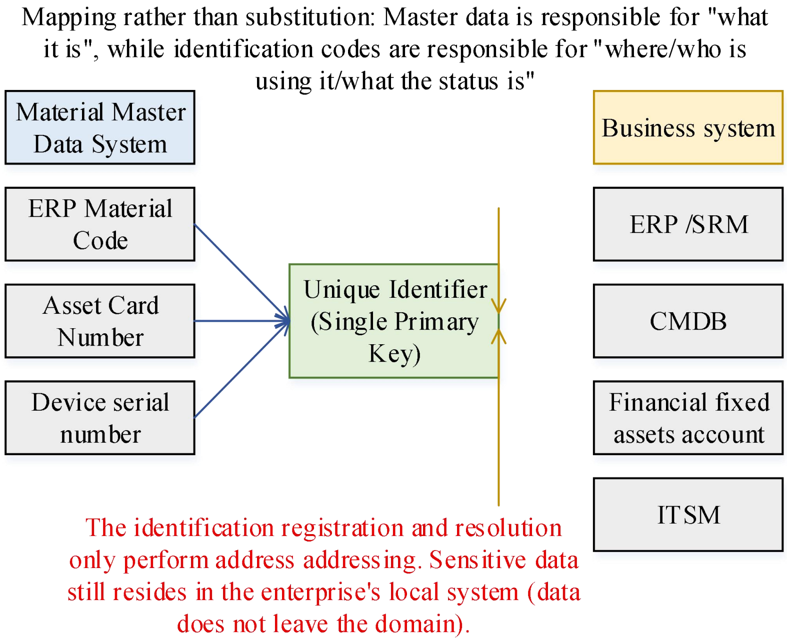

Figure 3. The relationship between the identification code, the main data of materials, and the business system

3.2. Solutions to Pain Points in IT Equipment Management

(1) Solving "Account-Physical Discrepancy": Mandatory scanning of QR codes at each stage of physical state change (such as warehousing, shelving, relocation, and decommissioning), with the identification code serving as a trigger to update the real-time data in the background system (ERP, CMDB), ensuring synchronization between the digital world and the physical world [3-4]. (2) Achieving "Full Chain Traceability": Scanning any device identification code presents its "past and present" in one step - from procurement requests, contracts, orders, suppliers, original configuration, to historical maintenance records, component replacements, configuration changes, and performance histories, forming a complete digital asset file [17]. (3) Empowering "Intelligent Maintenance": Maintenance personnel can quickly obtain complete equipment information by scanning on-site and create work orders; the identification code serves as a data index, automatically linking real-time performance data from monitoring systems (such as Zabbix, Prometheus) and knowledge base fault solutions, significantly improving troubleshooting efficiency [24, 27]. (4) Supporting "Group Management": The unified identification system enables the headquarters of the group to transparently and visually display the entire IT asset panorama across the country and even globally, providing a data foundation for unified resource scheduling, idle asset reuse, and standardized compliance audits [31-32]. Specific scenarios and data assets can be found in Section 3.3 Table 1.

3.3. Lifecycle Stage - Application Scenario Mapping for Identifier Resolution

In order to apply the above capabilities throughout the entire asset management process, this article divides the IT asset life cycle into five stages: pre-phase, delivery, deployment, operation and maintenance, and retirement, totaling eleven steps. It also provides the corresponding identification, interpretation of application scenarios, and the key data assets generated for each step, as shown in Table 1. This table not only demonstrates the dynamic value of the identification code beyond the static "what it is" - "where/who is using it/what is the status", but also provides a requirements list for the subsequent effectiveness framework (Table 2) and implementation path.

Table 1. IT Asset Lifecycle Stages - Application Scenarios for Identification and Resolution - Key Data Asset Mapping

Stage	Stage; Section	Identification interpretation application scenarios	Key data assets
Preparation stage	Demand planning	Equipment selection traceability (check compatibility · historical failure rate of the same model); Supplier identification prefix performance correlation; Purchase order binding	Technical specification documents, supplier ratings, purchase lists
Preparation stage	Procurement configuration	Standardized configuration template association; Supplier SLA binding; Spare parts list association	Configuration template library, SLA agreements, spare parts lists
Delivery stage	Pre-installation delivery	Factory pre-write unique identification binding serial number/MAC; Digital delivery package association; Logistics tracking	Pre-configured images, digital twin models, logistics status
Delivery stage	Receipt acceptance	Barcode scanning for arrival verification of serial number/firmware version; Write back of acceptance result to identification file	Serial number lists, acceptance confirmation forms
Deployment stage	Shelf deployment	Intelligent inspection (scan the list · automatic recording); Fault diagnosis (parameters/historical/solutions); Predictive maintenance (health model); Configuration version binding · change impact analysis; Performance and energy efficiency statistics by identification	Cabinet location maps, configuration backups, initialization reports, health models
Deployment stage	Test delivery	Test results/performance benchmark binding; Monitoring access verification association	Test reports, performance benchmarks, monitoring validations
Operation and maintenance stage	Monitoring and alarm	Real-time monitoring indicators binding; Alarm - identification association for quick location of responsible equipment	Monitoring indicators, alarm records, logs
Operation and maintenance stage	Maintenance management	Preventive maintenance plan binding; Firmware/configuration backup/backup part replacement record association with identification	Maintenance plans, configuration backups, spare parts replacement records
Operation and maintenance stage	Change management	Hardware/configuration change binding; Migration/downlisting trigger identification status update; RCA association	Change orders, RCA reports, rollback plans
Retirement stage	Data destruction	Destroy process binding; Automatically generate destruction proof · full audit traceability (NIST)	Data destruction certificates, media destruction records
Retirement stage	Equipment disposal	Retirement approval association; Residual value assessment based on historical data; Asset write-off; Permanent preservation of disposal records	Retirement applications, residual value assessments, asset write-off vouchers

3.4. Effectiveness Dimension and Measurement Framework

Based on the application scenario mapping, this paper further summarizes eight quantifiable effectiveness dimensions that enable the empowerment of IT asset management through identification and resolution, and assesses their coverage intensity in each lifecycle stage, forming an effectiveness measurement framework (Table 2). The coverage intensity is divided into three levels: "strong" (mechanism-native guarantee), "medium" (reachable in some links), and "weak/no" (not in the main scope). This framework serves as both a demonstration tool for the value of the solution and a baseline for the subsequent assessment of pilot program effectiveness.

Table 2. Dimension of Identification Analysis Effectiveness × Lifecycle Stage Coverage Matrix

Effectiveness dimensions	Early stage	Delivery	Deployment	Operations and Maintenance	Retirement
Consistency rate of accounts and physical inventory	Medium	Medium	Strong	Strong	Strong
Completeness rate of full-chain traceability	Strong	Strong	Strong	Strong	Strong
Uniformity rate of cross-system identities	Strong	Strong	Strong	Strong	Strong
Efficiency of inventory inspection and patrol	—	—	Strong	Strong	Medium
Time taken for fault location and troubleshooting	Medium	—	Strong	Strong	—
Automation rate of operation and maintenance	—	—	Strong	Strong	—
Reusability rate of idle assets	—	—	Medium	Medium	Medium
Coverage rate of compliance audits	Medium	—	Medium	Medium	Strong

Based on the similar RFID/identification-based asset management practices in the industry [19-20], the framework-based expected target ranges for each dimension can be provided: ① The dynamic consistency rate of accounts and physical inventory will increase from the traditional manual ledger's 80% - 90% to > 98%; ② The efficiency of asset inventory (single inventory working hours) will decrease by 50% - 70%; ③ The completeness rate of full-chain traceability for key links will approach 100%; ④ The cross-system identity uniformity rate (ERP/CMDB/fiscal ledger identity mapping coverage rate) will be > 95%; ⑤ The time for fault location and troubleshooting will decrease by 30% - 50%; ⑥ The automation rate of operation and maintenance (predictive maintenance/automatic work order ratio) will increase by 20% - 40%; ⑦ The reuse rate of idle assets (from a group unified perspective) will increase by 10% - 30%; ⑧ The compliance audit coverage rate (destruction/disposal process) will approach 100%. These are the framework-based expected ranges based on similar practices. The final empirical values will depend on the scale of the pilot and data quality, and will be verified with real pilot data in subsequent research. [44]

4. Application Architecture and Implementation Pathway

4.1. Overall Application Architecture

A digital mainline architecture centered on the identification resolution system is constructed, as shown in Figure 4. It is divided into four layers from bottom to top. The sensing and identification layer attaches QR codes or RFID tags carrying unique identification resolution codes to each IT device; the network and resolution layer connects to the national top-level nodes and industry secondary nodes, and deploys enterprise-level identification resolution nodes, responsible for identification registration, resolution and management; the platform and data layer builds a unified IT asset management platform, with its core functions including full lifecycle management of identification, connection with enterprise nodes, and data connectors with backend business systems (ERP, SRM, CMDB, ITSM). The platform does not replace the original system, but acts as a "data bus" and "association engine"; the application and presentation layer provides Web management consoles based on identification codes, mobile scanning APPs, and data visualization dashboards for different roles such as asset managers, operation engineers, procurement and finance personnel, etc. [4, 16-17].

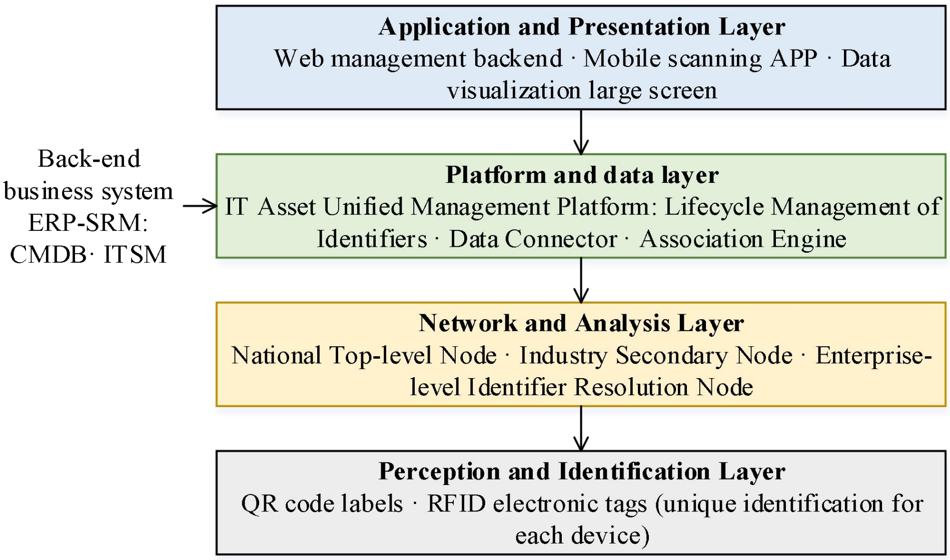

Figure 4. Application Architecture of IT Asset Full Life Cycle Management Platform Based on Identifier Resolution (Four Layers)

4.2. Design of Identification Coding Scheme

Under the national top-level coding rules, customizable object classification codes and serial numbers can be set, forming a coding scheme that both complies with national standards and meets the enterprise's refined internal management requirements. The recommended structure is "national code - industry code - enterprise code/object classification - serial number", for example, following the 88.101.xxx/IT.SRV.xxxxxx specification, where IT represents the IT asset category, SRV represents the server (NET represents the network device), and the following is the instance serial number [6,12]. This scheme maintains global uniqueness and authority while retaining the flexibility of classification management within the enterprise, and can seamlessly adapt to the complex IT asset categories of group enterprises [4,29].

4.3. Key Implementation Steps

(1) Standard setting and coding design: Establish a cross-departmental working group to formulate the "IT Equipment Identification and Coding Specification", clearly defining classification rules and serial number generation logic. (2) Platform construction and system integration: Develop or purchase an asset management platform with identification management capabilities, focusing on developing deep integration interfaces for systems such as SAP ERP and CMDB to achieve automatic data synchronization. (3) Business process reengineering and pilot implementation: Select new data center projects or certain types of newly purchased equipment as pilot cases, reengineering the closed-loop process from procurement application (i.e., pre-generation of identification codes), arrival inspection and warehousing, shelving deployment, daily operation and maintenance to retirement, and ensuring barcode scanning operations and data write-back at each stage. (4) Comprehensive promotion and deep application: Promote the successful model to the existing and incremental IT assets of the entire group; based on the accumulated full life cycle data, develop intelligent applications such as asset health evaluation, full life cycle cost analysis, and predictive maintenance [16-17, 32].

4.4. Potential Challenges and Countermeasures

(1) Resistance to system transformation: Adopting an "incremental" transformation strategy, by developing plug-in microservices to interface with the existing system, it avoids large-scale invasive modifications to the core system. (2) User confusion in the initial coexistence of multiple codes: Through a unified identification carrier (such as labels with both QR codes and memorable aliases printed), strengthening training to ensure that scanning is the most efficient path for each business scenario, and guiding users to change their habits. (3) Data quality and governance: From the very beginning of implementation, establish strict data quality verification rules to ensure that the collected data at key nodes such as data entry and asset allocation is accurate and complete [3-4].

4.5. Security and Permission Model

The design of "separation of encoding and data" naturally aligns with data security requirements: the parsing returns data addresses rather than the data itself. Enterprise nodes control the accessible data range within the authorized scope and implement the principle of "data remaining within the domain" [4, 13]. On top of this, it is recommended to build a three-level parsing permission model: (1) Complete internal parsing within the enterprise - asset managers and operation personnel can read and write the full set of associated data within their responsibilities; (2) Limited cross-organizational parsing within the group - the minimum view is granted based on roles, supporting unified management of the group and the reuse of idle assets, but without exposing sensitive configurations; (3) Limited parsing for external collaborators - only public attributes (such as equipment type, compliance status) can be parsed, and sensitive data does not leave the domain [4, 13]. A full audit mechanism for parsing logs and status change logs is also recommended to be built to meet compliance requirements such as GB/T and NIST, and to integrate with the enterprise's existing 4A/IAM system to avoid the new risk of "identification islands" replacing "data islands".

5. Case Verification - Taking a Large Energy Enterprise as an Example

In early 2021, a large energy enterprise took the lead in building a secondary node of the industrial internet identification resolution system for the petrochemical industry, providing identification resolution public services to the entire industry [16,33]. This practical background made this enterprise a typical scenario for verifying the "single code + main data collaboration" path in this paper: On the one hand, the enterprise has established a mature main data system for materials, which is highly compatible with the "mapping rather than substitution" collaborative method; on the other hand, its IT assets are widely distributed, diverse in categories, and strictly managed, and urgently need cross-system identity unification and full life cycle traceability [31-32].

At the pilot level, it is recommended to select a newly built data center or a certain type of newly purchased network equipment as the entry point: generate identification codes in the procurement application stage and bind the identification with the serial number, MAC address in the factory pre-configuration process; through deep integration with SAP ERP and CMDB, achieve a barcode closed loop and automatic data re-writing for each link from storage, shelving, relocation, and retirement; maintenance personnel can scan the barcode on-site to obtain complete equipment information and create work orders, and link the real-time performance data of the monitoring system. This path extends the existing main data system of materials into a "digital main line" with the minimum renovation cost.

In the organizational and data governance aspect, it is recommended to simultaneously establish identification main data management norms and cross-domain resolution permission models: clarify the entire life cycle of identification application, activation, deactivation, and cancellation, standardize the quality verification rules for each business system's field rewrites, and define the data range that external collaborators can access through the identification under the principle of "data remaining within the domain" [4,13]. Only by taking governance first can the integrated benefits brought by identification resolution be continuously and safely released, avoiding the new problem of "identification islands" replacing "data islands".

At the effectiveness level, based on the effectiveness framework in Section 3.4, this paper distinguishes two types of effectiveness: the first is the "achievable expected effectiveness" at the architecture level - cross-system identity unification, full chain traceability, and consistent account and reality, which is guaranteed by the "single code + main data collaboration" mechanism natively (the corresponding dimensions in Table 2 are all "strong" coverage during the deployment/operation/retirement stages); the second is the quantified indicators that need to be verified through pilot - such as account and reality consistency rate > 98%, inventory efficiency + 50% - 70%, troubleshooting time - 30% - 50% (see Table 2 expected range). These quantified values are the frameworkal expectations based on similar RFID/identification asset management practices [19-20], and the empirical indicators after large-scale promotion need to be further evaluated with the real data from the pilot. This paper focuses on architecture and feasibility demonstration, and the relevant empirical data will be the key supplement for subsequent research. [43,44]

6. Conclusion and Outlook

This paper demonstrates the feasibility and applicability of implementing the full life cycle management of IT assets for group enterprises based on the industrial internet identifier resolution single-code scheme. By using the identifier resolution code as the sole primary key and integrating it with the existing intelligent association of material master data, this scheme adopts a lightweight approach of "mapping rather than replacing", achieving maximum data integration and collaboration benefits with the minimum cost of modification. The research systematically reviews the technical foundation and standardization progress of the identifier resolution system, and presents application scenarios mapping (Table 1), a quantifiable effectiveness dimension framework (Table 2), and a four-layer implementation architecture. An example of a large energy enterprise that led in the construction of the secondary node of the petrochemical industry is provided for illustration.

Future research and practice should focus on: (1) Patent protection and standardization of coding details, forming replicable "energy enterprise solutions" and "reference paradigms" [14, 16]; (2) Engineering implementation and performance optimization with deep integration with specific enterprise business systems; (3) Intelligent application innovation based on full-chain data, such as asset health evaluation, AIOps, and the digital twin derivative on the platform shown in Figure 4 [28, 21-25]; (4) Deepening of security and privacy governance, improving the permission model and audit mechanism for cross-domain resolution under the principle of "data remaining within the domain" [4, 13]. This paper provides a forward-looking and operational theoretical framework and practical reference for the digital and intelligent management of IT assets of large group enterprises, and the proposed path can also be used as a reference for other group enterprises with mature master data systems.

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